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Sustainable Consumption: The Contribution of Research

Workshop, 10-12 February 2005
Gabels Hus, Oslo

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The Contribution of Research

Workshop, 10-12 February 2005, Gabels Hus, Oslo

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Overview

The implementation of sustainable consumption requires research to assess the environmental impacts of different lifestyles, to develop proposals for changes in consumption patterns, to deliver insights into the factors that shape consumption, to develop and evaluate scenarios, and to study and evaluate efforts of implementation. It requires research to deliver tools and information to policy makers, industry and the interested public. Such ambitious goals can only be achieved through an international, collaborative research effort. This seminar takes stock of the current research in order to develop a common research agenda and a proposal for a research infrastructure, consisting of common classifications, protocols, databases, and assessment methods. The first part of the workshop focuses on the assessment of household environmental impacts, the understanding of consumption patterns and consumer behaviour, examples of sustainable consumption, acceptability of policy measures, and scenario analysis.

The second part of the workshop discusses the development of a common, interdisciplinary research approach and a common research agenda. This effort may include the development of common data bases, data formats, models, protocols, indicators and assessment methods so that research becomes more cumulative and results can be more easily compared. It also requires that researchers from different disciplines develop a common platform, which includes a set of core research questions and common publication channels. This workshop is a first step towards developing the proposal for such a research infrastructure, as well as charting out a plan of action to put it in place.

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Impact Assessments

Analysis of environmental impacts of consumption in Finland

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Introduction

In defining consumption and its constituents two approaches based on the European national accounts, ESA1995 are used. First, consumption is defined as consumption expenditure of households and it is partitioned according to the COICOP classification. Secondly, an extended consumption concept is used, actual individual consumption including the individual consumption expenditures of government and private non-profit institutions, too. The partition of actual individual consumption is based on the basic needs approach.

It is argued that actual individual consumption provides, besides a more theoretically sound framework, also a more unbiased international comparison between countries with different institutional arrangements in welfare provision.

For analysis of environmental impacts, wide arsenal of the Finnish physical flow accounts 1999 is used to introduce seven impact categories: total material requirement, primary energy use, waste generation, greenhouse potential, acidifying potential, ground-level ozone and eutrophication.

Total environmental impacts of consumption with two alternative consumption definitions and classifications are estimated for the year 1999 using input-output model.

Estimates of the environmental impacts of the structural chance of consumption are provided by applying the environmental impact intensities of the year 1999 at a rather disaggregate, 57 consumption goods classification for which time-series 1975 – 2003 are available for consumption expenditure of households and which can be extended to the actual individual consumption.

The material is based on a pilot work for the Finnish Ministry of Environment.

Consumption in national accounts

The place of the household consumption in national accounts turns up from Table 1 where gross domestic product (GDP) is constructed from the expenditure side. Consumption expenditure of households takes about a half of GDP. Often we speak about private consumption expenditure which contains furthermore consumption expenditure of non-profit institutions. This is because the non-profit institutions, which contain e.g. pariches, political and civil organisations, occupational organisations, athletic clubs etc., are thought to produce services benefiting households free of charge.

Table 1. *Household consumption and the structure of the Finnish GDP in national accounts 2003, million euros and percent*

Gross domestic product by expenditure approach	M€	%
1 Final consumption expenditure	106 362	75
Private consumption expenditure	74 552	52
- consumption expenditure of households	71 475	50
- consumption expenditure of non-profit institutions	3 077	2
Government consumption expenditure	31 810	22
- individual consumption expenditure	20 608	14
- collective consumption expenditure	11 202	8
2 Gross fixed capital formation	25 898	18
- private gross fixed capital formation	21 797	15
- government gross fixed capital formation	4 101	3
3 Changes in inventories	411	0
4 Exports of goods and services, net	9 293	7
Exports of goods and services	53 056	37
Imports of goods and services (-)	43 763	31
5 Statistical Discrepancy	554	0
6 Gross domestic product at market prices (1+2+3+4+5)	142 518	100

The concept of consumption expenditure of households can be specified moreover by Table 2. In national accounts the consumption expenditure of households by consumption commodities is accounted in accordance with the concept of “consumption expenditure of households in Finland” which also contains the consumption of foreign households in Finland but don’t include the expenditures of Finnish tourists abroad. The concept is then corrected at the total level by adding the consumption expenditure of Finnish households abroad and by subtracting the expenditure of foreign households in Finland, after which the concept “(resident” consumption expenditure of households” of Table 1 is reached. However, as Table 2 shows the share of tourist expenditures are rather small.

Table 2. *Concepts of consumption expenditure of households in national accounts and its structure in the year 2003*

	M€	%
1 Consumption expenditure of households in Finland	71 736	100
2 Consumption expenditure of resident households in the rest of the world	1 395	2
3 Consumption expenditure of non-resident households in Finland	1 656	2
4 Consumption expenditure of households (1+2-3)	71 475	100
5 Consumption expenditure of non-profit institutions	3 077	4
6 Private consumption expenditure (4+5)	74 552	104

7 Individual consumption expenditure of general government	20 608	28
8 Total individual consumption expenditure =Actual individual consumption (6+7)	95 160	132

Table 2 also presents the extension of the consumption expenditure of households into the concept ”actual individual consumption” which is included into European national accounts since 1995. The actual individual consumption includes consumption expenditure of non-profit institutions and individual consumption expenditures of general government. The individual consumption expenditure of general goverment contains public services for households from among which most important are education and health and social services. – Collective consumption expenditure on the other hand covers general administration, military expenditures and maintenace of public infrastructures.

Actual individual consumption would be a better welfare indicator than consumption expenditures of households – or GDP. Also in international comparisons it would give more correct picture on the econimc welfare, because in different countries different institutional arrangement result that the different share of welfare services are provided by means of public institutions and funded by taxation and different shares by direct expenditures of households.

Time series of consumption expenditure of households and of actual individual consumption are provided by the Finnish national accounts uniformly from the year 1975. Time series of Finnish GDP, consumption expenditure of households and actual individual consumption at constant 2000 prices in the years 1975 – 2003 are presented in Figure 1.

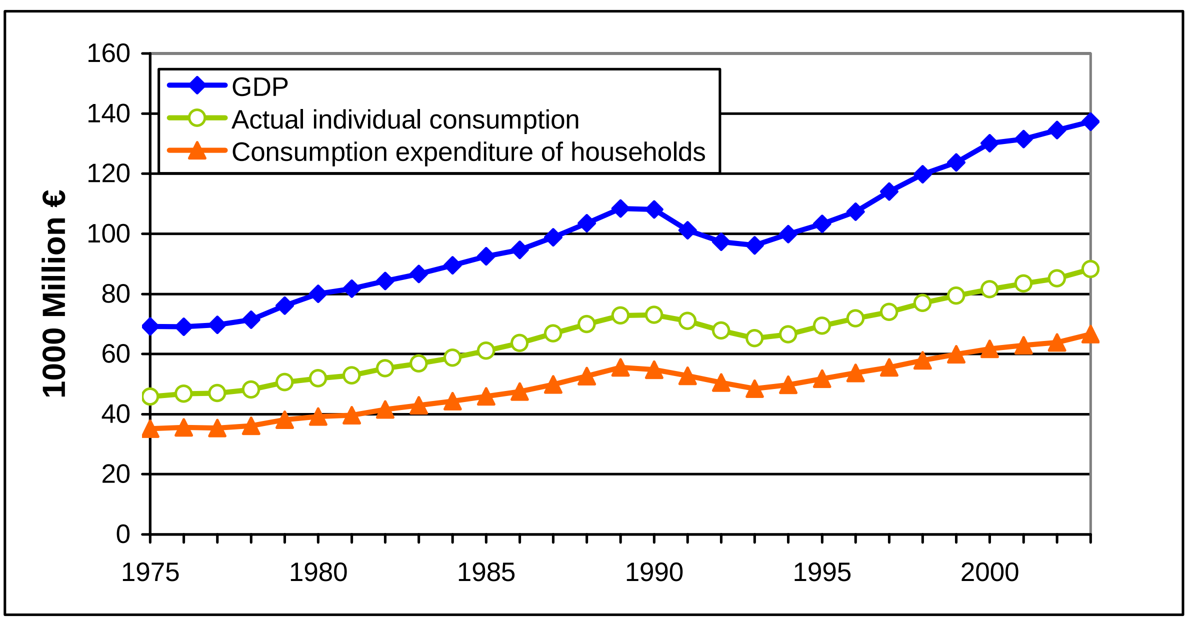

Figure 1. *Development of the volume of Finnish GDP, consumption expenditure of households and actual individual consumption 1975 – 2003, 1000 million euros at 2000 prices*

Table 3 shows the average yearly growth rates of the volumes of GDP, consumption expenditure of households and actual individual consumption in long term, 1975 – 2003, and in the last decade of the study period. Table shows that the consumption expenditure of households has been grown somewhat slower than GDP and that actual individual consumption grew a little bit faster than consumption expenditure of household in the lon run but turned to grow slower at the last decade.

Table 3. *Average yearly growth rates of the volume of GDP, consumption expenditure of households and actual individual consumption in different time periods*

	1975 - 2003	1993 - 2003
GDP	2,5	3,6
Consumption expenditure of households	2,3	3,2
Actual individual consumption	2,4	3,1

In the division of consumption commodities national accounts use classification by purpose, COICOP. COICOP is hierarchical classification system where main division consists of 12 classes and in the Finnish national accounts most detailed level is 5-number level on consisting of 152 commodity classes on which the uniform time series are provided from the year 1975.
In this study at the calculation level division into 57 commodities, mainly 3-number level of COICOP is used which in tables and diagrams are further aggregated into 15 commodity groups.
The classification of consumption expenditures of households, the expenditure shares and growth of the volume are presented in Table 4.

Table 4. *Consumption expenditure of households by commodity group in the year 2003 million euros at 2000 prices and growth 1990 – 2003, per cent*

		COICOP	Consumption expenditure M€, 2000 hin.	Distribution %	Growth 1990 - 2003 %
1	Food and non-alcoholic beverages	C01	8 472	12,7	24
2	Alcoholic beverages and tobacco	C02	3 945	5,9	4
3	Clothing and footwear	C03	3 299	4,9	16
4	Housing	C041-C44	15 342	22,9	43
5	Electricity and heating fuels	C045	1 340	2,0	-1
6	Furnishings and household maintenance	C05	3 402	5,1	25
7	Health	C06	2 614	3,9	39
8	Purchase of vehicles	C071	3 607	5,4	10
9	Operation of personal transport equipment	C072	4 144	6,2	4
10	Transports services	C073	1 434	2,1	2
11	Communication	C08	2 510	3,7	306
12	Recreation and culture	C09	7 524	11,2	26
13	Education	C10	289	0,4	80
14	Hotels, cafes and restaurants	C11	4 403	6,6	2

15	Miscellaneous goods and services	C12	4 609	6,9	18
	Total		66 934	100,0	24

In division of the actual individual consumption a basic needs approach is applied in this study. The consumption is divided into six categories: housing, food, welfare, moving, leisure and others. Basic need categories have been formed from COICOP classification as in Table 5.

Table 5. Formation of basic need categories from COICOP classification

Basic Needs	COICOP	
1 Housing	C04	Housing
	C05	Furnishings and household maintenance
2 Food	C01	Food and non-alcoholic beverages beverages and tobacco
	C1111a	Food catering services
	C1112	Cafeterias
3 Welfare	C06	Health
	C10	Education
	C124	Social protection
4 Moving	C07	Transport
5 Leisure	C02	Alcoholic beverages and tobacco
	C09	Recreation and culture
	C1111b	Alcohol catering and other services
	C112	Accommodation services
	C122	Prostitution
	C123	Personal services and effects n.e.c.
	C127	Other services n.e.c.
6 Others	C03	Clothing and footwear
	C08	Communications
	C121	Personal hygiene and beauty care
	C125	Insurance
	C126	Financial services n.e.c.

Table 6 shows how the actual individual consumption is formed from consumption expenditures of households and government and non-profit institutions.

Table 6. *Actual individual consumption by basic need in the year 2003 million euros and growth 1990 – 2003, per cent*

	Consumption expenditure of hh.	Gov. and n-pi expenditure	Total actual individual consumption	Distribution %	Growth 1990 – 2003 %
Housing	20 084	41	20 125	23	36
Food	10 591	0	10 591	12	25
Welfare	3 795	18 989	22 784	26	20
Moving	9 185	36	9 221	10	6
Leisure	14 617	2 530	17 147	19	13
Others	8 662	0	8 662	10	40
Total	66 934	21 596	88 530	100	22

Environmental loads of industrial products and consumption commodities

Environmental loads of the production and consumption processes of the Finnish economy for the year 1999 are provided by the physical flow accounts of Finland (Mäenpää 2004).

Environmental loads are broken down into two main groups, input factors and output factors:

- Input factors
  - Material input
  - Primary energy
- Output factors
  - Final waste
  - Greenhouse gases
  - Acidifying emissions
  - Emissions forming ground-level ozone
  - Discharges causing eutrophication of water bodies

The contents and measurement of the components are as follows.

Material input is measured on the industry level as direct material input of intermediate products and of raw materials extracted by the industry from nature. The total material input of products and national product components is calculated using only material input external to the economy and the sum of raw materials and unused extraction from domestic nature and direct and indirect material inputs of imports. Material inputs are measured as mass, million kilograms, Mkg.

Primary energy is measured as the net calorific value of used fuels and as the energy value of electricity purchased from outside and of energy sources used for generation of heat. The measurement unit is terajoule, TJ.

Final waste is the amount of generated waste going straight to landfills or waste management. Final waste is measured as mass, million kilograms, Mkg.

Greenhouse gas emissions are formed by emissions of mineral-based carbon dioxide, methane and nitrous oxide into air. Their greenhouse effects are calculated in carbon dioxide equivalent amounts, where the weighting factor of methane is 21 and that of nitrous oxide 310. The unit is million kilograms of carbon dioxide equivalents, Mkg CO_2 eqv.

Acidifying emissions are formed by emissions of sulphur dioxide, nitrogen oxides and ammonia into air. They are measured as their acidifying effects in equivalent amounts with sulphur dioxide, in which case the weighting factor of nitrogen oxides is 0.4 and that of ammonia 1.6.

Ground-level ozone has a detrimental effect on plants. Emissions generating ground-level ozone are methane, nitrogen oxides, carbon monoxide and non-methane hydrocarbons. The effect of emissions on ozone formation is measured by POCP values (Photochemical Ozone Creation Potential) where the weight of emissions is 0.003 for methane, 0.727 for nitrogen oxides, 0.064 for carbon monoxide and 0.209 for non-methane hydrocarbons.

Discharges causing eutrophication of water bodies are formed by discharges of phosphorus and nitrogen to waters and water deposits of nitrogen oxides and ammonia. Discharges causing eutrophication are measured in phosphorus equivalent (PO_4) amounts, in which case the general weighting factors used are total type 0.42, total phosphorus 3.06, nitrogen oxides 0.008 and ammonia 0.023. In addition, for total phosphorous and nitrogen are used industry-specific correction factors that take account of the variation of phosphorus and nitrogen components usable for algae.

The weighting factors of emissions are based on those used in the Finnish Environment Institute's life cycle analyses (Seppälä 1999).

In the calculation level of the physical flow accounts the economy has divided into 150 industries. In Table 7 the main economic quantities and environmental loads by industries are presented were industries are aggregated for presentation purposes into 30 in number. Beneath the industries there are direct loads of the final use processes. By dividing environmental loads by the value of output we get the direct load coefficients of (industry) products with units kg/€, g/€ or MJ/€

For calculating total environmental loads embodied in products we use hybrid input-output model as follows. Let P be load type x industry matrix of direct environmental load coefficients of industries and let A^D be the industry x industry €/€ domestic intermediate input coefficient matrix and A^M intermediate input matrix of imports. Then the matrix product $P(I-A^D)^{-1}$ gives total embodied domestic environmental loads per unit value of each industry product. If we assume – as we do in this study – that the imported products are produced abroad by the same technology and same environmental unit loads as corresponding domestic industries then the calculation can be extended to matrix product $P(I-A^D - A^M)^{-1}$ which now gives the embodied loads of unit products both at home and abroad. The indirect loads abroad can be obtained by difference $P(I-A^D - A^M)^{-1} - P(I-A^D)^{-1}$.

For calculating the environmental loads of consumption commodities we need furthermore industry x commodity transformation matrix T which transforms the industry products valued at basic prices to consumption commodities valued at market prices. In matrix T products of same industry may go into several consumption commodity groups and same commodity may include products from several industries. Matrix T includes the trade and transportation margins for each consumption commodities and thus the environmental loads of distribution stage are also taken into account.

The whole input-output model for calculating the environmental loads per unit consumption commodity is then $P(I-A^D - A^M)^{-1}T$. Direct environmental loads of households due to consuming those commodities have to be added, however, into these loads, too.

The input-output model used is rather detailed containing 139 industries and 53 consumption commodity groups. One further assumption implied by the input-output model is that all products of an industry are produced using the same average technology and generating same average environmental loads per unit product. Use of disaggregate i/o-model and aggregating the results only at the final stage of calculation reduces this aggregation bias.

Table 7. *Economic outcomes and environmental loads by industry in Finland 1999 (Mäenpää 2004)*

	Output M€	Value added M€	DMI Mkg	Primary energy TJ	Final waste Mkg	GHG emiissions Mkg CO_2 eqv	Acidifying emissions 1000 kg SO_2 eqv	Ground-level ozone 1000 kg POCP eqv	Eutrophi-cation 1000 kg PO_4 eqv
1 Agriculture, hunting and fishing	4 120	1 534	39 727	38 749	173	11 834	91 504	19 471	19 328
2 Forestry, logging etc	2 931	2 316	50 158	4 530	0	387	2 522	4 514	724
3 Mining of energy minerals	261	97	9 377	165	3	1 406	9	9	138
4 Other mining and quarrying	605	191	101 037	7 402	11 207	216	542	253	8
5 Manuf of food products	8 266	1 936	9 165	25 823	96	675	1 208	855	51
6 Manufacture of textiles etc	1 489	592	151	3 694	8	90	160	116	8
7 Manuf of wood and wood products	4 908	1 262	28 345	29 602	58	634	1 288	3 021	23
8 Manuf of pulp and paper .	13 453	4 234	64 250	374 179	1 372	4 586	23 635	22 212	1 355
9 Publishing, printing etc	3 900	1 568	627	4 468	12	33	70	1 280	1
10 Manuf of coke & petroleum refin.	2 533	175	14 245	33 011	41	3 424	7 964	10 537	59
11 Manufacture of chemicals etc	4 612	1 639	8 351	57 864	1 760	2 524	11 883	6 509	184
12 Man. of rubber & plastic products	2 192	935	615	8 149	10	64	178	266	7
13 Manuf of mineral products	2 004	824	13 548	19 679	197	1 963	1 834	1 374	14
14 Manufacture of basic metals	5 229	976	13 796	99 422	927	5 237	12 145	3 677	223
15 Manufacture of metal products	3 938	1 597	1 293	8 243	16	187	162	684	25
16 Manuf of machinery & equipment	8 735	2 753	922	9 497	57	105	173	444	2
17 Manuf of electrical equipment	18 482	6 108	510	7 812	50	28	56	379	1
18 Manuf. of transport equipment	2 952	936	329	4 600	18	57	170	644	1
19 Manufacturing n.e.c.	1 461	583	338	2 723	9	27	47	535	1
20 Recycling	96	19	1 194	181	79	4	4	6	0
21 Electricity, gas & water supply	4 214	2 199	15 156	2 062	355	21 582	43 917	25 840	284
22 Building	11 498	4 768	31 099	11 037	1 258	772	3 501	8 664	65
23 Civil engineering	3 614	1 343	77 200	8 988	11	1 015	5 305	9 425	93
24 Wholesale and retail trade	19 888	11 133	719	48 378	321	1 153	3 247	5 686	54
25 Hotels and restaurants	4 095	1 514	781	14 825	185	92	88	131	1
26 Transport & telecommunication	17 914	10 925	3 867	144 800	52	10 209	64 095	102 058	1 004
27 Dwellings	13 090	9 202	996	104 712	15	710	823	3 151	11
28 Public administration & services	28 595	19 056	625	53 791	200	530	640	902	6
29 Sewage and refuse disposal	862	486	3 401	2 798	16	2 507	81	411	4 929
30 Other service activities	26 942	15 268	348	42 326	207	239	242	605	2
Household consumption			10 351	278 840	1 438	9 132	20 753	72 138	1 818
Government consumption									
Capital formation			123 489		1 070				
Exports			37 875		370				
Total	222 880	106 171	663 884	1 452 350	21 593	81 423	298 246	305 797	30 421

Share of household consumption on the total environmental load of the economy

In Table 8 the total supply and use balances of the Finnish economy and its environmental loads for outlining the environmental loads of household consumption as a part of the total economy. Origins of the economic monetary flows and environmental loads divided by domestic sources and imports from abroad are found in the supply side. The final use side is divided according to the national accounts into private and government consumption, capital formation and exports. The consumption expenditure of households is the most part of the private consumption and the share of the non-profit institutions is very small.

Table 8. *The total balances of monetary flows and environmental loads of Finnish economy 1999 (Mäenpää 2004)*

	Monetary flows		Total material requirement		Primary energy		Final waste	
	Mrd €	%	Mrd kg	%	PJ	%	Mrd kg	%
Supply								
Domestic	120	77	262	53	1 452	72	22	20
Imports	35	23	232	47	557	28	84	80
Total supply	155	100	494	100	2 009	100	106	100
Final use								
Private consumption	60	39	102	21	780	39	18	17
Government consumption	26	17	31	6	120	6	4	4
Capital formation	23	15	113	23	183	9	16	15
Exports	45	29	248	50	926	46	68	64
Total final use	155	100	494	100	2 009	100	106	100

	Green house gases		Acidifying emissions		Ground level ozone		Eutrophication	
	Mrd kg	%	Mkg	%	Mkg	%	Mkg	%
Supply								
Domestic	81	62	298	67	306	76	30	66
Imports	50	38	145	33	98	24	16	34
Total supply	132	100	443	100	404	100	46	100
Final use								
Private consumption	53	40	186	42	183	45	25	55
Government consumption	9	7	25	6	19	5	3	7
Capital formation	14	11	41	9	38	9	3	8
Exports	55	42	192	43	164	41	14	31
Total final use	132	100	443	100	404	100	46	100

Environmental loads of consumption expenditure of households 1999

The basic tables of environmental load tables of consumption expenditure of households calculated by the input-output model are presented in Tables 8 and 9. Under the row Total the consumption commodities are divided into goods and services, but two service groups, however, housing and transport services are taken separate. Because many consumption commodity groups contain both goods and services, the division into goods and services has been done from detailed classification of 57 commodities of the calculation base level. Table 10 presents the per cent distributions of the environmental loads over the commodity groups.

The environmental load coefficients of consumption commodity groups or environmental load per one euro of consumption expenditure are illustrated in Figures 2 and 3or total material requirement and green house gases. – Same type of diagrams could be easily calculated for all load types from the data of Tables 8 and 9.

Table 8. *Consumption expenditure of households and material, primary energy and waste loads by consumption commodity group 1999*

		Consumption expenditure	Direct material input	Total material requirement			Primary energy			Final waste		
				Mkg			TJ			Mkg		
		M€	Mkg	Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total
1	Food and non-alcoholic beverages	7 676	3 008	4 052	6 062	10 114	54 434	28 537	82 971	1 088	2 427	3 516
2	Alcoholic beverages and tobacco	3 252	499	577	861	1 438	7 713	4 163	11 875	84	380	463
3	Clothing and footwear	2 888	60	609	1 194	1 803	8 149	12 558	20 707	140	753	893
4	Housing	13 578	0	13 088	6 017	19 105	128 214	11 551	139 765	545	1 794	2 339
5	Electricity and heating fuels	1 295	1 700	3 797	7 431	11 228	196 022	1 655	197 677	133	121	254
6	Furnishings and household maintenance	2 767	228	1 236	2 773	4 008	13 098	14 722	27 820	327	1 875	2 202
7	Health	2 106	15	631	633	1 264	6 593	4 464	11 056	74	496	570
8	Purchase of vehicles	2 932	80	261	1 199	1 460	3 584	9 176	12 760	84	658	743
9	Operation of personal transport equipment	3 541	2 657	991	5 281	6 272	102 340	10 640	112 980	234	942	1 175
10	Transports services	1 374	1	711	733	1 443	18 626	11 073	29 699	39	230	269
11	Communication	1 821	13	1 474	503	1 977	4 770	2 271	7 041	47	281	328
12	Recreation and culture	6 588	1 017	4 273	3 345	7 619	27 873	17 742	45 616	623	1 976	2 600
13	Education	305	0	67	68	135	1 274	195	1 469	7	23	29
14	Hotels, cafes and restaurants	3 918	561	1 709	1 962	3 671	29 546	8 803	38 350	303	710	1 014
15	Miscellaneous goods and services	3 898	511	1 783	27 140	28 923	13 973	8 410	22 382	635	1 079	1 714
	Total	57 939	10 351	35 258	65 201	100 459	616 209	145 961	762 170	4 364	13 744	18 108
	Goods	29 442	9 789	15 990	53 812	69 802	406 378	104 501	510 879	3 211	9 908	13 119
	Housing	13 578	0	13 088	6 017	19 105	128 214	11 551	139 765	545	1 794	2 339
	Transport services	1 374	1	711	733	1 443	18 626	11 073	29 699	39	230	269
	Other services	13 545	561	5 469	4 640	10 109	62 991	18 836	81 827	569	1 812	2 381

Table 9. *Environmental loads on air and waters by consumption commodity group 1999*

		GHG emissions Mkg CO_2 ekv			Acidifying emsissions 1000 kg SO_2 ekv			Ground-level ozone 1000 kg PCOP ekv			Eutrophication 1000 kg PO_4 ekv		
		Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total
1	Food and non-alcoholic beverages	7 560	4 233	11 793	46 686	22 182	68 868	14 932	7 263	22 196	9 349	4 234	13 583
2	Alcoholic beverages and tobacco	578	482	1 061	2 383	1 668	4 051	1 340	788	2 129	379	255	634
3	Clothing and footwear	508	892	1 400	1 517	2 437	3 954	1 372	1 567	2 938	207	274	481
4	Housing	4 720	1 278	5 998	8 741	2 606	11 346	9 782	1 737	11 519	3 444	261	3 705
5	Electricity and heating fuels	6 461	622	7 083	10 412	699	11 111	15 945	527	16 472	170	83	253
6	Furnishings and household maintenance	650	862	1 513	1 952	2 217	4 170	1 851	1 561	3 412	217	188	405
7	Health	410	354	764	1 153	963	2 117	979	611	1 590	150	92	242
8	Purchase of vehicles	217	506	724	654	1 271	1 925	617	1 054	1 671	91	113	204
9	Operation of personal transport equipment	7 910	2 868	10 779	23 048	2 790	25 838	66 908	2 742	69 651	585	393	978
10	Transports services	1 324	1 116	2 440	5 011	6 838	11 850	8 196	9 646	17 842	138	187	325
11	Communication	309	215	523	949	553	1 502	772	336	1 107	100	65	165
12	Recreation and culture	2 007	1 544	3 551	7 974	4 956	12 930	4 554	2 740	7 294	1 246	659	1 904
13	Education	67	23	89	170	57	227	138	36	174	20	7	27
14	Hotels, cafes and restaurants	1 746	995	2 741	10 337	4 741	15 078	9 646	2 855	12 501	959	698	1 657
15	Miscellaneous goods and services	821	691	1 512	2 393	1 864	4 257	1 952	1 222	3 173	288	193	481
	Total	35 288	16 682	51 970	123 380	55 843	179 223	138 984	34 685	173 669	17 345	7 700	25 045
	Goods	25 482	12 191	37 673	93 655	39 049	132 704	106 655	18 726	125 380	12 137	6 239	18 376
	Housing	4 720	1 278	5 998	8 741	2 606	11 346	9 782	1 737	11 519	3 444	261	3 705
	Transport services	1 324	1 116	2 440	5 011	6 838	11 850	8 196	9 646	17 842	138	187	325
	Other services	3 763	2 097	5 860	15 974	7 350	23 323	14 352	4 576	18 928	1 626	1 013	2 639

Table 10. *Distribution of consumption expenditure and environmental loads by consumption commodity group 1999, per cent*

	Consumption expenditure	Direct material input	Use of natural resources	Primary energy	Final waste	GHG emissions	Acidifying emissions	Ground level ozone	Eutrophication
1 Food and non-alcoholic beverages	13	29	10	11	20	23	39	13	55
2 Alcoholic beverages and tobacco	6	5	1	2	3	2	2	1	3
3 Clothing and footwear	5	1	2	3	5	3	2	2	2
4 Housing	23	0	19	18	13	12	6	7	15
5 Electricity and heating fuels	2	16	11	26	1	14	6	9	1
6 Furnishings and household maintenance	5	2	4	4	12	3	2	2	2
7 Health	4	0	1	1	3	1	1	1	1
8 Purchase of vehicles	5	1	1	2	4	1	1	1	1

9 Operation of personal transport equipment	6	26	6	15	6	21	14	40	4
10 Transports services	2	0	1	4	1	5	7	10	1
11 Communication	3	0	2	1	2	1	1	1	1
12 Recreation and culture	11	10	8	6	14	7	7	4	8
13 Education	1	0	0	0	0	0	0	0	0
14 Hotels, cafes and restaurants	7	5	4	5	6	5	8	7	7
15 Miscellaneous goods and services	7	5	29	3	9	3	2	2	2
Total	100	100	100	100	100	100	100	100	100
Goods		95	70	67	73	73	74	72	74
Housing		0	19	18	13	12	6	7	15
Transport services		0	1	4	1	5	7	10	1
Other services		5	10	11	13	11	13	11	10

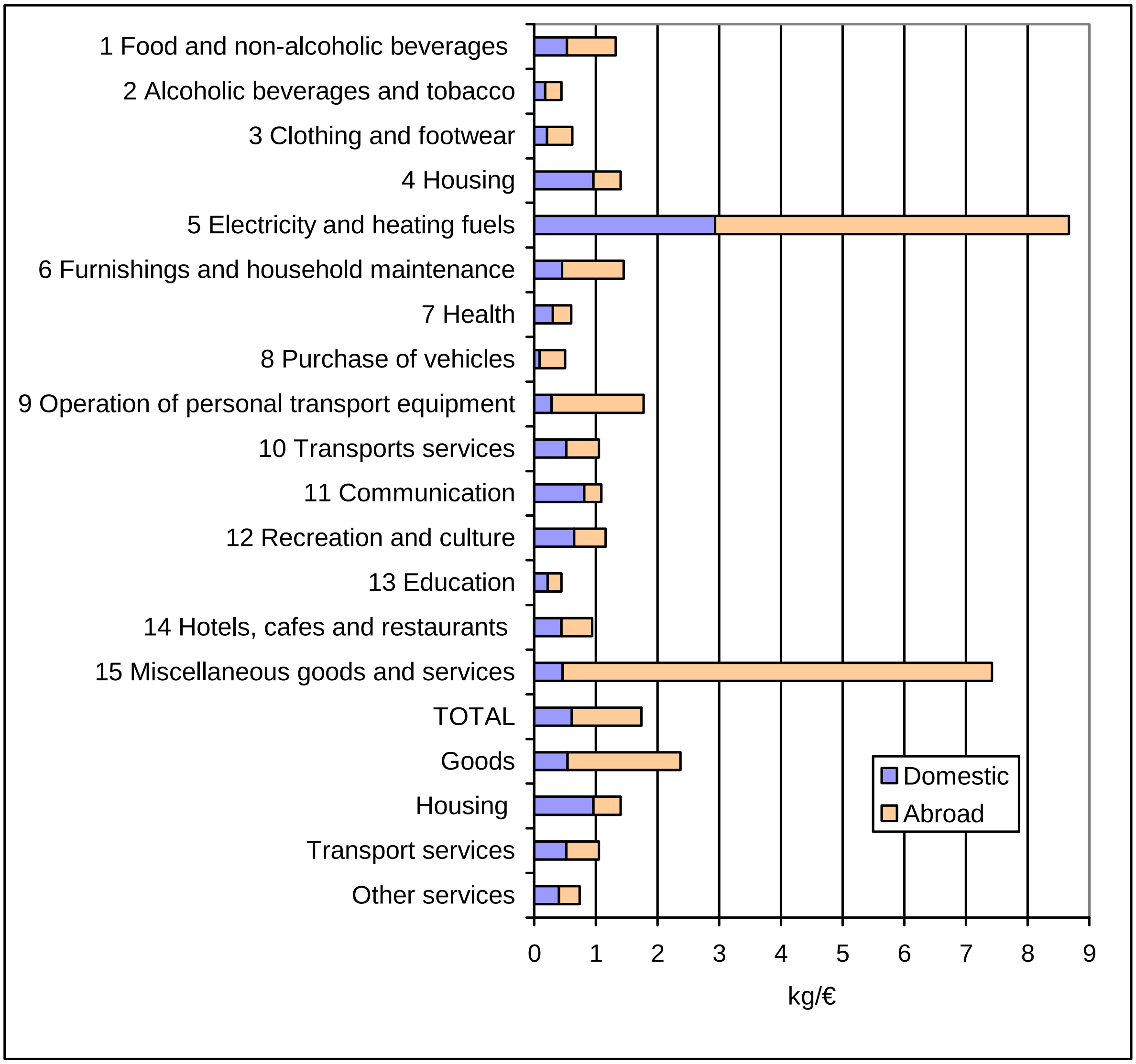

Figure 2. *Total material requirement by consumption commodity group 1999, kg/€*

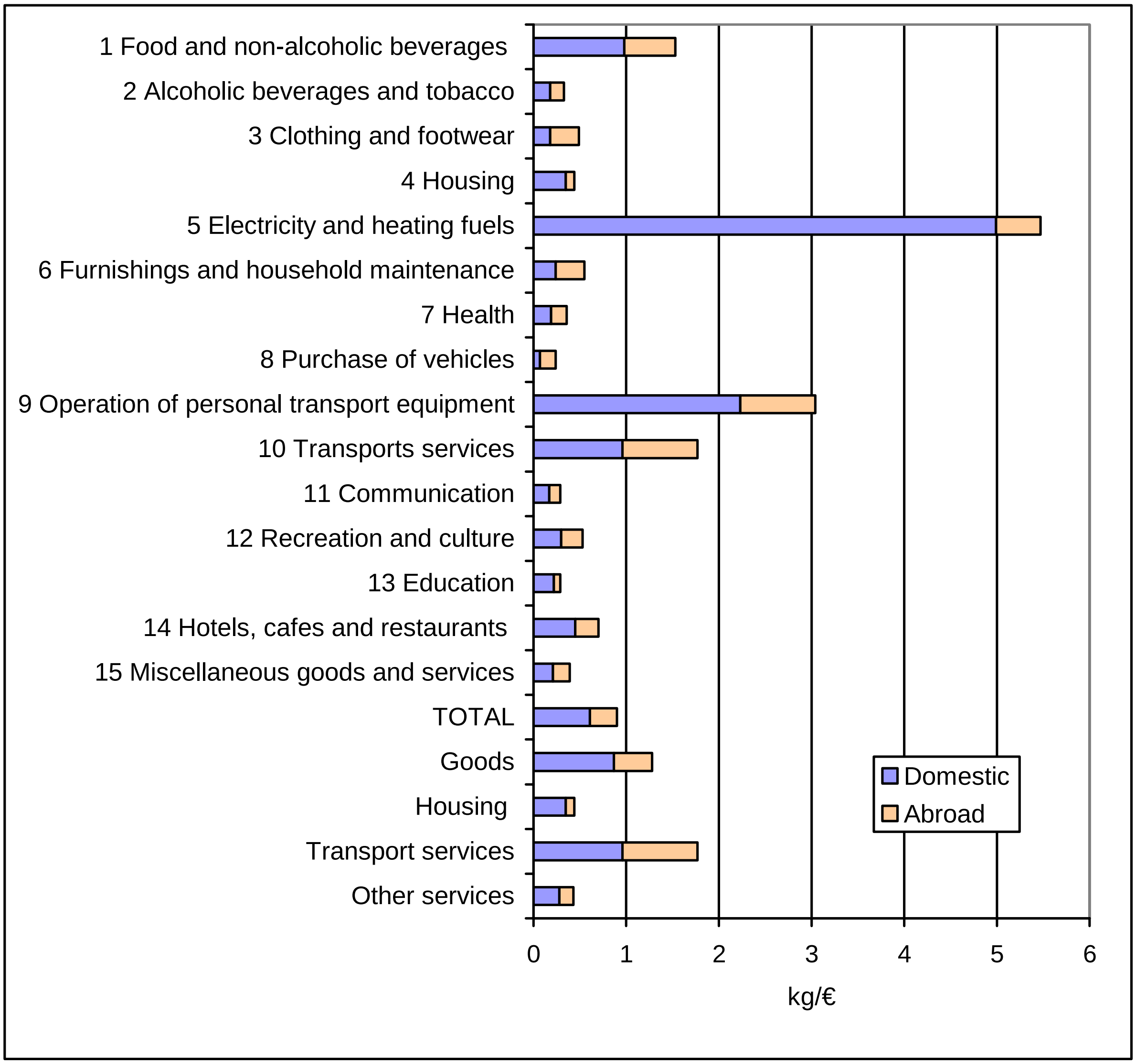

Figure 3. *Green house gas emissions by consumption commodity group 1999, kg CO_2 eqv/€*

Structural change of consumption and environmental loads in time

Changes of the total environmental loads of household consumption over time can be composed into three components: changes in the total volume of the consumption, the changes in the commodity structure of consumption and changes in the consumption expenditure and changes in the production technologies of the consumption.
In the following we analyse environmental load effects of the changes in the structure of consumtpion. The calculation method applied is such that the constant price time series of consumption expenditure of 57 commodities are multiplied by fixed load factors of the year 1999 and then the loads are added up by load type.

The structural change is environmental load increasing, if the growth of the load calculated by fixed load coefficients is higher than the growth of the total volume of consumption expenditure. The structural change has been load decreasing if the growth of the load with fixed load coefficients is lower than the growth of the consumption expenditure volume.
Figure 4 shows the calculation results for the period 1975 – 2003 and Figure 5 for the last then years. Figure 4 shows that the structural change decreased all load types in the long range and Figure 5 shows that in the last decade only the amount of final waste has been incresed more than the volume of consumption.
We speak about (absolute) decoupling of economic growth and environmental load if when the economy is growing the environmental load does not increase. The relative decoupling is the case if the load is increasing but less than the economic growth. Thus the results indicate that the structural change of the consumption has not attained the absolute decoupling but the moderate relative decoupling has nevertheless reached.

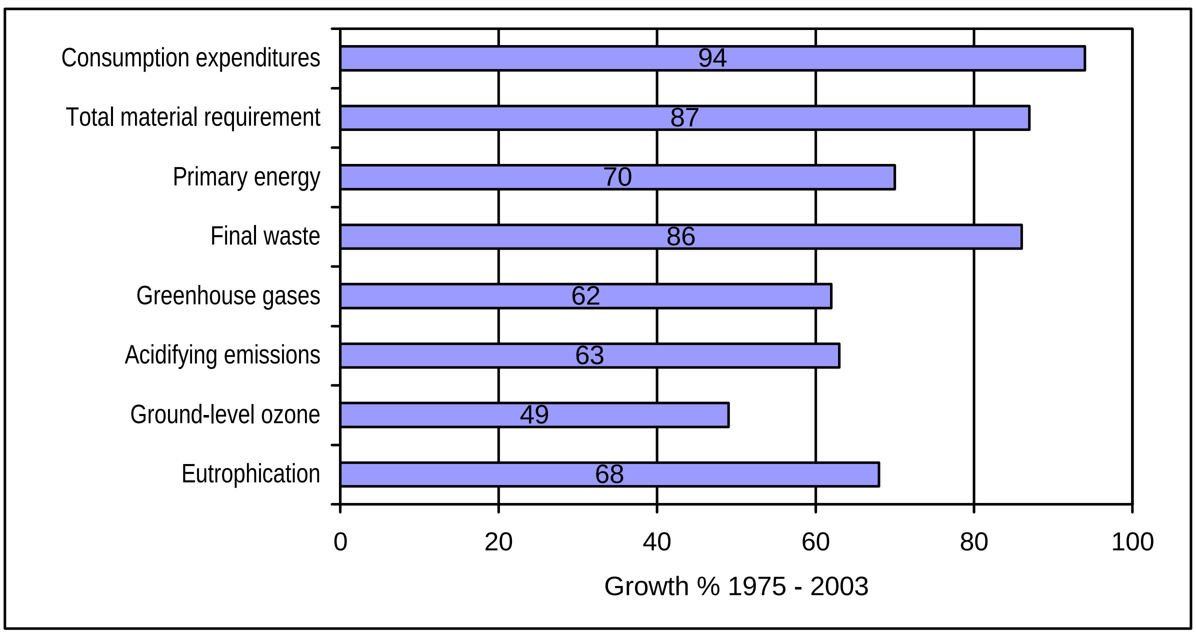

Figure 4. *The growth of the volume consumption expenditure of households and its environmental loads 1975 – 2003 with fixed load factors of the consumption commodities of the year 1999*

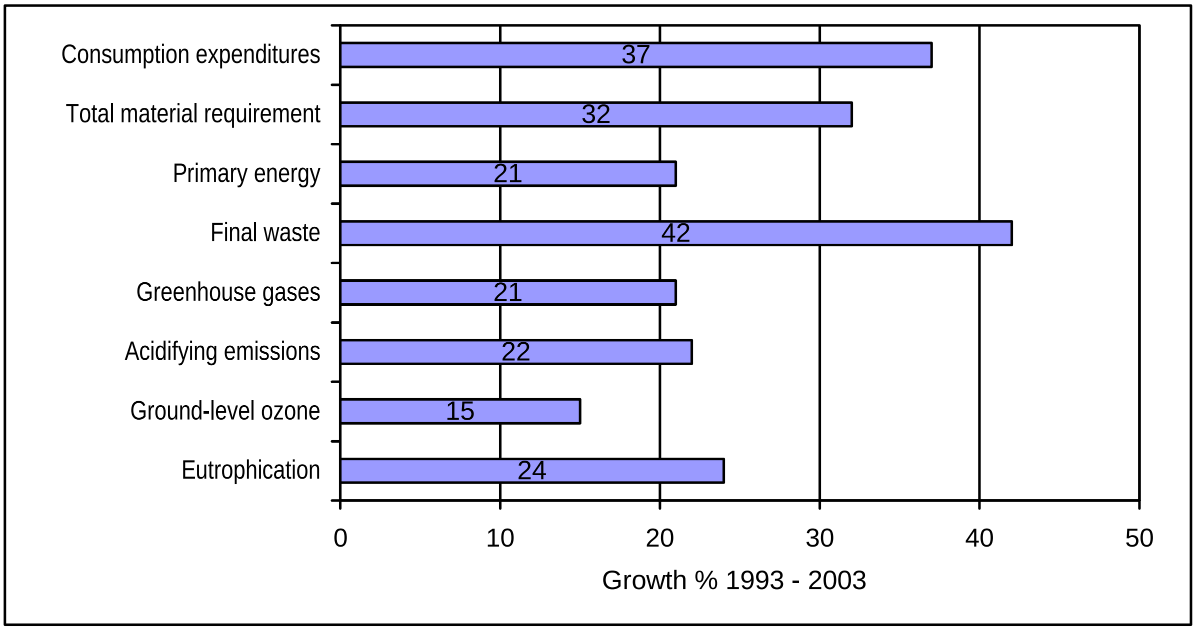

Figure 5. *The growth of the volume consumption expenditure of households and its environmental loads 1993 – 2003 with fixed load factors of the consumption commodities of the year 1999*

Figures 6 and 7 illustrate the yearly development of the total volume of consumption expenditure and environmental loads 1975 – 2003.

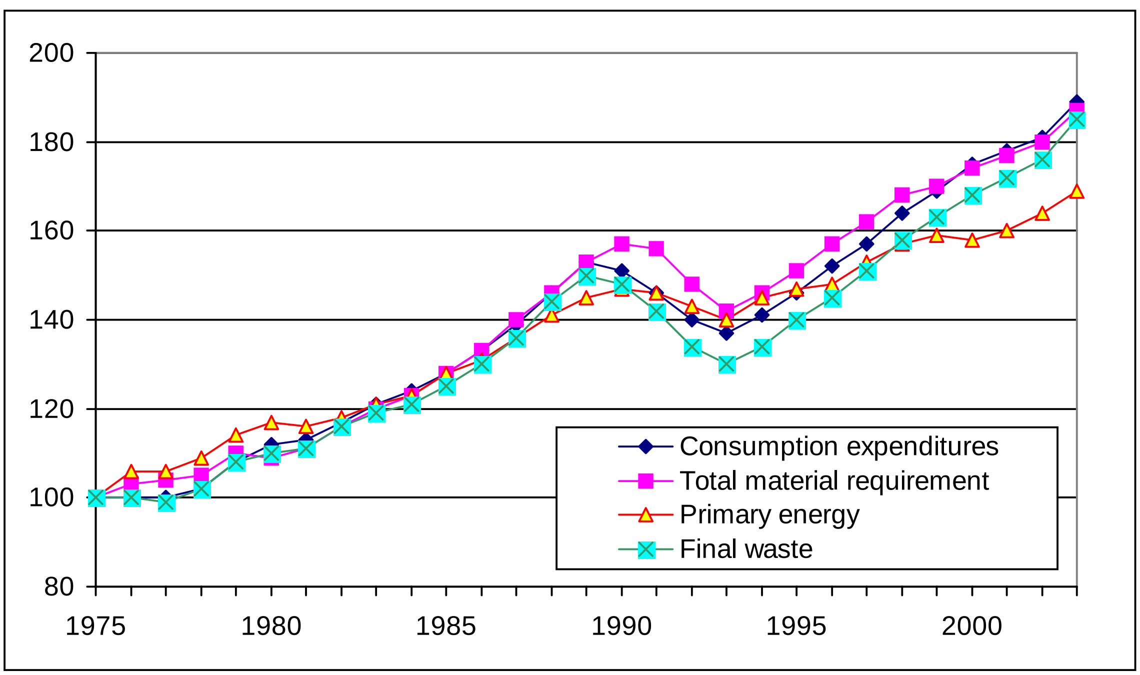

Figure 6. *The growth of the volume of actual individual consumption and its total material requirement, primary energy and final waste impacts with fixed 1999 load factors of commodities, indices 1975 = 100*

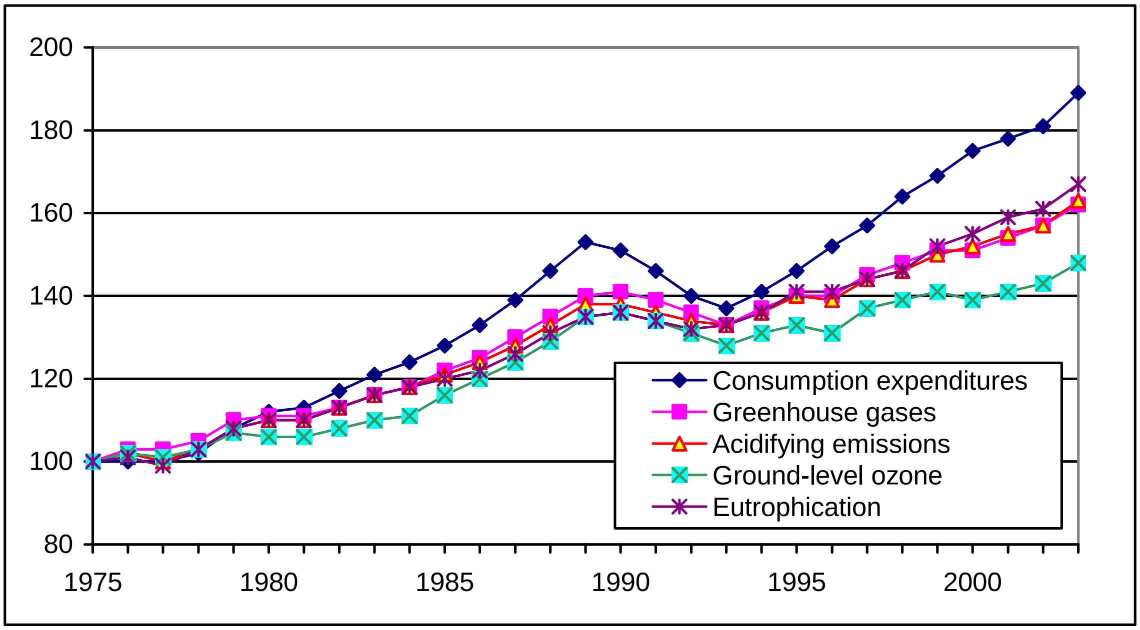

Figure 7. *The growth of the volume of consumption expenditure of households and its loads on air and waters with fixed 1999 load factors of commodities, indices 1975 = 100*

Environmental loads of basic needs

Environmental loads of actual individual consumption classified in accordance with the basic needs are presented in Table 11. Table 12 and Figure 8 show the percent distribution of the loads. Figures 9 and 10 show the growth of the volume of actual individual consumption and its environmental loads in the whole study period and in the last decade. In Figures 11 and 12 the development is illustrated as time series diagrams.

Table 11. *Value and environmental loads of actual individual consumption by basic need category 1999*

	Consumption expenditure	Direct material input	Total material requirement Mkg			Primary energy TJ			Final waste Mkg		
	M€	Mkg	Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total
1 Housing	17 673	1 929	18 151	16 236	34 386	337 468	27 975	365 443	1 006	3 796	4 803
2 Food	9 624	3 259	5 014	7 165	12 179	71 041	33 426	104 467	1 259	2 822	4 082
3 Welfare	13 395	15	3 042	3 197	6 239	40 807	16 033	56 840	376	1 727	2 103
4 Moving	7 879	2 738	1 987	7 225	9 211	124 730	30 945	155 675	358	1 834	2 193
5 Leisure	13 984	1 786	6 391	6 040	12 431	60 344	28 935	89 279	943	3 013	3 956
6 Others	7 806	584	3 694	28 651	32 346	24 394	22 650	47 044	800	2 045	2 845
Total	70 361	10 310	38 278	68 514	106 792	658 783	159 964	818 747	4 744	15 237	19 980
Goods	29 717	9 748	16 091	53 939	70 029	407 677	108 347	516 024	3 231	10 239	13 470

Services	40 644		562	22 188	14 575	36 763	251 106	51 617	302 723	1 512	4 998	6 510

	Green house gases Mkg CO_2 eqv			Acidifying emissions 1000 kg SO_2 eqv			Ground-level ozone 1000 kg PCOP eqv			Eutrophication 1000 kg PO_4 eqv		
	Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total	Domestic	Abroad	Total
1 Housing	11 840	2 768	14 608	21 130	5 533	26 662	27 599	3 833	31 431	3 833	533	4 367
2 Food	8 579	4 785	13 364	52 788	24 804	77 592	20 684	8 943	29 627	10 001	4 640	14 641
3 Welfare	2 600	1 433	4 032	6 920	3 791	10 711	5 550	2 438	7 988	893	389	1 282
4 Moving	9 462	4 497	13 960	28 741	10 914	39 655	75 750	13 452	89 202	817	694	1 511
5 Leisure	4 044	2 865	6 909	16 747	9 605	26 352	11 532	5 362	16 894	2 291	1 336	3 627
6 Others	1 478	1 734	3 213	4 446	4 696	9 142	3 764	3 020	6 784	542	514	1 057
Total	38 003	18 081	56 085	130 772	59 343	190 115	144 878	37 048	181 927	18 377	8 108	26 485
Goods	25 586	12 442	38 028	94 184	39 822	134 006	107 060	19 264	126 325	12 289	6 336	18 625
Services	12 417	5 639	18 056	36 588	19 521	56 109	37 818	17 784	55 602	6 088	1 772	7 860

Table 12. *Distribution of the value and environmental loads of actual individual consumption by basic need category in the year 1999, percent*

	Consumption expenditure	DMI	TMR	Primary energy	Final waste	GHG emissions	Acidifying emissions	Ground-level ozone	Eutrophi-cation
1 Housing	25	19	32	45	24	26	14	17	16
2 Food	14	32	11	13	20	24	41	16	55
3 Welfare	19	0	6	7	11	7	6	4	5
4 Moving	11	27	9	19	11	25	21	49	6
5 Leisure	20	17	12	11	20	12	14	9	14
6 Others	11	6	30	6	14	6	5	4	4
Total	100	100	100	100	100	100	100	100	100
Goods	42	95	66	63	67	68	70	69	70
Services	58	5	34	37	33	32	30	31	30

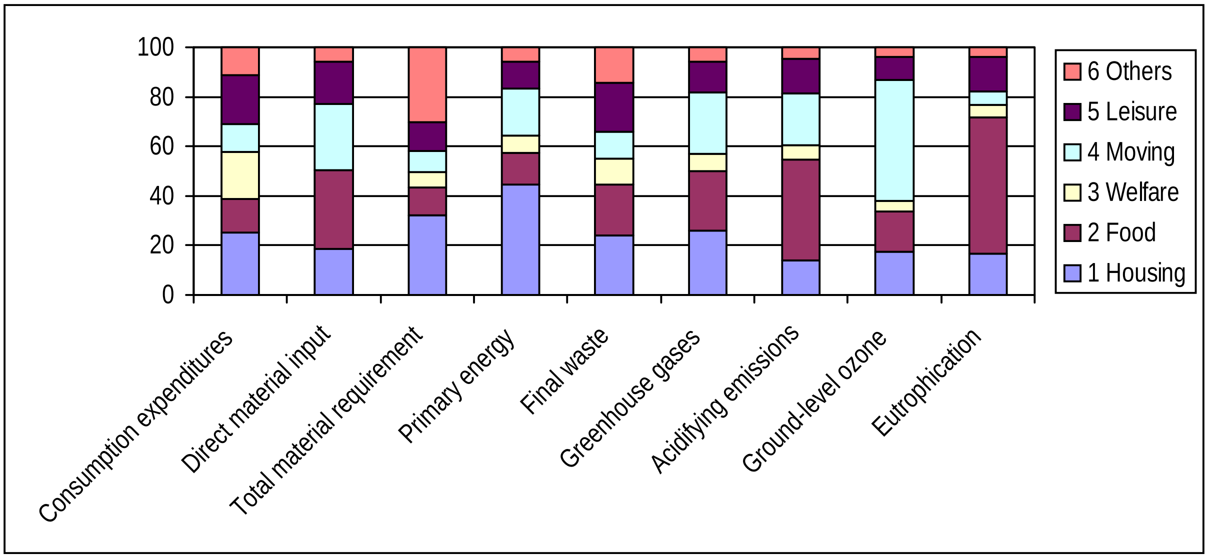

Figure 8. *Distribution of the value and environmental loads of actual individual consumption by basic need category in the year 1999, percent*

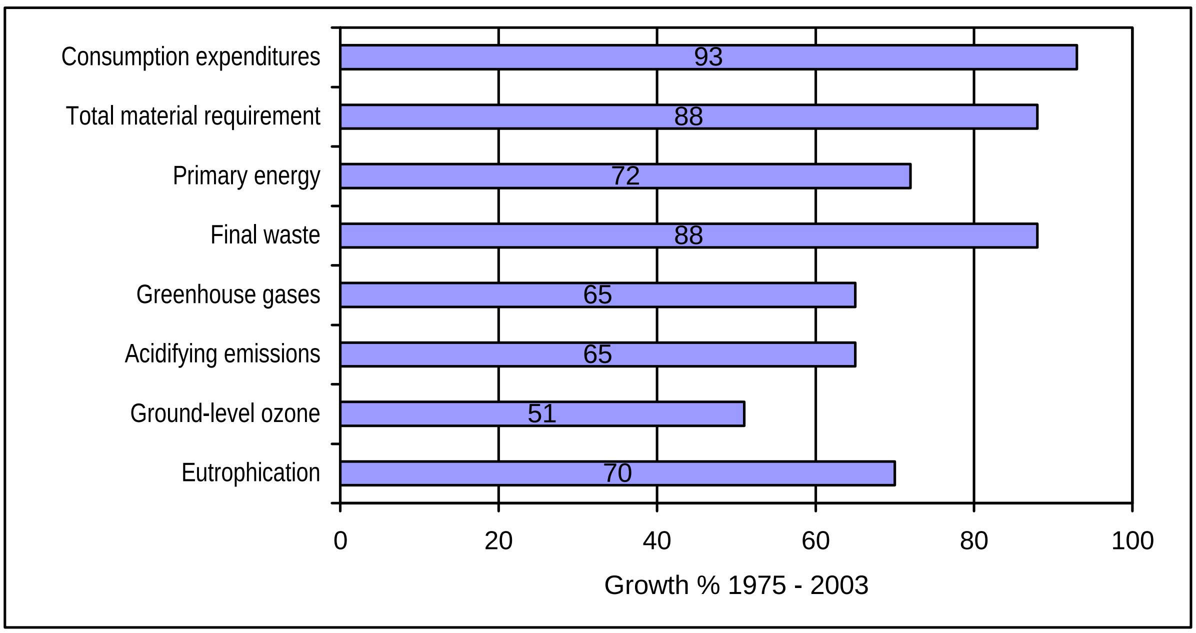

Figure 9. *The growth of the volume the actual individual consumption and its environmental loads 1975 – 2003 with fixed load factors of the consumption commodities of the year 1999*

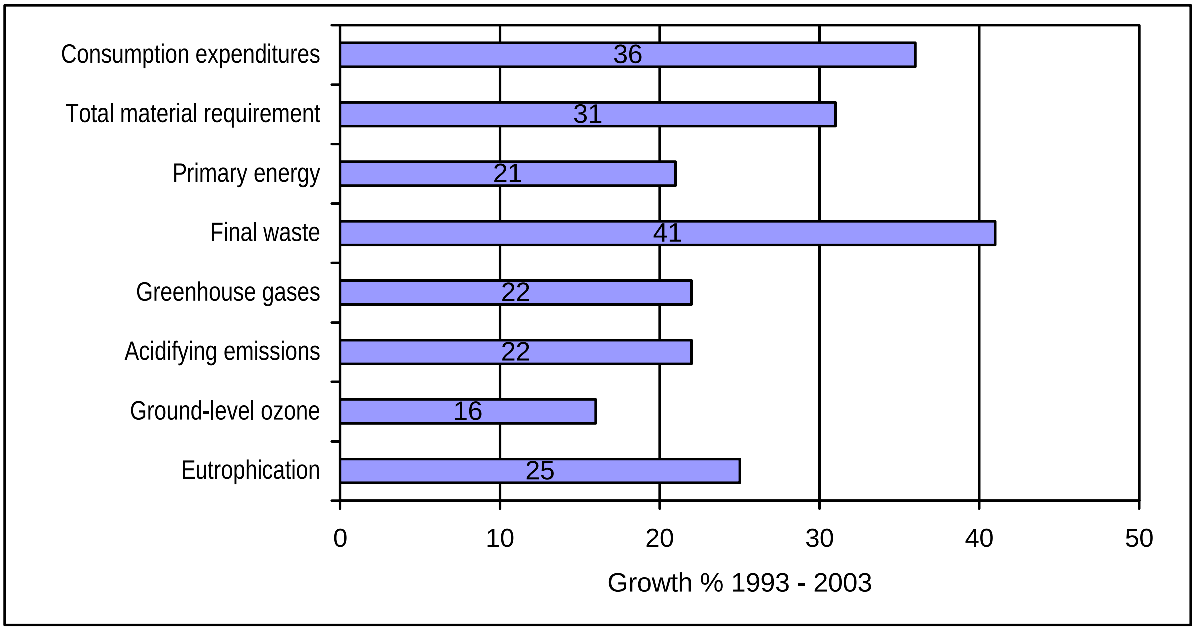

Figure 10. *The growth of the volume the actual individual consumption and its environmental loads 1993 – 2003 with fixed load factors of the consumption commodities of the year 1999*

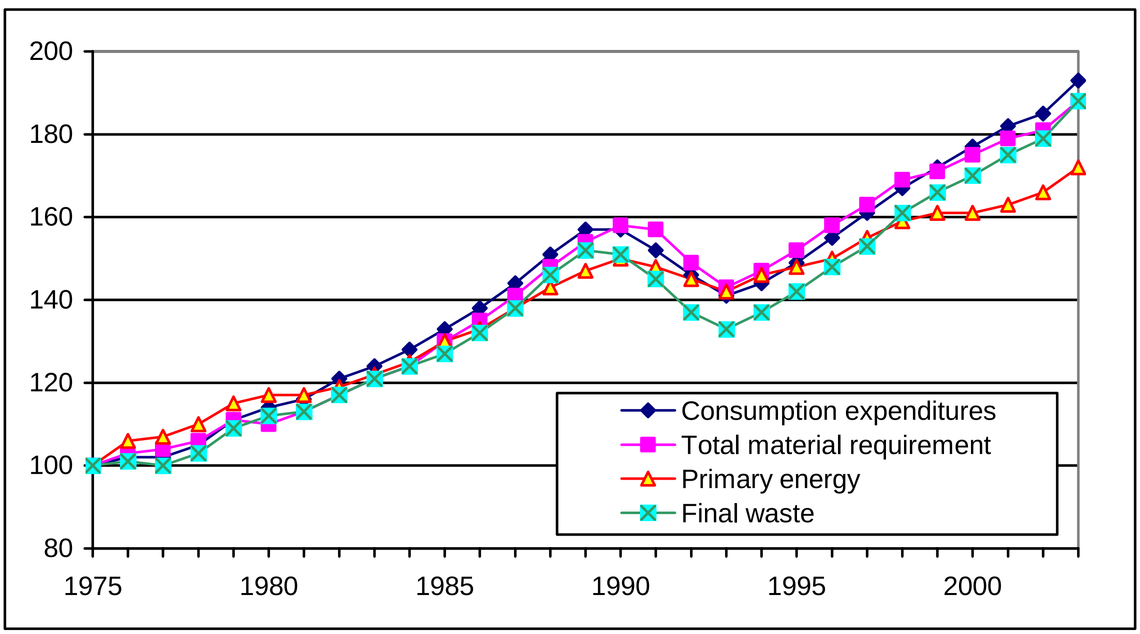

Figure 11. *The growth of the volume of actual individual consumption and its total material requirement, primary energy and final waste with fixed 1999 load factors of commodities, indices 1975 = 100*

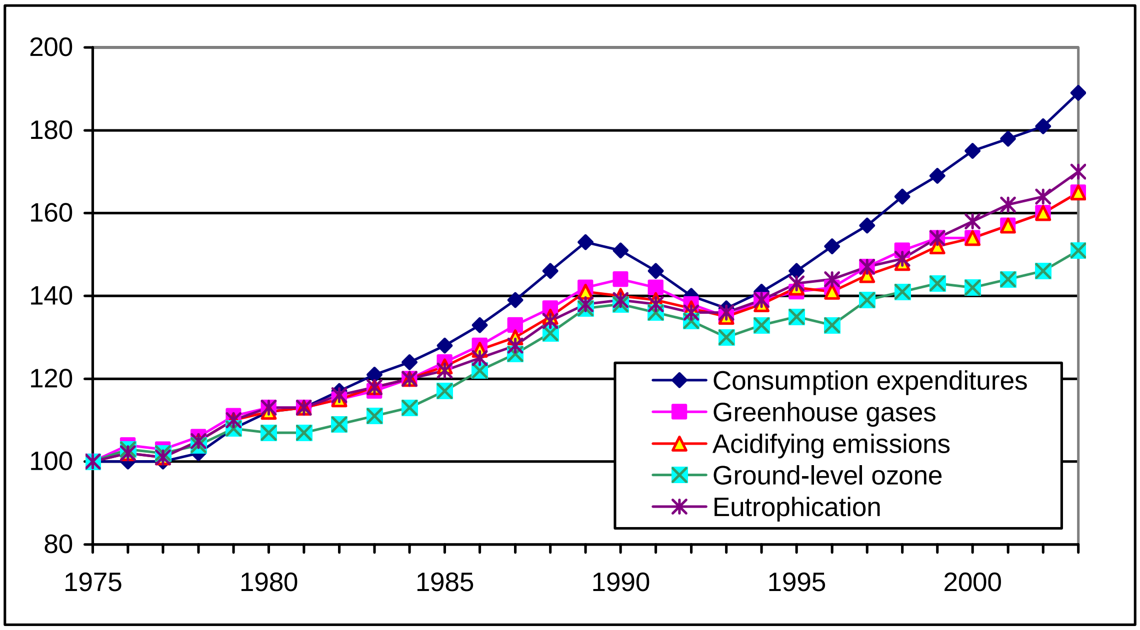

Figure 12. *The growth of the volume of actual individual consumption and its loads on air and waters with fixed 1999 load factors of commodities, indices 1975 = 100*

Conclusions

Environmental impacts of household consumption has been analysed in this study by combining the consumption expenditure concepts of national accounts into input-output model and furthermore integrating the physical industrial environmental load data and monetary input output data into hybrid input-output model.
The usual approach focusing into consumption expenditures of households has also been extended into concept of actual individual consumption likewise included in national accounts which contain the household oriented services supplied by the government and non-profit institutions free on charge besides the commodities bought by the own costs of households. Especially in international comparisons the actual individual consumption would be more independent on the differing institutional structures of national economies.
In this study the assessment of environmental impacts of consumption is based on the throughout data of one year, 1999. However, one important question of analysis, the effect of changes in consumption structures, have been done by using the benchmark data of one year to the time series of consumption expenditures available in national accounts for relatively long period.
At present EU countries at least are removing into compilation of constant price yearly supply and use tables from which the input-output tables can be worked out straightforward. This will enable more versatile analysis of the environmental impacts of the changes in consumption.

One restriction of the input-output model is the implicit assumption that all products of an industry are produced by the same average technology and thus also with same environmental unit loads. This put limitations on how detailed commodity groups can be analysed by the model. For example, if we use an input-output model were agriculture is one industry, that is plant cultivation and animal husbandry are together, then we cannot analyse the effects of removing foodstuff diet from animal based foods to vegetable food. Often, however, the important and feasible changes in consumption structures may lie on this kind of micro level.

References

Mäenpää, I. 2004. Physical flow accounts, Finland 1999, Thule Institute, University of Oulu, Manuscript 22.9.2004, to be published by Statistics Finland

Seppälä, J. 1999. Vaikutusten laskenta elinkaariarvioinnissa – vertailtavana DAIA- ja Ekoindikaattorit 95 –menetelmät. Suomen ympäristökeskuksen moniste 172. Helsinki

Statistics Finland 2003a. National accounts 1995-2001, Revised tables. SVT National Accounts 2003:2. Helsinki.

Statistics Finland 2003b. Structure of the Finnish economy 1995 – 2000, Supply and use tables, input-output. SVT National Accounts 2003:4. Helsinki.

United Nations, European Commission, International Monetary Fund, OECD, World Bank 2003. Integrated Environmental an Economic Accounting 2003. Final draft, http://unstats.un.org/unsd/environment/seea2003.pdf

Pollution Embodied in Norwegian Consumption

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Abstract

A promising way to reduce environmental impacts of consumer expenditure is through the encouragement of more sustainable consumption patterns. This requires a consistent and accurate framework to identify the most sustainable lifestyles and consumption patterns. With the increase in international trade, it is becoming increasingly important to accurately determine environmental impacts resulting from imports. Many previous studies have unrealistically assumed that imports are produced using domestic production technology. For countries with diverging technology and energy mixes the likely errors are significant. This study applies a methodology that explicitly includes technology differences to the case of Norway. It is found that the majority of emissions in Norwegian consumption are embodied in imports; signifying the importance of considering regional technology differences. The methodology is then used to determine environmental impacts at three levels; national, aggregated households, and household types.

Keywords

Input-output analysis; Embodied pollution; CO_2; SO_2; NOx; Trade; Sustainable consumption; Balance of trade; Household consumption; Environmental impacts;

1 Introduction

For countries with a high proportion of imports an accurate method of determining emissions embodied in trade is essential. This is particularly important when there are significant technology differences between the domestic economy and its trading partners. To date, most

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studies determining the environmental impacts of consumption have assumed that imports have the same production technology as the domestic economy. For some industrialized countries this approximation is adequate. Although as production technologies start to diverge and energy mixes differ, then this assumption is clearly inadequate. Recently, some studies with more accurate methods of determining pollution embodied in trade have started to appear in the literature (Ahmad and Wyckoff, 2003; Lenzen et al., 2004b; Nijdam et al., 2005).

Norway is particularly interesting for studies of energy and pollution embodied in trade due to its high proportion of imports and since most of its domestic electricity is supplied by hydropower. Consequently, relative to domestic production, Norwegian imports are expected to have a high degree of embodied pollution (Hertwich et al., 2002). This has implications when studying the environmental impacts of domestic economic activities, including the study of different consumption patterns.

In this article, the environmental impacts of Norwegian consumption are calculated at four different levels; national, aggregated households, household types, and a Product Service System (PSS) (c.f. Munksgaard et al., 2005). At the national level, issues such as a "balance of trade" for pollution can be studied. Also, the issue of who is responsible for pollution, consumer or producer, can be addressed (Munksgaard and Pedersen, 2001). Analysis at the aggregated household level allows identification of the most important economic sectors generating pollution and identifies areas where environmental improvement initiatives should be targeted. At a more detailed level, the Norwegian Survey of Consumer Expenditure (SCE) can be used to compare the environmental impacts of different household consumption patterns and broad life-style differences (Hertwich, 2004). At the most detailed level, a specific PSS, car-sharing, is analyzed. The rebound effect becomes an important counterpart of this calculation.

This article is structured as follows. First, the theoretical framework is introduced and the data presented. The bulk of the paper presents different applications of the methodology. Particular focus is given to illustrating the potential of the methods used to address environmental issues of different consumption patterns. Finally, advantages and limitations of the methodology are discussed and future research areas identified.

2 Theoretical framework

The environmental impacts are calculated using input-output analysis (IOA) (Miller and Blair, 1985). In summary, the total output of the economy is given by intermediate consumption and final consumption,

$$x = Ax + y \tag{1}$$

where A is the interindustry requirements matrix and y represents various demands on the economy. A can be decomposed into two components representing the interindustry requirements of domestically produced goods and the interindustry requirements of imported goods, $A = A^d + A^i$.

In this article Norway (NO) is the domestic economy; denoted region 1. For the development of the theoretical framework assume that Norway trades with $m - 1$ regions. The notation is given in Table 1. The output in each region for the total demand in Norway can

Name	Description
x_i	Output of region i
y_i^d	Final domestic demand on domestic production
y_{ij}	Imports to final demand from region i to region j
A_i^d	Interindustry requirements on domestic production in region i
A_{ij}	Interindustry requirements of imports from region i to j
$A_i^{im} = \sum_{j \neq i} A_{ij}$	Total interindustry requirements of imports in region i
$A_i = A_i^d + A_i^{im}$	Total interindustry requirements in region i

Table 1: The notation used for the multi-region formulations.

be expressed as (Peters and Hertwich, 2004),

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_m \end{pmatrix} = \begin{pmatrix} A_1^d & A_{12} & A_{13} & \dots & A_{1m} \\ A_{21} & A_2^d & A_{23} & \dots & A_{2m} \\ A_{31} & A_{32} & A_3^d & \dots & A_{3m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ A_{m1} & A_{m2} & A_{m3} & \dots & A_m^d \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_m \end{pmatrix} + \begin{pmatrix} y_1^d + \sum_{j \neq 1} y_{1j} \\ y_{21} \\ y_{31} \\ \vdots \\ y_{m1} \end{pmatrix} \tag{2}$$

The matrix is a generalization of the interindustry requirements, A, in standard IOA. The columns in the matrix represent the inputs into production; the off diagonal matrices are the imports into production. The rows represent the exports to foreign regions. The first element in the demand vector represents final demand on domestic production and the other elements are imports into final demand. The matrix equation, (2), is the same as the multi-regional models developed by Miller and Blair (1985). Lenzen et al. (2004b) developed a similar model using the make-use framework; on collapsing their make-use blocks into symmetric matrices the same model results. Ahmad and Wyckoff (2003) also used a similar model to calculate emissions embodied in trade.

The data requirements for (2) are significant; at this stage we do not know of any countries that collect the required data. However, this data is often available for the total imports into industry, A_i^{im}. Further, trade statistics often give the trade between given countries at the commodity level. Given this it is possible to approximate A_{ij} and y_{ij} using trade shares. Further, in a similar study, Lenzen et al. (2004b) found that direct trade with the domestic economy is dominant, and the resulting induced trade between other regions is negligible. Given these approximations, (2) becomes

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_m \end{pmatrix} = \begin{pmatrix} A_1^d & 0 & 0 & \dots & 0 \\ \hat{s}_2 A_1^{im} & A_2^d & 0 & \dots & 0 \\ \hat{s}_3 A_1^{im} & 0 & A_3^d & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \hat{s}_m A_1^{im} & 0 & 0 & \dots & A_m^d \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ \vdots \\ x_m \end{pmatrix} + \begin{pmatrix} y_1^d + y_1^{ex} \\ \hat{s}_2 y_1^{im} \\ \hat{s}_3 y_1^{im} \\ \vdots \\ \hat{s}_m y_1^{im} \end{pmatrix} \tag{3}$$

where $y_1^{ex} = \sum_{j \neq 1} \left(A_{1j}^{im} x_j + y_{1j} \right)$ is the total exports from Norway, including both industry and final demand, and the share of imports from each region is estimated using

$$\{s_i\}_j = \frac{\{M_i\}_j}{\{M_{total}\}_j} \tag{4}$$

where $\{M_i\}_j$ is the total imports of good j from region i and $\{M_{total}\}_j$ is the total imports of good j into Norway. Calculations show that it is important to consider the trade shares in individual sectors and not the average of all sectors (Peters et al., 2004).

Extracting the individual equations from the matrix, (3), gives the output in Norway,

$$x_{NO} = (I - A^d_{NO})^{-1} \left(y^d_{NO} + y^{ex}_{NO} \right) \tag{5}$$

where y^{ex}_{NO} is total Norwegian exports and the output in the other regions is

$$x_i = (I - A^d_i)^{-1} M_i \qquad \text{for } i > 1 \tag{6}$$

where

$$M_i = \hat{s}_i (A^{im}_{NO} x_{NO} + y^{im}_{NO}) \tag{7}$$

is the total imports (interindustry plus final demand) into Norway from region i.

The pollution embodied in trade is calculated as, $E_i = F_i x_i$. If it is assumed that each region has the same technology as Norway, then $A_i = A_{NO}$ and $F_i = F_{NO}$ for all $i > 1$.

3 Data sources and data preparation

3.1 Trade data

To reduce the required data, data was only collected for Norway's seven major importing partners: Sweden (SE), United Kingdom (UK), United States (US), Germany (DE), Denmark (DK), Japan (JP), and China (CH). These countries represent 61% of the import value of Norway's commodity and services imports. The minor trading partners were then aggregated under one of the seven major importing partners according to energy use per capita, CO_2 emissions per capita, and gross domestic product per capita[1]. Using this method 100% of Norway's imports are captured. The aggregated importing regions are: Sweden (SE), United Kingdom (UK), North America (NA), Germany (DE), Denmark (DK), Japan (JP), and Developing Countries (DC). Most European countries were assumed to have German, Danish, or Swedish technology and most developing countries were assumed to have Chinese technology. Table 2 shows the import and trade shares for each aggregated region.

Region	**Code**	**Import**	s_i
Sweden	SE	14%	19%
United Kingdom	UK	13%	14%
North America (US)	NA	10%	12%
Germany	DE	10%	25%
Denmark	DK	7%	14%
Japan	JP	4%	7%
Developing (CH)	DC	4%	10%
Total		61%	∼100%

Table 2: The aggregation of Norway's import trade.

[1] From the World Bank data query service; `http://devdata.worldbank.org/data-query/`

3.2 Input-output, emissions, and energy data

The input-output (IO), energy and emissions data came from a variety of sources and consequently required several manipulations to make the data set consistent. First, the data was mapped into a NACE[2] classification with 49 sectors that gave the best overlap of the datasets. Second, the Consumer Price Index (CPI) in each country was used to convert the monetary data into 2000 values [3]. Finally, the currencies were converted into Norwegian Krone (NOK) for the base year of 2000[4]. Unfortunately, not all the data was available in basic prices. The producer prices include taxes and subsidies and so are higher than the basic prices. Where possible, adjustments were made for Financial Intermediation Services Indirectly Measured (FISIM). The Norwegian domestic production data included the indirect requirements of fixed capital formation. The data is summarized in Table 3.

Country	**Original sectors**	**Valuation**	**Year**	**Source**
NO	56	Basic	2000	Statistics Norway
SE	58	Basic	2000	Eurostat and NSO
UK	58	Basic	1995	Eurostat and NSO
US	91	Producer	1996	Suh and Huppes (2002) and NSO
DE	58	Basic	2000	Eurostat and NSO
DK	58	Basic	2000	Eurostat and NSO
JP	93	Producer	1995	Nansai et al. (2003)
CH	124	Producer	1997	Hubacek (2002) and NSO

Table 3: A summary of the data used. NSO stands for national statistics office.

A limitation with the emissions data was a common subset of pollutants. We only had emissions data overlap for CO_2, SO_2, and NOx. Future studies should include a broader range of pollutants. Due to space limitations only the results for CO_2 are shown in this article; further results are presented in Peters et al. (2004).

4 The importance of technology differences

The importance of technology differences between different regions can be illustrated through a comparison of the total emission intensities,

$$F_{i,total} = F_i(I - A_i^d)^{-1} \tag{8}$$

The elements in each row represent the total emissions, including indirect emissions, for one NOK of output. The emission intensity multiplier is defined as the sum of the row elements,

$$F_{i,multiplier} = \sum_j \{F_{i,total}\}_j \tag{9}$$

and gives an indication of the overall emission intensity in a given region.

[2]See the RAMON database in EUROSTAT; `http://europa.eu.int/comm/eurostat/ramon`
[3]CPI values taken from the OECD's sourceOECD database; `http://caliban.sourceoecd.org/`
[4]`http://www.oanda.com/convert/fxhistory`

Country	Total multiplier		
	CO_2	SO_2	NOx
NO*	1.54 kg/NOK	2.07 g/NOK	11.24 g/NOK
NO	1.00	1.00	1.00
SE	1.11	1.00	1.44
UK	2.00	8.21	0.90
US	3.68	7.77	1.05
DE	2.04	1.52	0.28
DK	1.74	3.11	1.36
JP	1.50	3.00	0.94
CH	16.16	85.96	6.98

Table 4: The total normalized multiplier of emission intensity in each region. NO* gives the actual values in Norway.

Country	Electricity, hot water		
	CO_2	SO_2	NOx
NO*	0.01 kg/NOK	0.02 g/NOK	0.06 g/NOK
NO	1.0	1.0	1.0
SE	8.4	9.8	4.4
UK	40.4	206.4	18.7
US	77.8	265.9	50.8
DE	65.3	36.0	14.3
DK	58.5	14.8	21.7
JP	20.4	8.3	4.2
CH	258.5	1171.4	134.9

Table 5: The normalized emission intensities in each region for NACE sector 40: Production and distribution of electricity, steam and hot water supply. NO* gives the actual value in Norway.

Country	Food products and beverages		
	CO_2	SO_2	NOx
NO*	0.03 g/NOK	0.03 g/NOK	0.30 g/NOK
NO	1.00	1.00	1.00
SE	1.06	0.88	0.85
UK	1.48	7.67	0.42
US	1.24	2.56	0.16
DE	1.67	1.81	0.15
DK	2.02	2.86	1.06
JP	1.10	3.34	0.41
CH	10.24	78.87	2.60

Table 6: The normalized emission intensities in each region for NACE sector 15: Manufacture of food products and beverages. NO* gives the actual value in Norway.

Table 4 shows the multiplier of the emissions intensity for each of the regions. Norway has considerably lower emissions per NOK for both CO_2 and SO_2. Although, the differences are not so prominent for NOx; this is due to the high NOx emissions from Norway's offshore industries. Norway's generally lower emission intensities is due to Norway's high use of hydropower to generate electricity; see Table 5. Despite this, Norway does not always have the lowest emission intensity in a given sector. Table 6 shows the emission intensities for the "manufacture of food products and beverages". This sector is a particularly important sector in terms of total Norwegian expenditure and consumer needs. In this sector, Norway generally has a lower emissions intensity, although the differences are considerably smaller. Similar variations are found in other sectors, highlighting the different production technologies and industry structures in the different countries.

The differences demonstrated in Table 4, 5, and 6 show that it is crucial to incorporate the different technology of different regions when determining emissions embodied in trade. The differences are particularly prominent for developing countries and can be as large as three orders of magnitude. Even for small to moderate amounts of trade with developing countries it is likely that the emissions embodied in trade with foreign regions will be significant.

5 Pollution embodied in Norwegian consumption

5.1 Total emissions

Table 7 shows the CO_2 emissions for total Norwegian demand. In the table $y_{domestic}$ represents the emissions resulting from Norwegian domestic demand on domestic production, y_{export} represents the emissions resulting from export demand, and y_{import} represents the emissions resulting from imports into final demand categories. The emissions in Norway are the total direct and indirect emissions resulting from the demand $y_{domestic}$ or y_{export}. *Indirect imports* are required in the production of the these demands and the resulting embodied emissions are tabulated in the rows for each region. The column y_{import} represents the *direct imports* to consumers and all these emissions occur in the foreign regions.

Carbon Dioxide	$y_{domestic}$ 10^9 kg	y_{export} 10^9 kg	y_{import} 10^9 kg
NO	14.0	35.8	0.0
SE	0.8	0.9	0.6
UK	0.9	1.4	0.8
NA	2.5	1.5	1.2
DE	1.9	3.0	1.9
DK	0.5	0.5	0.6
JP	0.2	0.3	0.7
DC	4.1	5.1	7.5
Foreign	10.8	12.7	13.3
Total	**24.8**	**48.6**	**13.3**

Table 7: The CO_2 emissions in all regions from total Norwegian final demand.

Table 7 shows that a large portion of emissions occur in foreign regions as a consequence of Norwegian production. For instance, to produce the domestic consumer demand in Norway,

$y_{domestic}$, emits 14.0×10^9kg of CO_2 in Norway, but 10.8×10^9kg of CO_2 in foreign regions due to indirect imports. Of the foreign emissions the contribution from developing countries (DC) is dominant; this is despite DCs representing only 10% of Norway's imports; see Table 2.

Table 8 shows the emissions when imports are assumed to be produced with Norwegian technology. By comparing with Table 7 it is evident that assuming imports are produced with Norwegian technology leads to large differences in emissions. These differences highlight the importance of including technology differences to calculate pollution embodied in trade.

Carbon Dioxide	$y_{domestic}$ 10^9 kg	y_{export} 10^9 kg	y_{import} 10^9 kg
NO	14.0	35.8	0.0
Foreign	3.8	5.4	3.3
Total	**17.8**	**41.2**	**3.3**

Table 8: The CO_2 emissions when it is assumed that the foreign regions have the same technology as Norway.

Several results and generalizations can be drawn from these tables. First, of the Norwegian domestic emissions, 72% of the emissions result from exports; however, only 38% of Norway's domestic output is from exports. This signifies that production of Norwegian exports are more CO_2 intensive than production of domestic demand. Second, about 50% of the impacts from Norwegian consumption activities occur in other regions. About half of these impacts occur in developing countries which represent only 10% of Norwegian imports. Third, assuming other regions have Norwegian technology, greatly underestimates the impacts of Norwegian imports.

5.2 Balance of Trade

The results from the previous section highlight an important issue resulting from climate change policies such as the Kyoto Protocol; namely, "carbon leakage" (Wyckoff and Roop, 1994). A country that is a part of the Kyoto Protocol may reduce its emissions by importing from a foreign region. If the foreign country has a worse emissions profile than the domestic economy, then total global emissions will increase due to trade. This problem can be reduced by including all countries in the Kyoto Protocol. An alternative approach is to make the consumer, and not the producer, responsible for emissions (Munksgaard and Pedersen, 2001).

Table 9 shows different methods of expressing the environmental impact for Norway (Munksgaard and Pedersen, 2001). The "producer" column shows the total emissions embodied in Norwegian production. The "consumer" column shows the total emissions embodied in Norwegian final demand. The "net" column is the difference between producer and consumer; equivalently, it is a trade balance of exports minus imports. These values can be derived from Table 7. The figures with an asterisks, *, in each figure is the official figure reported by Statistics Norway. When this figure is compared to the emissions occurring in foreign regions it can be argued that the figure is a poor representation of Norwegian environmental impacts, particularly for pollutants with global impacts.

For the arguments here, it is assumed that the indirect imports are embodied in the produced good. This implies that all the upstream emissions from production processes, in both the domestic economy and foreign regions, are allocated to the produced good that is sold to a final demand category. For instance, the emissions from producing the imports

Carbon Dioxide	Producer $y_{dom} + y_{ex}$	Consumer $y_{dom} + y_{im}$	Net $y_{ex} - y_{im}$
NO	49.8*	14.0	35.8
Foreign	23.6	24.1	-0.6
Total	**73.4**	**38.1**	**35.3**

* This is the official emissions figure for Norway.

Table 9: The balance of trade for CO_2 emissions (millions of tonnes).

required in Norwegian production are allocated to the the producer of the final good in Norway, not the region that produced that import. This definition is consistent with the concept of life-cycle emissions and ignores political and geographical boundaries.

Munksgaard and Pedersen (2001) raise the argument of who should be responsible for the pollution; the producer or the consumer. The current approach is the producer. If the producer is responsible then the total Norwegian impacts are higher than if the consumer is responsible. This reflects that a large fraction of the Norwegian economy (38%) is based pollution intensive exports (72% of CO_2 emissions). When total imports are included, Norway is a net exporter of pollution; see the last column in Table 9.

In terms of international global climate change policies, should Norway be punished for being an exporter of pollution? Given the Norwegian energy mix is high in the use of hydropower, the emission intensities of Norway in the exporting sectors is relatively low compared to other regions. This would suggest that Norway should be encouraged to export energy intensive goods due to its low greenhouse gas emissions. This argument would favor making the consumer responsible for pollution. If the consumer is responsible, then they need to purchase goods from the country with the lowest embodied emissions intensity.

5.3 Household consumption

If the consumer is responsible for environmental impacts, then a method is needed to determine the pollution from household consumption. Table 10 shows the total emissions resulting from Norwegian household demand. Again, the proportion of the emissions coming from foreign regions is large. The column for domestic demands has been broken into three sections; emissions due to household consumption without margins, estimated emissions from trade and transport margins (see Peters et al., 2004), and the total emissions.

Carbon	Domestic			Imports	Total
Dioxide	Household	Margins	Total		
NO	5.6	0.8	6.4	0.0	6.4
Foreign	4.5	0.4	4.9	7.1	12.0
Total	**10.1**	**1.2**	**11.3**	**7.1**	**18.4**

Table 10: The CO_2 emissions from total Norwegian household consumption (million tonnes). The direct household fuel use of 4.9 million tonnes has not been added to these figures.

Table 10 shows that the embodied emissions dominate the domestic emissions. Approximately 16% of Norwegian household consumption comes from imports, but approximately 65% of all emissions occur in foreign regions when compared to the total emissions. The differences are particularly apparent when it is assumed that Norwegian imports are produced

NACE code and abbreviated description		CO_2		SO_2		NOx		Expenditure	
		10^9 kg	Rank	10^6kg	Rank	^{6}kg	Rank	%	Rank
HH	Direct household use	4.90	1	0.91	20	19.00	1	-	-
15	M. of food products	2.38	2	7.50	2	16.12	2	11.5	2
70-74	Business activities	1.64	3	3.85	4	6.16	5	21.0	1
18	M. of wearing apparel	1.63	4	11.21	1	4.61	6	2.4	11
60	Land transport	1.19	5	0.43	28	8.70	4	4.2	6
24	M. of chemicals	1.08	6	4.58	3	2.35	9	1.8	17
23	M. of petroleum products	0.87	7	1.89	10	2.00	11	1.5	19
63	Support transport activities	0.57	8	1.60	13	3.75	7	3.3	9
36	M. of furniture	0.57	9	2.95	7	1.70	13	2.3	12
17	M. of textiles	0.57	10	3.15	5	1.44	16	1.3	22
34	M. of motor vehicles	0.56	11	1.39	15	1.07	20	3.8	7
26	M. of non-metallic products	0.55	12	1.77	11	1.16	18	0.3	38
1	Agriculture and hunting	0.55	13	1.71	12	3.19	8	1.8	16
61	Water transport	0.52	14	2.09	9	10.77	3	0.6	28
62	Air transport	0.50	15	0.25	30	1.54	15	0.9	24
27	M. of basic metals	0.48	16	1.27	17	0.73	24	0.0	44
19	M. of leather products	0.45	17	2.97	6	1.32	17	0.8	26
35	M. of other transport equip.	0.37	18	2.16	8	0.95	22	0.9	25
29	M. of machinery and equip.	0.33	19	0.82	21	0.61	27	1.4	20
32	M. of communication equip.	0.29	20	1.59	14	0.74	23	1.3	21

Table 11: The domestic and imported emissions from the top 20 ranking Norwegian household consumption sectors. The NACE descriptions have been abbreviated. M. stands for Manufacturing.

with domestic technology (see Peters et al., 2004).

Of more interest is a study of the pollution coming from production in different sectors instigated by Norwegian household demand. Table 11 shows the total domestic and foreign emissions resulting from the top 20 ranking sectors. Many of the high ranking expenditure sectors that are not listed are service related and have low emissions. Generally the worst emissions occur in the same sectors and this would suggest targeting, for instance, the top ten ranking sectors. Much of the impacts from one sector may occur indirectly in other sectors due to the interindustry linkages (c.f. Lenzen, 2002).

Of particular interest would be to follow the interindustry linkages through the trade flows. For instance, 97% of the household expenditure on “Manufacture of wearing apparel” is imported. Of the imports to final demand, 52% of wearing apparel comes from developing countries and the CO_2 emission intensity is 35 times worse in developing countries then Norway. From an environmental perspective, the study of these value chains through structural path analysis will give valuable insight into where to direct environmental improvements.

Many household expenditure categories provide essential services and reduced consumption may be difficult. However, many “non-essential” items appear the top ranking paths. This suggests that consumers will have different expenditure patterns even if they have the same income; these different expenditure patterns could be said to represent the consumers “life-style”. A study of more detailed consumer consumption patterns may identify which life-style choices have smaller environmental impacts. This leads into an analysis of consumption patterns at a more detailed household level.

	Average	1 person	2 person	3 person	4 person	5 person
Direct	..	1.9	4.0	4.8	5.3	5.1
Domestic	2.7	2.0	2.7	3.0	3.7	4.0
Indirect import	2.3	1.6	2.3	2.6	3.1	3.3
Direct import	3.0	1.7	3.1	3.8	4.4	5.0
Total	..	7.2	12.1	14.2	16.4	17.4

Table 12: The breakdown of CO_2 emissions for household size. All numbers are tonnes CO_2. The direct fuel use in the average household was not available. Indirect imports are the imports required for domestic production. Direct imports are the imports purchased by the household.

5.4 Survey of Consumer Expenditure

The survey of consumer expenditure (SCE) gives the average consumption for a variety of household types covering socio-economic status, income, region, and so on. The data is collected primarily to calculate the Consumer Price Index (CPI), but is also suitable for comparing the environmental impacts of different types of consumers. The first of these types of studies was conducted for energy consumption by Herendeen and Tanaka (1976) and Herendeen (1978); ironically the second study was for Norway. Since then, other similar studies have been performed with a focus on energy consumption or environmental impacts (e.g. Vringer and Blok, 1995; Wier et al., 2001; Lenzen et al., 2004a; Hertwich, 2004).

The calculations performed here are illustrative to demonstrate the use of SCE for sustainable consumption studies. For a full description of the data preparations see Peters et al. (2004). Figure 1 shows the CO_2 emissions for three different categories; age of the highest wage earner, total household consumption, and household size. Only data for CO_2 emissions is shown; the other emissions follow similar trends. Only direct fuel use was available for household size. For household size the direct fuel use comprised approximately 30% of the total household emissions, Table 12. It is expected that direct fuel use would be a similar magnitude in other categories. Other studies show a higher proportion of direct fuel use; about 50% in Wier et al. (2001). The large difference results from the large proportion of impacts coming from imports in this study.

Figure 1a) shows the CO_2 emissions for the age of the highest wage earner. The structure of the curve introduces the concept of modeling the emissions profile of an individual as they progress through life. The curve shows that as an individual progresses into married life the household size increases, hence emissions also increase. Eventually the siblings leave home, household size decreases, and as the person ages their impacts decrease. The impacts per Norwegian Kroner decreases slightly throughout the life-cycle.

Figure 1b) shows the CO_2 emissions for total household expenditure. Not surprisingly, impacts increase with income; the emissions intensity increases slightly over the range of incomes. In conjunction with other studies (e.g. Herendeen, 1978) low income households have a high proportion of emissions resulting from essential requirements such as heating and food, whilst high income household purchase more luxury items with a higher value added component.

Figure 1c) shows the CO_2 emissions with number of persons in the household, see also Table 12. Consistent with other studies, the emissions increase with household occupants, but the impact per person decreases. In conjunction with Figure 1a) this suggests the impacts of the middle age groups would have a superior per capita performance due to increased

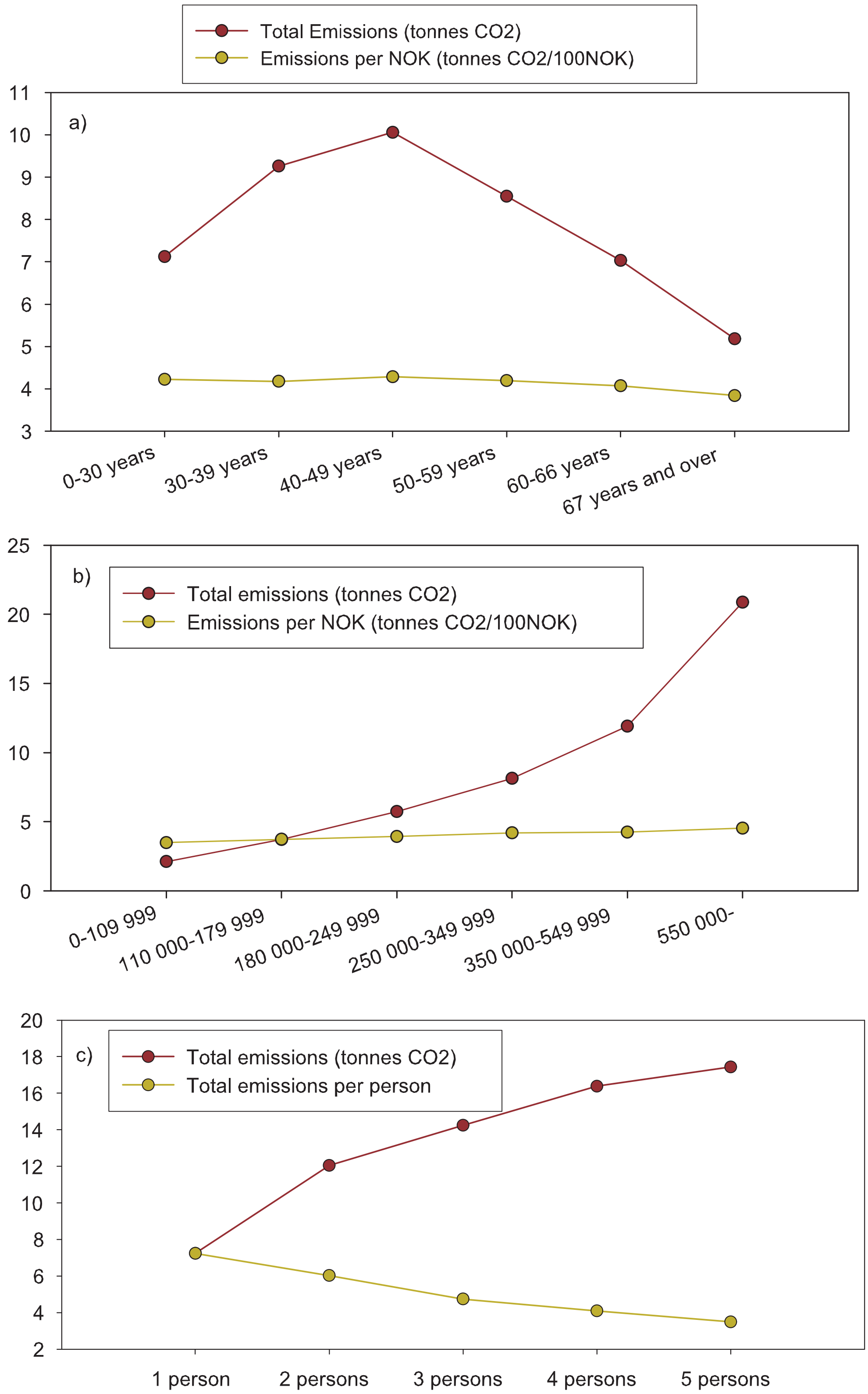

Figure 1: CO_2 emissions and emissions intensities for various household groups: a) Age of highest wage earner, b) Total household consumption, and c) Household size. Only the household size figure includes direct fuel use in the household.

household occupants in families; unfortunately data was not available to perform this calculation. The results suggest larger household sizes should be encouraged; for instance, encouraging siblings to live at home longer, the elderly to live with siblings or retirements villages, younger people to live together, communal living arrangements, and so on.

5.5 Product Service Systems: Car sharing

Car-sharing schemes build a promising case for sustainable consumption programs. They are organized arrangements, collectives or business ventures, where members can reserve cars when they need them and pay automotive expenses on a variable basis[5]. The systems motivate a more efficient use of cars and other transport modes, influencing consumer behavior through their organizational and cost structures. They induce less driving, increased use of public transport, walking and biking, and increase savings in transport budgets (Whitelegg and Britton, 1999).

In the analysis we compare car-sharing schemes to other modes of transport in terms of their environmental impact, given total transport emissions and rebound emissions from the remaining household consumption. From the Norwegian Survey of Consumer Expenditure (SCE), we construct a consumption bundle for transport services and non-transport services for the average Norwegian household. Then, based on the Norwegian Travel Survey (NTS) (Denstadli and Hjorthol, 2002), we construct various household transportation scenarios and compare the resulting household environmental impacts. Due variations in expenditure, an analysis of the rebound effect is important (Hertwich, 2005).

The environmental impacts for the transport services are determined using Life Cycle Analysis (LCA) (Heijungs and Suh, 2002), while the environmental impacts of non-transport consumption and the rebound effect are calculated using IOA. Global Warming Potential (GWP) is taken as the environmental impact indicator. Emissions for transport were deter-

[5]Here we distinguish from informal car-sharing, where friends or work colleagues may travel together on a shared basis.

	Car only	**Bus & Car**	**Bus & Coach**	**Car share -light**	**Car share -intensive**
Car - distance (vkm)	19,206	10,755	0	0	0
- cost (NOK)	46,740	37,212	0	0	0
Bus - distance (pkm)	0	10,492	15,787	11,276	13,297
- cost (NOK)	0	11,720	11,720	11,720	11,720
Coach - distance (pkm)	0	0	5,216	0	0
- cost (NOK)	0	0	3,406	0	0
Car share - distance (vkm)	0	0	0	2,268	6,371
- cost (NOK)	0	0	0	7,057	19,824
Total travel distance (pkm)	27,769	26,041	21,003	16,493	24,445
Total travel cost (NOK)	46,740	48,931	15,126	18,777	31,543
Non-transport GWP	7,934	7,934	7,934	7,934	7,934
Transport GWP	5,589	4,315	1,971	1,934	3,356
Rebound GWP	465	392	1,516	1,395	970
Total GWP	13,988	12,641	11,421	11,263	12,261

Table 13: The variable travel distance scenario. GWP in kg CO_2-e.

	Car only	Bus & Car	Bus & Coach	Car share -light	Car share -intensive
Car - distance (vkm)	19,206	10,755	0	0	0
- cost (NOK)	46,740	37,212	0	0	0
Bus - distance (pkm)	0	10,492	15,787	11,276	13,297
- cost (NOK)	0	11,720	11,720	11,720	11,720
Coach - distance (pkm)	0	0	5,216	0	0
- cost (NOK)	0	0	3,406	0	0
Car share - distance (vkm)	0	0	0	2,268	6,371
- cost (NOK)	0	0	0	7,057	19,824
Air - distance (pkm)	28,980	24,434	94,549	86,976	60,498
- cost (NOK)	13,972	11,781	45,586	41,935	29,169
Total travel distance (pkm)	56,748	50,475	115,552	103,469	108,127
Total travel cost (NOK)	60,712	60,712	60,712	60,712	60,712
Non-transport GWP	7,934	7,934	7,934	7,934	7,934
Transport GWP	14,370	11,719	30,619	28,288	24,307
Rebound GWP	0	0	0	0	0
Total GWP	22,304	19,653	38,553	36,222	32,241

Table 14: The variable travel distance with air travel scenario. GWP in kg CO_2-e. Note that the air travel distances are in units of person kilometers (pkm) and therefor 94,549pkm represents 41,108km with a ticket cost of 19,820NOK for household with 2.3 occupants.

mined using the EcoInvent LCA database. For the IOA calculations it was assumed that imports are produced with Norwegian technology. More detailed calculations and details on the scenarios can be found in Briceno et al. (2005).

In the first scenario households with different transport mixes are compared; see Table 13. Overall, the scenarios with a high proportion of bus use have lower transportation GWP. The car share light user has the lowest transport emissions reflecting the lower overall distance; that is, it is assumed that they use a higher proportion of non-motorized transport services. It is assumed that the rebound expenditure is evenly distributed over all non-transport expenditure. The rebound emissions increase the total GWP by up to 10%, but they do not effect the overall ranking of the different transport choices.

An alternative scenario was to assume that the household spends surplus money allocated for transport on air travel, Table 14. An average cost per kilometer was estimated for are travel and so the travel distance is proportion to the money spent on travel. The results show a considerable change. The transport users with the lowest costs associated with bus and car transport now have the highest emissions due to the use of air travel. For the bus only user, the amount of air travel represents a round-the-world trip, while of the car user the air travel represents a trip from northern to southern Europe. These numbers indicate that spending extra income on air travel leads to significant environmental impacts that may negate perceived emission reductions.

6 Conclusion

The calculations performed here demonstrate the importance of including explicit calculations for the emissions embodied in trade. Due to Norway's energy mix the emissions in foreign regions were a significant proportion of the total impacts of Norwegian production and consumption. The emissions from developing countries was particularly significant which has implications for climate change policies such as the Kyoto Protocol.

Calculations were performed at four different scales to show the different applications of the theoretical framework. At the national level it was shown the majority of emissions from Norwegian production and consumption is embodied in imports; a disproportionate amount from developing countries. Different methods of calculating the total impacts from Norway were considered; producer responsibility or consumer responsibility. Currently, it is assumed that the producer is responsible for pollution, but since Norway is a net exporter of pollution then consumers are made responsible for a larger portion of pollution than they actually consume. It is argued that a better approach would be to have the consumer responsible for emissions, thereby encouraging consumers to purchase from regions with low embodied emission intensities.

The environmental impacts of total aggregated households also showed a large portion of the emissions coming from imports. It was also found that a large percentage of the emissions came from a limited number of sectors. The importance of value chains through both interindustry linkages and trade flows was discussed.

Calculations were then performed at the household level. These studies allow more detailed studies of emissions resulting from different consumption patterns. It is hoped that future studies in this direction will allow detailed studies of lifestyles and sustainable consumption patterns. At the most detailed level a product service system was analyzed. The results were very sensitive to the way the rebound expenditure was spent. If, for instance, the money saved through using public transport and non-motorized transportation was spent on air travel, then the rebound emissions overcame any environmental benefits.

Various technical issues were identified through this study, including:

- Consistency of IO, trade, emissions, and energy data across the various statistical sources.
- The handling of competitive and non-competitive imports.
- How best to adjust for different currencies: Market Exchange Rates or Purchasing Price Parity.
- Details of imported goods should be collected through the SCE.
- More detail is required on direct fuel use in the SCE.
- More detail is required on transportation usage in the SCE. Perhaps through combinations of the SCE and the Norwegian Travel Survey (Denstadli and Hjorthol, 2002).
- A recurring issue since the initial studies (Herendeen and Tanaka, 1976) is the difficulty with taxes and margins.
- Dealing with different markups on similar products of different branding or quality is problematic.
- Emissions from the international transportation of goods needs to be estimated.

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References

Ahmad, N., Wyckoff, A., 2003. Carbon dioxide emissions embodied in international trade. DSTI/DOC(2003)15, Organisation for Economic Co-operation and Development (OECD).

Briceno, T., Peters, G., Solli, C., Hertwich, E., 2005. Using life cycle approaches to evaluate sustainable consumption programs: Car sharing. Working paper, Industrial Ecology Programme, Norwegian University of Science and Technology, Trondheim, Norway.

Denstadli, J. M., Hjorthol, R., 2002. 2001 Norwegian Travel Survey. Institute of Transport Economics.

Heijungs, R., Suh, S., 2002. Computational structure of life cycle assessment. Kluwer Academic Publications, Dordrecht, The Netherlands.

Herendeen, R., 1978. Total energy cost of household consumption in Norway, 1973. Energy 3, 615–630.

Herendeen, R., Tanaka, J., 1976. Energy cost of living. Energy 1 (2), 165–178.

Hertwich, E., 2004. Lifecycle approaches to sustainable consumption: A critical review. Environmental Science and Technology , submitted.

Hertwich, E., 2005. Consumption and the rebound effect: An industrial ecology perspective. Journal of Industrial Ecology 9 (1/2), to appear.

Hertwich, E., Erlandsen, K., Sørensen, K., Aasness, J., Hubacek, K., November 2002. Pollution embodied in Norway's import and export and its relevance for the environmental profile of households. In: Hertwich, E. (Ed.), Life-cycle Approaches to Sustainable Consumption Workshop Proceedings. Interim Report IR-02-073. International Institute for Applied Systems Analysis, Laxenburg, Austria, pp. 63–72.

Hubacek, K., 2002. Emission intensities for China (unpublished data). International Institute for Applied Systems Analysis, Laxenburg, Austria.

Lenzen, M., 2002. A guide for compiling inventories in hybrid life-cycle assessments: Some Australian results. Journal of Cleaner Production 10, 545–572.

Lenzen, M., Dey, C., Foran, B., 2004a. Energy requirements of Sydney households. Ecological Economics 49, 375–399.

Lenzen, M., Pade, L.-L., Munksgaard, J., 2004b. CO_2 multipliers in multi-region input-output models. Economic Systems Research 16 (4), 391–412.

Miller, R., Blair, P., 1985. Input-output analysis: Foundations and extensions. Englewood Cliffs, NJ, Prentice-Hall.

Munksgaard, J., Pedersen, K. A., 2001. CO_2 accounts for open economies: Producer or consumer responsibility? Energy Policy 29, 327–334.

Munksgaard, J., Wier, M., Lenzen, M., Dey, C., 2005. Using structural economics to measure the environmental pressure of consumption at different spatial levels. Journal of Industrial Ecology 9 (1/2), to appear.

Nansai, K., Moriguchi, Y., Tohmo, S., 2003. Compilation and application of Japanese inventories for energy consumption and air pollutant emissions using input-output tables. Environmental Science and Technology 37 (9), 2005–2015.

Nijdam, D., Wilting, H. C., Goedkoop, M. J., Madsen, J., 2005. Environmental load from Dutch private consumption: How much pollution is exported? Journal of Industrial Ecology 9 (1/2), to appear.

Peters, G., Briceno, T., Hertwich, E., 2004. Pollution embodied in Norwegian consumption. Working Paper 6/2004, Industrial Ecology Programme, Norwegian University of Science and Technology (NTNU), Trondheim, Norway.
URL `http://www.indecol.ntnu.no/`

Peters, G. P., Hertwich, E., 2004. Production factors and pollution embodied in trade: Theoretical development. Working Paper 5/2004, Industrial Ecology Programme, Norwegian University of Science and Technology.
URL `http://www.indecol.ntnu.no/`

Suh, S., Huppes, G., 2002. Missing inventory estimation tool using extended input-output analysis. International Journal of Life Cycle Assessment 7 (3), 134–140.

Vringer, K., Blok, K., 1995. The direct and indirect energy requirements of households in The Netherlands. Energy Policy 23 (10), 893–910.

Whitelegg, J., Britton, E. E., 1999. Carsharing 2000 - A hammer for sustainable development. World Transport Policy and Practice (special issue) 5 (3).

Wier, M., Lenzen, M., Munksgaard, J., Smed, S., 2001. Effects of household consumption patterns on CO_2 requirements. Economic Systems Research 13 (3), 259–274.

Wyckoff, A. W., Roop, J. M., 1994. The embodiment of carbon in imports of manufactured products: Implications for international agreements on greenhouse gas emissions. Energy Policy 22, 187–194.

From theory to practice - Towards an efficiency of consumption

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Abstract

In theory, by making appliances more energy efficient, the households' aggregated energy consumption should be reduced. In practice though, this does not seem to be the case: Results of efficiency improvements are delayed, disturbed and/or reduced. The ***use*** of products change as their technological performance is changed. Energy efficient light bulbs could be left on continuously, while conventional light bulbs might be turned off during the day. Car engines are more energy efficient, but that is per kilogram of car – and the average weight of cars have increased in parallel, or more thereby offsetting the gains. Throne-Holst (2003) shows this tendency for the VW Golf since its introduction on the market in 1974 and up till today. We believe that the developments on greater efficiency can go independent from developments of other properties of a car, in this instance, and that this is the problem.

From this it follows that the mere theoretical value of energy efficiency of products would not be the correct number to apply when calculating expected domestic energy savings. We will have to include the everyday setting in which most products appear. Rather than performing this on an individual level, we will try to give a more general description of some relevant features of everyday life in Western Households, that contribute to determine the use of products, and thereby the actual energy efficiency of technological development.

Introduction

In a Directive from the European Commission in 2003 on household refrigerators and freezers, it is first stated that they account for *"..a significant part of total Community household energy demand. The further scope for a reduction of energy use by these appliances is substantial*". The "*success*" of the labelling scheme of these products is based on the "*rise of the efficiency index of new refrigerators and freezers by over 30 % between 1996 and 2000*" (European Commission, 2003). Resulting energy savings from efficiency measures seems more or less implicitly anticipated. From this we can derive that they expect reductions or at least curbed growth in energy consumption from the labelling measures, as there is no logic in wanting energy efficient devices on the market without expecting changes in the consumption of energy. We believe there is reason to question this assumption.

This strongly resembles what we call the "techno-optimist" tradition. Its main feature is the belief that the developments in technology alone will solve the environmental challenges we face today. Little or no consideration is given to implementation and actual use of the developed products, and not much consideration is given to our present consumption patterns. First and foremost is the well-known book *Factor Four: Doubling Wealth, Halving Resource Use*, where the authors claim: "*Or to put it another way, it means we can accomplish everything we do today as well as now, or better, with only one-quarter of the energy and materials we presently use*" (Weizsäcker et al., 1997). In this frame of understanding, technology will do "the dirty work" of reducing the environmental load, so there will be no need to change consumption patterns, and accordingly no need for consumer asceticism or self-sacrifice.

In the foreword of a book reporting from the Dutch national research programme Sustainable Technology Development, it is said: *"..one of the main responsibilities of the present generation to future generations is to work today to find technological breakthroughs with the potential to deliver eco-efficiency improvements of the needed scale within the relevant time constraints*." (Jansen and van Grootveld, 2000).

Technological development is an important factor when we envision a sustainable society, but we should not rest on it exclusively. Certain measures and important choices must still be made regarding our consumption patterns or lifestyle.

1. Energy efficiency

In a number of areas, energy efficiency efforts have paid off, and technological developments have resulted in great savings. The problem is that too often "other developments" occur in parallel that tend to delay or reduce the resulting savings. Is this the result of economic forces? Could it be explained by saved fuel costs being used in new areas, so that without the improvements of the engines, the security devices would not have come about? This argument is applied by economists first and foremost, and they call it "The Rebound Effect".

1.1 The Rebound Effect

The rebound effect can be quantified as the difference between the mechanically derived energy saving resulting from an increase in efficiency and the actual energy savings (Musters, 1995; VTPI, 2002). In other words:

Rebound Effect = Potential savings – Actual savings

Khazzom (1980) describes the effect in a well-known article, although he does not actually use the term "rebound effect". He criticizes the idea that energy savings of mandated efficiency standards can be derived mechanically: If standards raise the efficiency of a car with 1%, fuel demand is expected to drop 1%.

Those who expect such one-to-one relationships overlook that changes in energy efficiency of appliances have a "price content", according to Khazzom (1980). If you buy an appliance that is twice as efficient as your old one, the effective price of fuel is reduced to a half. As long as the elasticity of energy demand with respect to energy price is not zero, there will be a pressure on energy demand. This pressure will at least partly offset the mechanically derived energy savings.

In a response to a paper in the journal Energy Policy, concerning nuclear energy and energy efficiency, Len Brookes writes an answer on the issues of energy efficiency, *The greenhouse effect: the fallacies in the energy efficiency solution* (Brookes, 1990). Here he repeats and develops Khazzoms arguments:" …there is no evidence that using energy more efficiently reduces the demand for it" (Brookes, 1990). The conversion factor of fuels to useful energy has improved drastically over the last 100 years, he claims, and yet we now consume more energy both in total and per capita. A simple explanation to this is that the implicit price for the commodity "energy" have been reduced due to the efficiency development, and the demand have responded to the falling prices.

In a survey of the rebound effect, Greening et al. (2000) claim that an increased demand for an energy service, not countered by an increase in the fuel price, can diminish technological efficiency gains. Although this is firmly rooted in neoclassical economic theory, which is controversial in itself, the real controversy concerns the identification of sources and the size of the rebound effect, say the authors. The authors conclude that although efficiency improvements are partially offset by increases in consumption, they will result in an overall reduction in the consumption of energy.

In many ways the debate concerning the existence and size of the rebound effect presuppose or contain the debate on technology's role and ability in solving environmental problems. To those who argue that the rebound effect is small or non-existent, the following claim from *Factor Four* sounds familiar: "Or to put it another way, it means we can accomplish everything we do today as well as now, or better, with only one-quarter of the energy and materials we presently use" (Weizsäcker et al., 1997). Some claim that in this line of thinking energy efficiency programs are the ultimate "free lunch" for politicians, not only enabling them to meet environmental targets but also to do that in a costless or even profitable way without politically unpopular measures (Brookes, 2000).

So far, it is the economical understanding of the rebound effect that has been presented, but it seems quite clear that the ***term*** "rebound effect" is very much confined to the economical sphere. Several non-economists discuss similar features; where potential eco-efficiency gains are offset by growth in consumption, without the authors using or referring this term (McDonough and Braungart, 1998; Náray-Szabó, 2000; Uiterkamp, 2000). Uiterkamp (2000), a professor of the Environmental Sciences, refer to the phenomenon: "This seems to be a common finding: technological improvements are offset by volume effects resulting from behavioral, social or demographic factors". In an extensive review of the literature on energy consumption in the years preceding 1997, Aune (1998), a sociologist, makes no reference to the rebound effect. This might be explained by the fact that she was looking for literature on energy consumption, rather than energy conservation. But again it looks like the rebound explanation is confined to the economists' sphere.

It seems likely that growth in consumption can occur without being a response to a change in the effective price of a consumer good or service. In line with this thinking it is suggested that energy efficiency measures can be offset by growth in consumption through other mechanisms than a pure price mechanism.

1.2 Beyond the Rebound Effect: Household dynamics

An example of this would be how the growth in the number of households we witness especially in the Western world (Liu et al., 2003), at least partly offset eco-efficiency measures on household goods and home insulation. As growth in household numbers globally is more rapid than population growth on a global scale, it means that the numbers of persons per household is shrinking (ibid.). This is probably an even clearer trend on Western countries. This poses a challenge since smaller households have higher per capita resource consumption (ibid.; Kok et al., 2003; Throne-Holst et al., 2002).

Some of the reasons for the growth in household numbers/ reduction in household size are listed in Liu et al. (2003; 532): "*Proximate causes of a reduction in household size include lower fertility rates, higher per capita income, higher divorce rates, ageing populations, and a decline in the frequency of multi-generational families living together*".

This growth in the number of households has a twofold environmental effect:

1): Increased living area: this is a combined effect of greater prosperity – increased comfort and bigger houses – and a tendency towards a greater number of households or fewer persons per household. More domestic space to heat/cool: Between 1972 and 1992, the total amount of energy used for space heating in Denmark (national aggregate) fell with more than 30% (Meyer et al., 1994). The authors claim that this was a result of a targeted policy including energy taxes and subsidies. This resulted from better insulation and other technical measures in addition to a more careful usage of heating (ibid; 24). But it turns out that per square meter living area the reduction was actually more than 50% (ibid; 93). 20% of the improvement or more was eaten by other factors. The reason for the discrepancy is (of course) an increase in the number of square meter living area per person in the same period.

Additionally, more living space also boosts the need for space on where to build the housing units as well as building materials (Liu et al., 2003).

2): A growing number of households also mean that more household appliances are sold. This goes especially for the items that comprise a common standard/basic appliances like: refrigerator, cooker (stove), washing machine, television set etc. This standard would also include furniture. We would expect the numbers of cars to increase for the same reason.

All these products increase the indirect energy use of households. Indirect energy use is the energy needed to produce and transport the products to the households (Throne-Holst et al., 2002).

1.3 Challenges from empirical material

How do developments in other areas actually influence our consumption levels and patterns? What are the mechanisms that reduce the real gross energy savings from efficiency measures?

Refrigerators/freezers

Norwegian material indicates that new, energy efficient household appliances do not necessarily substitute old ones, but are rather added to the "machine park". That is, when you buy a new refrigerator or freezer, the old one regularly is not thrown away or disposed off, but rather moved out into the garage, basement or cabin (Strandbakken, 2005). Here it is plugged in, and continues to be in use, most likely as a "back-up" cold appliance for sodas, beers and pizzas, and situations where there is an extra need for capacity, like parties. Hence the households total energy use for refrigeration purposes ***increases*** as a result of the purchase of a new energy efficient device. Of course would this be even worse if your new refrigerator was less energy efficient. But our point here is to show how energy efficiency gains may be delayed.

Washing machines

There has been a strong rise in researchers' interest in clothing care and washing machines in the later years, and several authors have noted the strong increase in usage (Shove, 2003; Klepp, 2003; Weaver et al., 2000; Vezzoli, 2000). The different authors have given different explanations, and have contrary focuses, but it seems rather clear that the increased use of washing machines has its roots in developments in other areas:

Clothes: introduction of new textile fibres that have to be cleaned separately and sometimes more often, as well as a shift in fibre preferences, most notably from wool to cotton. And a growing number of coloured textiles, that also have to be washed separately, to avoid cross-colouration (Klepp, 2003: 96-97). At the same time hygienic standards have changed: The question of why we wash has two main reasons (Klepp, 2003: 209-213): there are social reasons that mean avoiding social exclusion. In addition we have aesthetic reasons, where smell has a prominent place. Both factors tend to increase the number of washing cycles per household.

So the technical development of washing machines and washing powders that have resulted in a lower environmental load per washing cycle, have not delivered a smaller aggregated environmental load from clothes washing, at least not in the scale to be expected when looking at the efficiency improvements of each machine or cycle. It has been disturbed and reduced by changes in clothing habits and washing habits.

Mobility

Much has been gained in fuel efficiency of car engines since their invention, and this progress has especially speeded up in the last 20-30 years. So most of today's car engines are very efficient, and do have very low fuel consumption. But this changes if we shift the focus from fuel use per ***weight unit of car***, to fuel use ***per car***: Parallel to the development in engine performance, car designs have changed as well, resulting in the increased weight of most cars. Among the strong contributors are safety devices (Throne-Holst, 2003). To reduce damage if cars collide steel beams and air bags are installed. Air conditioning and servo control are more typical comfort measures. These contribute both by their weight, and some also increase the direct energy demand (to run the air conditioning, for instance).

Are demands for security and comfort developments that are and should be justified outside the strict economic framework? And are they independent of environmental frameworks as well?

1.4 The Haunting of the Rebound Effect

The three examples we just have described, can obviously be "forced" or reduced into an economic framework, and accordingly be explained by the rebound effect. The real price of energy is shrinking, and our demands for energy use are therefore increased. Electricity is so versatile, the demand for it is very flexible, and it can be used for satisfying "endless" needs:

- It is because the real price of energy is getting lower that we have the second refrigerator still running in the basement.
- The washing machine is used more, because the price per washing cycle is cheaper
- The low real price of fuels, makes us able to demand greater security and comfort in our cars

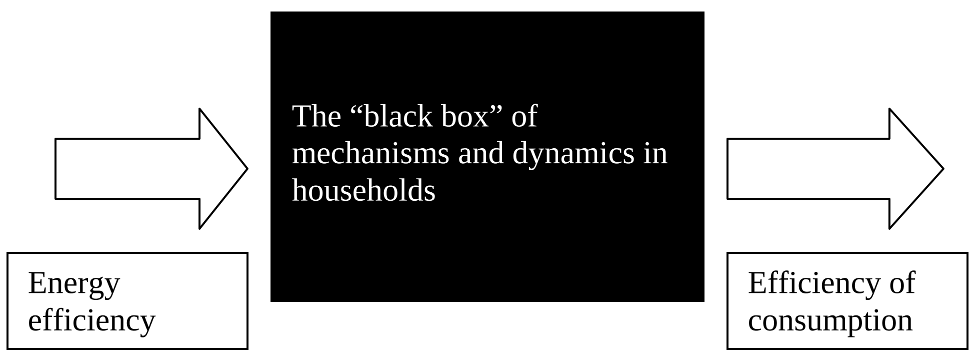
So, are we just witnessing the Rebound effect at play once again? In socioeconomic models societal matters tend to be reduced to economic considerations only. To this we would claim otherwise: in a rather rhetorical fashion we could ask: are all everyday actions the result of economic considerations? In Norway the societal focus appear to be that although approximately 10% of total consumption expenditure income is used for food, many households use more than 10% their available time trying to cut back these costs. Much more money could probably been saved in their remaining 90% of consumption. Of these 90%, much is probably more or less taken for granted, and energy expenditures are probably one of these. From this we may deduct that changes in energy prices do not necessarily have a great impact on consumption patterns, within reason of course. Regarding energy prices, we believe there is need to separate between effects on consumption from rapid or sudden changes, and changes in the long term.

When changes in lifestyle and consumption patterns occur, for instance due to an increased concern for environmental issues or as results of reduced number of adults per household we believe that the purely economic approach offers a too narrow explanation of consumer behavior. Basically, I do not drive the extra kilometers because of lower fuel prices, but because I try to meet challenges of career, family and social-cultural belonging. Economy obviously is a constraint, but fuel prices do not explain my increased mobility after divorce or job change. Neither will reduced price per washing cycle explain changing hygiene standards.

2. Energy efficiency of consumption

Although the Rebound Effect seems to describe or explain certain aspects of the fallacy of energy efficiency, we believe that there are other important aspects that not are covered. Among them is the idea that not all choices and actions by households are based on economic consideration alone.

Other authors have proposed the term “efficiency of use” to address to apparent problems with “energy efficiency” (e.g. Throne-Holst, 2003). Here we propose the term “efficiency of consumption”. It can be illustrated as follows:



As we can see from this illustration the mechanical energy efficiency is a very important input and determinant of the efficiency of consumption, but the two are not equal. Energy efficiency is moulded and shifted in the meeting with the “black box” of the household and the activities and choices made there. Developments in the energy efficiency is therefore crucial to improve the efficiency of consumption, but the transformation of energy efficiency in the everyday life of households must be taken into consideration when calculating expected reductions in energy use from efficiency measures.

On the consumption side, households are an appropriate unit, as most of consumption takes place in this context. Household consumption is also considered “..the very basis of economic activity” (Kok et al., 2003). This is because choices on the households’ spending to a high degree affects activities on the production side, and associated environmental loads.

Incorporated in ***consumption*** are the following points (Throne-Holst, 2004):

- planning of purchases

- the moment of purchase
- use
- durability
- repairs
- purchase of supplements
- disposal

With this in mind, we believe that the new term “efficiency of consumption” frame more of the actions performed by households that are relevant to get a clearer picture of the final savings from efficiency measures. It also embraces the products’ complete presence in the household. Each of the seven points above should, where relevant, be included in an evaluation and analysis of households’ energy use. Through such an approach we will get closer to the real energy use in households.

It should be noted that we by this do not exclude a possible “rebound effect”, it may well be one of the dynamics in the households, and together with others participate in determining the shifting of the energy efficiency.

We hope that others see this as a fruitful and fertile way of getting to grips with the problems of realizing efficiency efforts into actual energy savings. Especially we hope to achieve a greater understanding what mechanisms and forces that are at play when products and services are chosen and used by the households. Ultimately this will help us to more potent and effective ways of changing consumption patterns and reach sustainability.

References

- Aune, M. (1998): *Nøktern eller nytende. Energiforbruk og hverdagsliv i norske husholdninger*. STS rapport 34. Trondheim : Centre for technology and society, Norwegian University of Science and Technology.
- Brookes, L. (1990): *The greenhouse effect: the fallacies in the energy efficiency solution.* Energy Policy 18 (2): 199-201.
- Brookes, L. (2000*): Energy efficiency fallacies revisited*. Energy Policy 28 (6-7), pp. 355-366.
- European Commission (2003): *Commission Directive 2003/66/EC of 3 July 2003 with regard to energy labelling of household electric refrigerators, freezers and their combinations.* Official Journal L 170, 09/07/2003, pp.0010-0014.
- Greening. L.A., Greene, D.L., Difiglio, C. (2000): *Energy efficiency and consumption -the rebound effect - a survey.* Energy Policy 28 (6-7), pp. 389-401.
- Jansen, L., van Grootveld, G. (2000): *Foreword*. In: Weaver, P., Jansen, L., van Grootveld, G., van Spiegel, E., Vergragt, P. 2000. *Sustainable Technology Development.* Sheffield: Greenleaf Publishing Limited, pp.7-9.
- Khazzoom, J.D. (1980): *Economic Implications of Mandated Efficiency in Standards for Household Appliances*. The Energy Journal 1(4), pp. 21-40.
- Klepp, I.G. (2003): *Fra rent til nyvasket. Skittent og rent tøy.* Professional Report no.2-2003, Oslo: SIFO.
- Kok, R., Falkena, H.J., Benders, R.M.J., Moll, H.C., Noorman, K.J. (2003): *Household metabolism in European countries and cities.* ToolSust-Deliverable No.9: Integration Report of WP 2. IVEM-onderzoeksrapport nr. 110. Groningen: University of Groningen.
- Liu, J., Daily, G., Ehrlich, P.R., Luck, G.W., (2003): *Effects of household dynamics on resource consumption and biodiversity*. Nature 421 (6922), pp. 530-533.
- McDonough, W., Braungart, M. (1998): 25th July 2002, *The NEXT Industrial revolution.* The Atlantic Monthly Company, October 1998. Available:
- www.theatlantic.com/issues/98oct/industry.htm, email: web@theatlantic.com [Webmaster].

- Musters, A.P.A. (1995): *The Energy-Economy-Environment Interaction and The Rebound Effect.* Internal Report ECN-I—94-053. Netherlands Energy Research Foundation ECN.
- Náray-Szabó, G. (2000): *The role of technology in sustainable consumption*. In: Heap, B., Kent, J. (Eds.), *Towards sustainable consumption. A European perspective*. London: The Royal Society, pp. 67-73.
- Shove, E. (2003): *Comfort, Cleanliness and Convenience. The Social Organization of Normality.* New Technologies/New Culture Series. Oxford: Berg Publishers.
- Strandbakken, P. (2005): *Produktlevetid og miljø.* PhD.thesis, University of Tromsø. *Forthcoming.*
- Throne-Holst, H., Stø, E., Kok, R., Moll, H. (2002): *Household Metabolism in Fredrikstad.* ToolSust-Deliverable No.8: Norwegian National Report. Project Report No. 9-2002. Lysaker: SIFO.
- Throne-Holst, Harald (2003): *The Fallacies of Energy Efficiency: The Rebound Effect?* Paper at the "Strategies for sustainable energy technology", workshop in Trondheim November 20-21.
- Throne-Holst, Harald (2004): *Bærekraftig forbruk?* Feature article, Dagsavisen, 01.12.2004, pp.3.
- Uiterkamp, A.J.M.S. (2000): *Energy consumption: efficiency and conservation*. In: Heap, B., Kent, J. (Eds.), *Towards sustainable consumption. A European perspective*. London: The Royal Society, pp. 111-115.
- Vezzoli, Carlo (2000): *The Clothing Care Function*. Final report, Sushouse Project. Delft: Delft University of Technology
- VTPI (2003): 13th February 2003, Victoria Transport Policy Institute, TDM Encyclopaedia, *Rebound Effects, Implications for Transport Planning*, Available: http://www.vtpi.org/tdm/tdm64.htm, email: tdm@vtpi.org [Owner].
- Weaver, P., Jansen, L., van Grootveld, G., van Spielgel, E., Vergragt, P. (2000). *Sustainable Technology Development*. Sheffield: Greenleaf Publishing Limited.
- Weizäcker, E.v., Lovins, A.B., Lovins, L.H. (1997): *Factor Four. Doubling Wealth - Halving Resource Use*. London: Earthscan.

The fallacy of *ceteris paribus* and real consumers - An attempt to quantify rebound effects.

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Abstract

Sustainable consumption assessment extends the scope of life cycle assessment in at least two respects: First, sustainable consumption looks also into societal and economic consequences of consumption and second, the impact on the consumption pattern becomes relevant above the single product perspective. Two tools have been developed to address this second extension. The first tool is a checklist approach for the design phase of sustainable activities, products and services. It is semi-quantitative in nature and combines results from streamlined life cycle assessment with a rebound factor and an indicator that is supposed to indicate the propensity to consume less, i.e., to escape the consumption treadmill. The second tool is the assessment method we call "CHap". It allows (i) for a more generic functional unit that we call ultimate utility and is approximated by change in happiness and (ii) by allowing for less *ceteris paribus*[1] assumptions. Instead of accepting the assumption that only the product/activity at stake is allowed to change we look into actual changes in consumption patterns that occur at the same time. The CHap approach is demonstrated with data derived from households of young Japanese women using the examples of cloth dryers, personal computers and mobile phones. The results suggest that chosen examples have small impacts on happiness but that considerable changes in other consumption categories occur. Whether these observed changes can be considered to be rebound effects is less than obvious and may need additional information from the consumers. While the usefulness of the CHap approach will depend on the availability of a large quantity of consumption data for the consumer group at stake, the checklist approach is readily available.

[1] This Latin expression refers to the often used assumption in modelling, where everything else other than those variables that are explicitly allowed or supposed to change remain the same. In environmental product life cycle assessment, this assumption is used for most part of the production and consumption function.

1. Introduction

Attempts to reduce CO_2-emissions per capita prove to show limited success – if at all. Especially approaches relying primarily on technological progress that increase the energy efficiency of services have often failed to materialize expected reductions in fossil fuel consumption. Such concepts need to be extended by considering two additional mechanisms: First, existing products or services are not just replaced by the new and more efficient alternative and second, consumers have no intrinsic motivation to reduce energy consumption but to maximize ultimate utility. Therefore, ways to predict changes in consumption patterns and ultimate utility are needed in order to estimate CO_2 emission changes due to the introduction of new technologies or products.

1.1 Objectives

State-of-the art design and assessment methods used for sustainable production have many shortcomings when applied to sustainable consumption. Two shortcomings shall be addressed in this project:

1. Consumers rarely substitute ONE old consumption activity by ONE (and only one) new consumption activity. This yields to rebound effects that may turn the introduction of a new (seemingly) sustainable consumption activity into the reverse (or *vice versa*) (Greening et al. 2000, Binswanger 2001). Such behavioural changes in consumption are usually neglected by assuming *ceteris paribus*.

2. Practitioners of life cycle assessment methods often measure the utility of products and services in units such as kg, meters, square meters, or number of pieces and economists often use willingness to pay or actually paid market prices. However, consumers strive to maximize their ultimate utility that may better be approximated with measures of quality of life and subjective well-being. We suggest that the acceptability of changes towards sustainable consumption patterns can be improved when ultimate utility increases. This would also reduce compensational consumption addressed in point 1 above.

Understanding the consequences of activities, products, and services not only in terms of environmental life cycle impacts but also in terms of their impact on the change in consumption pattern and the change in utility has been the major objective of this project.

1.2 Approach

Taking the designer perspective we present two tools: one for the early design phase and one for the assessment of goods introduced in the (pilot) market. Both tools consider impacts on happiness, environment, and change in consumption patterns. The checklist approach for the early design phase relies on semi-quantitative assessments that are largely based on four formerly unconnected bodies of knowledge (see Section 2.1). The assessment approach builds on longitudinal panel data that allows to identify changes in household activities and subjective well-being and was combined with a hybrid method to assess changes in CO_2-emissions (see Section 2.2).

1.3 Underlying hypotheses and evidence from literature

In Hofstetter & Madjar (2003) we introduced the idea of limiting factors[2] and drivers of consumption. Drivers can be understood at the top level where we see individuals maximizing their ultimate utility. On a level lower basic needs and their satisfiers can be understood as well as drivers to consumption. We suggest that the better a consumption activity both fulfils basic needs and maximizes utility the lower the propensity to get into a tread mill. In a tread mill consumption does not really satisfy and triggers more consumption. This means that our new tools base on the hypotheses that:

a) The better an activity, product, or service satisfies basic needs and maximizes ultimate utility, the lower the propensity for more (material) consumption. In other words: There is a saturation for the willingness to increase utility and therefore also a saturation in consumption.

b) Maximizing ultimate utility is possible without increased material consumption or even with less than average consumption.

Although we did carefully review the literature there is only limited evidence to support those two hypotheses. Sure, there is enough evidence that non-materialistic people can have very high levels of happiness or that some countries with low GDP per capita score high on happiness. However, we know little what happens when these people attempt to change their happiness and/or consumption level. Some of this evidence will be presented here. Extended reviews in Hofstetter & Madjar (2003) and Madjar & Hofstetter (2004b) do provide enough support to justify work that builds on these hypotheses because there is as well no good evidence against these assumptions.

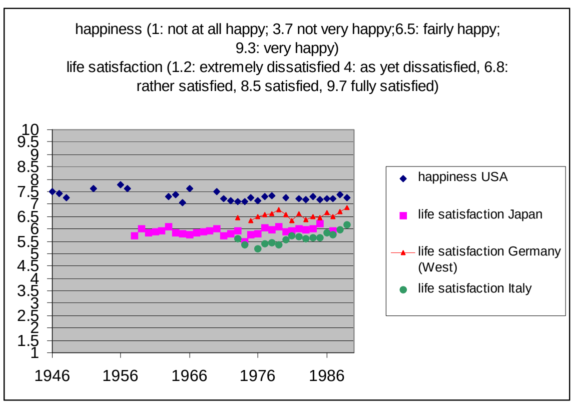
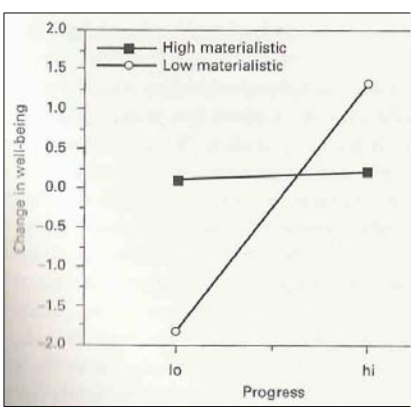


Figure 1: Happiness and life sections over time in four different nations (Veenhoven 1993). The scales have been transformed and the difference in values between nations has no meaning here.

Frey & Stutzer (2002) show that although income per capita in Japan rose between 1958 to 1991 from less than 3000 US$ to about 15'000 US$ the life satisfaction was more or less stable over this time (life satisfaction was between 2.5 and 2.8 rated on a 4-point scale, Figure 1 shows the result transformed to a scale from 0-10). The same applies to happiness levels in the USA and life satisfaction levels in Germany and Italy. This suggests that there is no correlation between GDP per capita and subjective well-being which is a necessary condition for hypothesis (b).



Kasser (2002) analyzed the influence of making

[2] such as money, time, space, skills, information, and other scarce resources

progress towards materialistic and non-materialistic goals and showed that making progress in materialistic goals did not enhance the well being level (high materialistic line) while achieving non-materialistic goals enhances the well-being level (see Figure 2). However, not achieving non-materialistic goals lowers the well-being level while not achieving materialistic goals hardly affects well-being. These are important findings and support at least hypothesis (b).

Figure 2: Changes in well-being as a function of the progress in materialistic and non-materialistic goals (Kasser 2002)

Diener & Oishi (2000) showed that those valuing love higher than money have a much higher life satisfaction than those who give priority to money (the higher the importance of love is, the higher is also the life satisfaction level (see Figure 3). They used data from 7'167 students in 41 countries. Therefore, this outcome is not biased by cultural factors. There is a positive correlation between love and life satisfaction but a negative correlation between money and life satisfaction. Therefore, this excludes "money" as measure for ultimate utility and would support hypothesis (a) with subjective well-being as utility measure.

Diener and Seligman (2004) discussed the causal way of happiness and materialism and suggested that although most studies concluded that materialism tend to decrease happiness it could also be that unhappiness could drive people to focus on extrinsic goals such as material wealth. Further they state that "longitudinal data indicate that part of the typical correlation between income and well-being is due to well-being causing higher incomes rather than the other way round". If this is true then it would be interesting to analyze what influence enhancing subjective well-being will have on materialism and consumption? Income is rather highly correlated with consumption. Will this possibly higher consumption be sustainable? Would this lead again to a negative effect (rebound effect) on happiness? This is why we suggest in Section 4 to falsify our hypotheses with additional analysis.

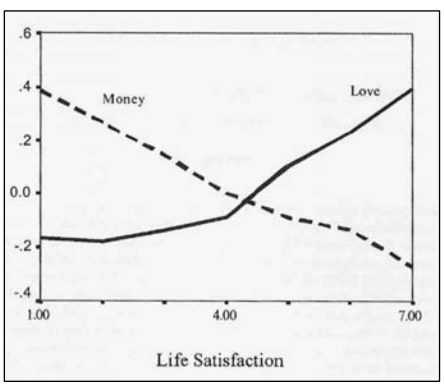


Figure 3: Relation between life satisfaction and love respectively money (Diener and Oishi 2000)

Based on the review in Hofstetter & Madjar (2003) we concluded that "happiness" might be a good indicator for ultimate utility. As long as no cross-cultural comparisons or generalizations are made, happiness is a good and simple self-reported measure of subjective well-being. Although both the checklist approach and the CHap method focus on happiness as a measure for ultimate utility our results sometimes also report life satisfaction and standard of living.

Section 2 provides short descriptions of the applied methods for both tools and Section 3 provides illustrations through examples. Section 4 offers a discussion of the results and conclusions from this work.

2. Methods

We propose two new tools for the sustainable consumption toolbox: First a checklist approach to support design for sustainable consumption[3] and second, a method to quantitatively assess behavioural aspects of consumption and its consequences on CO_2-emissions and happiness. The checklist-approach serves for the early design stages for sustainable activities, products, services (APS) when not all parameters are known and support is needed to come up with more sustainable alternatives. The quantitative assessment method is only applicable for APS that are at least partly introduced in the market for at least a year. It may serve to screen a large number of established APS and rank them according to the newly developed CHap index.

2.1 Design for sustainable consumption: The checklist approach

The semi-quantitative checklist approach combines four so far separated fields of importance to sustainable consumption:

i) The work on basic needs and satisfiers by Max-Neef (1991) is re-interpreted and operationalized.

ii) Happiness-enhancers have been compiled .

iii) Six limiting factors that have been proposed to cause rebound effects are combined to a rebound factor.

iv) A streamlined life cycle assessment is used to quantify potential life cycle impacts of APS.

Max-Neef (1991) suggested that there are nine universal basic needs (subsistence, protection, affection, understanding, participation, leisure/idleness, creation, identity, freedom) plus transcendence, which is not yet universal. He also gives a total of 129 satisfiers, i.e., factors that support the satisfaction of these needs when we look at the existential categories of "being" and "doing". Although "subsistence" is considered to be the most basic need neither Max-Neef nor we did apply a hierarchy to these needs. We also assumed that all satisfiers are equally important. Therefore, an activity, product or service (APS) that covers several satisfiers and needs would be preferable over APS that focus on one need only. The assumption is that the better basic needs are satisfied through APS, the less individuals would be prone to consume more.

The second building block assumes that only happy people will feel less pressure to consume more with the idea that this would make them happier. As stated before, this assumption needs more evidence. However, we are convinced that offering APS that increase happiness offer the needed basis for sustainable development. Table 2-1 offers a list of happiness enhancing activities that have been collected from psychologists, psychiatrist, anthropologists and other scientists (see, e.g., Fordyce (1993), Wiesemann (2003), Myers (2004), Varughese (2004), and Monthier (2004)). This unique list that builds on Hofstetter & Madjar (2003) and Madjar & Hofstetter (2004b) has been analyzed using elements of Vester's (2000) paper computer to identify this factors that

[3] Whenever we claim throughout this paper to develop tools for sustainable consumption we focus on the environmental and sometimes CO_2-dimension only.

are likely to play a very active role in stimulating or buffering other factors (Hofstetter & Madjar 2005). These insights on the relative influence on each other has led to a preliminary weighting of the happiness enhancers.

	Happiness enhancers	weight
A	keep busy and active	1
B	become an outgoing social personality creating networks	1.5
C	meaningful work that engages your skills	1.5
D	lower expectations & aspirations	1
E	positive, optimistic thinking for present and future	1
F	become present oriented	1
G	healthy personality (food, sleep, movements)	1.5
H	skill engaging leisure activities	1.5
I	be yourself	1
J	prioritize close relationships	1
K	nurture spiritual (religious) self	1.5
L	focus beyond self	1
M	don't equate happiness with money	1
N	Take control of your life, get organized	1
O	Enhance self-esteem	1.5
P	act extraverted	1.5
Q	have sex with a person you love	2
R	prioritize happiness, act happily	2.5
S	be grateful	1
T	give love a high value in life	1
U	set achievable important non-materialistic goals	2.5
V	be open for new experiences / changes in believes	1

Table 2-1: List of happiness enhancers and a preliminary relative weighting of importance (Hofstetter & Madjar 2005)

Hofstetter & Madjar (2003) identified six major limiting factors to consumption: money, time, space, skills, information, other limiting resources. These six factors are quantitatively modelled and combined to a rebound factor that indicates the tendency of a APS to stimulate or allow for additional (material) consumption. The underlying assumption is that rebound effects have the power to significantly alter the total environmental impacts due to the adoption of a new APS and need to be considered when making recommendations for sustainable consumption (see Section 4).

The following 10-step checklist to design for sustainable consumption builds on these building blocks:

1. Brainstorm on activities, products and services (APS) based on needs, satisfiers, and happiness enhancers (see Hofstetter & Madjar 2005).
2. Identify for each APS the covered needs and satisfiers. Add the number of covered satisfiers and multiply this number by the number of basic needs that are (partly) covered by these satisfiers.
3. Apply the list of happiness enhancers (Table 2-1) to the potentially new APS and make a list of factors that are completely satisfied (3 points), good contribution (2 points), and weak contribution (1 point).
4. Multiply the number of evaluation points from step 2 and 3 with each other. Rank the APS according to the total points and select the top scorers for next steps.
5. Identify for each new APS one to three most similar established APS that might be substituted by APS for sustainable consumption. This should not just be based on intuition but by looking at the basic needs that are most directly satisfied.
6. Adjust the number and repetitions of activities, products, or services to approximately match the size, amount or extent of the new APS described in step 1.
7. Repeat steps 2 and 3 to the identified established APS.

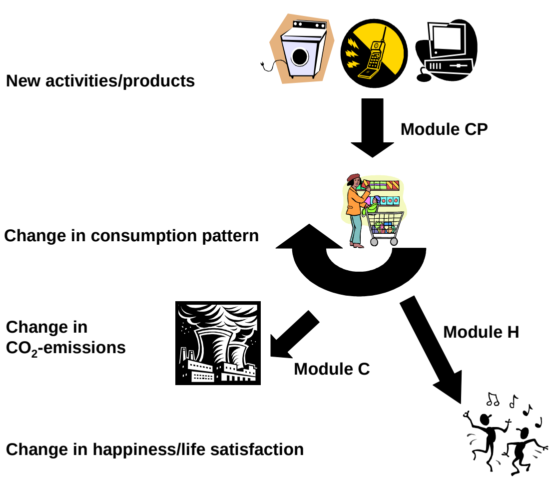
8. Guesstimate for each selected potentially new and existing APS the life cycle costs, hours completely absorbed by APS, dwelling space, and other resources. Further, the share of people without sufficient skills and information should be estimated.
9. Perform a streamlined LCA to get a first estimate on environmental life cycle impacts of all APS under consideration.
10. Use Table 3-1 to evaluate the new APS according to its potential for sustainable consumption and its competitiveness against established APS.

A similar checklist was also developed for improving existing APS and more details are available in Hofstetter & Madjar (2005).

2.2 CHap: An index to assess and rank sustainable consumption activities, products, and services

The methodology includes three modules (Figure 4). We selected the purchase and use of an automatic cloth dryer, a mobile phone and a personal computer as activities to demonstrate the method.

- Module CP calculates the change in **c**onsumption **p**atterns if one of the three mentioned goods has been purchased and supposedly put in service. Ozawa & Hofstetter (2004 c,d) provide the relevant data derived from young Japanese women.
- The data for module H has been derived together with the analysis for module CP and reports the change in **h**appiness when the a new good is purchased and used (together with all the other occurring changes in consumption pattern and lifestyle).
- Changing consumption patterns lead to changes in CO_2 emissions during the production and use phase of goods. These changes have been assessed in module C using a hybrid approach.



The three modules indicated by arrows can be combined to the index *CHap* that quantifies how much an activity contributes – when considering all simultaneous changes and rebound effects - to an increase in happiness and at what expense in terms of changes in CO_2-emission.

Figure 4: Overview on calculation procedure for CHap

This assessment process can be applied to a large set of activities that are suggested to contribute to a more sustainable development. The result could then be a list that ranks those activities either according to their contribution to increase happiness, or according to their changes in CO_2-emission or as a combination of both. This combination of both is the new index introduced here and called *CHap*:

$$\text{CHap}_{\text{i}} = W * \frac{\Delta Happiness_{\text{i}}}{Happiness_{ref}} - \frac{\Delta CO_{2,\text{i}}}{\text{CO}_{2,\text{ref}}} \qquad [-] \qquad (1)$$

Where happiness is measured on a scale from 1 to 5 and CO_2 emissions in kg. This formula allows that increased happiness and reduced CO_2-emissions contribute to higher scores of *CHap*. For $Happiness_{ref}$ we use here the value "2" because people that feel "average happy" get a score of "3" which makes that $\Delta Happiness$ will usually be smaller than 2. For $CO_{2,ref}$ again a person's equivalent per year has been chosen here (10'000 kg CO_2 per year and person). Further, the weighting factor *W* makes sure that an explicit weight must be given. A weight of *W=1* would mean in our case that an increase in happiness by two units (lifting a person from "average happy" to "very happy") is weighted as equal to a decrease of CO_2-emissions by 10'000 kg/a.

Formula (2) allows, once *W* is set, that all activities can be ordered from the highest CHap to the lowest. Where the top activities have the highest potential to contribute to sustainable consumption and the activities with the lowest scores are likely to have either high CO_2-emissions or a low or negative impact on happiness (or both).

Consumption elasticities are one of the new elements of this method. The term elasticities is borrowed from economics where elasticity is used to describe the change in demand (or supply) due to changes in prices. Here we are interested in change of demand due to changes in activities/product acquisition. The idea to calculate elasticities using panel data was inspired by Gershuny (2002) who used a similar approach to tackle with changes in time consumption.

The elasticity coefficients have been calculated as follows:

$$e = \frac{\text{Change of variable for adopters (NY) - Change of variable for non-adopters (NN)}}{\text{Change of variable for non-adopters (NN)}}$$

$$= \frac{NY - NN}{NN} \qquad (2)$$

In order to calculate the resulting CO_2-emissions from changes in induced consumption we use the following general formula:

$$CO_2\text{-emissions} = e*NN*I = (NY-NN)*I \qquad (3)$$

Where *I* is the CO_2-intensity of the variable at stake. The data on CO_2-intensities can be found in Appendix 1 by Sugai & Toyoda in Hofstetter et al. (2004). It is derived from input-output analysis using an extended input-output table for the Japanese economy. Process analysis and literature data was used for the three examples mobile phone, personal computer, and cloth dryer. The data on the change in consumption is taken from Ozawa & Hofstetter (2004c,d). For change in happiness we looked at the difference in change between the non-adopter group (NN) and the adopter group (NY). For a more detailed description of the method and assumptions we refer to Hofstetter & Ozawa (2005) and Ozawa & Hofstetter (2004c,d).

3. Results

3.1 Illustration example "gardening" for the checklist-approach

An old Chinese saying suggests that gardening may make people happy all life. Therefore, this looks like a perfect activity to illustrate the checklist for sustainable consumption. Here we show only the resulting evaluation Table 3-1. In Hofstetter & Madjar (2005) we assumed that having a dog, using a weekend house for maintenance work and walking, or starting yoga classes may be competing alternatives to gardening. We used desktop assumptions to fill in the table and would like to highlight only few issues here:

- In terms of need satisfaction and enhancing happiness the activities gardening, having a dog and starting yoga classes score rather similar. Only the weekend house scores much lower.
- The tendency to cause rebound effects has two sides to the coin. High costs, time and space demand etc. are good to avoid or reduce additional consumption. However, it also may make an activity, product or service less likely to be picked up by consumers. Also, the suggested evaluation procedure leaves much room for interpretation. Therefore, full transparency needs to be kept at the design and evaluation stage.
- We approximate in this example environmental impacts by primary energy demand guessed based on the assumed yearly costs. For the gardening we assumed a berry, fruit, salad and vegetable garden that would substitute for some of the household demand to be produced, stored, and transported elsewhere. Therefore, a net negative impact results.

Table 3-1: Evaluation table for sustainable consumption checklist, example "gardening" (Hofstetter & Madjar 2005)

Activities, products, services		**Garde-ning**	**Dog**	**Week-end House**	**Yoga**	**Remarks**
Number of covered satisfiers	S	79	64	44	54	
Number of covered needs	N	8	9	8	10	
Score	S*N	632	567	352	540	
Score from happiness enhancers	H	22.5	23.5	10	24	
Total score	H*S*N	14'220	13'536	3'520	12'960	higher means better potential for SC
Life Cycle Costs	Euro/a	200	2000	15000	600	
Ratio competing alternatives to gardening	C	1	10	75	3	Ratio >1 is better for avoiding rebound effects and worse for acceptability
Hours 100% absorbed	h	150	600	160	125	
Ratio competing alternatives to gardening	T	1	4	1.07	0.83	Ratio >1 is better for avoiding rebound effects
Occupied dwelling space	m^2	200	5	1	2	
Ratio competing alternatives to gardening	D	1	0.025	0.005	0.01	Ratio >1 is better for avoiding rebound effects
Other scarce resources		0	0	0	0	
Ratio competing	R	1	1	1	1	Ratio >1 is better for avoiding rebound

alternatives to gardening						effects and potentially worse for LCA
Share of people without required skills	%	10	20	10	30	
Ratio competing alternatives to gardening	L	1	2	1	3	Ratio >1 is better for avoiding rebound effects and worse for market potential
Share of people without required information	%	50	75	50	30	
Ratio competing alternatives to gardening	I	1	1.5	1	0.6	Ratio >1 is better for avoiding rebound effects and worse for market potential
Score for rebound effect	C*T*D*R*L*I	1	3	0.4	0.04	Ratio >1 means better for avoiding rebound effects
Environmental impacts analyzed by streamlined LCA	Primary energy kWh/a	-200	2000	15000	300	
Rank order happiness and satisfaction score	H*S*N	1	1	4	1	Highest score gives rank no.1 (only difference > 20% justifies different rank)
Rank order rebound effect		2	1	3	4	Highest ratio gives rank no. 1 (only difference > 20% justifies different rank)
Rank order impacts		2	6	8	4	Lowest Eco-Points gives rank no.1 (double weight rank order points, only difference > 20% justifies different rank)
Total rank order points		5	8	15	9	Just sum the three previous rows, lowest sum is best.

Weighting environmental impacts twice results in the final ranking in a comfortable "victory" of gardening followed by having a dog and taking yoga classes. In a real life application the designer could now select the most promising alternatives, make a business plan, and then make the final choice for the activity, product, or service to be offered.

3.2 CHap for cloth dryer, personal computer and mobile phones

In order to apply equations (1) and (3), we rely on the impressing Japanese Panel Survey of Consumers (JPSC) provided by the Institute for Research on Household Economics (IRHE) of Japan. Co-author Toshisuke Ozawa is approved user of the data and performed the statistical analysis using the three most recent years 1998-2000 for households of almost 1500 young women. Although the initial number of households seems large and even after combining the two samples from 1998-1999 and 1999-2000 we still were faced with very few remaining cases for adopters after excluding cases with major life events that affect our analysis. Therefore, the explanation power of the used data and analysis remains limited. Table 3-2 illustrates how a selection of 10 major events affects happiness and the purchase of durable goods. Only getting married did positively impact happiness in a statistically significant manner. However, there are many life events that correlate well with buying the three example products.

Table 3-2: Events that affect happiness and the possession of three technologies (Ozawa & Hofstetter 2004d) (Significant different at $p<0.05$ between NN and NY (+: increase; -: decrease))

	Got married	Gave birth to a child	Husband moved out for business reason	Started a new hobby	Took responsibility as a chairperson of an organization	Entrance exam and enrollment	Working	Have a full-time position	Living in a detached single family house	Living in an own condominium or house
Happiness	+									
Cloths Dryer				-					+	
Personal Computer	+			+	+			+		
Mobile Phone	+	-				+				+

Among the multiple results in Ozawa & Hofstetter (2004a-d) and Hofstetter & Ozawa (2005) we will present here a very small selection only. Table 3-3 gives an impression how a ranking list of sustainable activities, products and services could look like. We give here CHap values using a number of assumptions:

1. The calculated CO_2-emissions include statistically significant and non-significant changes in the whole consumption pattern within one year of adopting the new APS.
2. The results combine the two samples 1998-99 and 1999-00 and they also adjust for changes in family size by correcting with a per capita emissions value.
3. All changes in this year are attributed to the listed APS only.
4. The CHap for cloth dryers, personal computers, and mobile phones are the values after excluding all households that did show other life events that affect happiness in a major way.

Assessed activity	CHap	Rank
Using a personal computer	0.126	1
Having a baby	0.098	2
Using a cloth dryer	0.065	3
Using a mobile phone	0.059	4
Starting new lesson or learning	0.012	5
Taking leadership of a committee	0.009	6
Started living in a house	-0.014	7
Getting married	-0.143	8

Table 3-3: Comparing CHap with adjustment for change in family size for three durable goods and five life events.

The high ranking of having a baby is not the consequence of a happier family. On the contrary, the happiness actually decreases according to our analysis. However, the CO_2-correction for the additional person in the family results in a large negative change in emissions. In the case of getting married happiness increases but CO_2 emissions increase as well, especially if all the added durable goods and other expenditures are counted in one year only (while the happiness increase supposedly sustains).

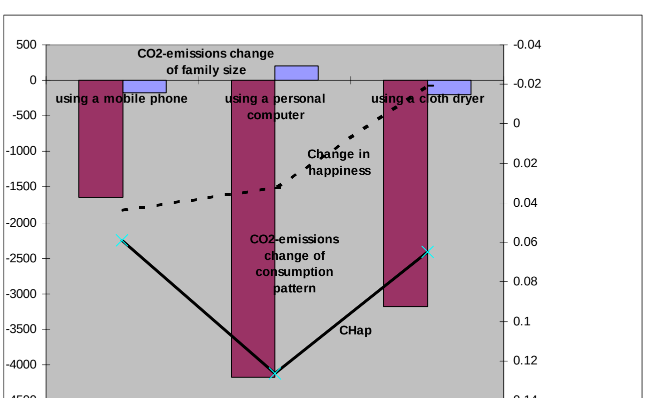


Figure 5: CHap and its constituting factors for three durable goods, correcting for major life events. (left y-axis: CO_2-Emissions in kg per household per year; right y-axis: change in happiness and CHap [-])

The very good ranks for the three durable goods need some further insights. Figure 5 provides the happiness which is positive for mobile phones and personal computers but negative for cloth dryer (all not statistically significant). The darker bars indicate changes in CO_2 emissions per household considering all changes in adopter households from those in non-adopter households. We can see that these bars are all heavily negative and this would not change if the CO_2-emissions due to changes in family size (light bars) would be considered. We should keep in mind that production and use of one year of a mobile phone, personal computer, and cloth dryer cause 18, 420, and 270 kg CO_2 respectively. This is 10% or less of what Figure 5 shows and *positive* not *negative*! This would imply a negative rebound effect of a factor of 10 or higher. The shown results are completely dominated by dramatic reductions in expenditure for transportation. This reduction can not be explained by avoiding trips by smart use of mobile phone and computer. We rather suspect that there are three bias at work:

i) After eliminating all cases with major affecting life events we end up with a very small number of adopters and sometimes non-adopters which makes the results arbitrary.

ii) Our method automatically assumes that the adoption is the cause for a change in consumption pattern. However, due to the nature of the analyzed APS, it is more likely that other changes in lifestyle are responsible for the observed change in impacts.

iii) The expenditure data for transportation -this is the data that proves to dominate the results- accounts for an average person in our sample in 2000 only 57'000 yen (570 USD) per year or 3.2% of income per capita. This amount does not account for car loans. Even if this would be included the total amount looks low. This means that the available data may not be sufficient to properly calculate CO_2-changes that account for all lifestyle and consumption changes.

4. Discussion and conclusions

Much has been achieved in bringing together so far isolated fields relevant to sustainable consumption. The two new tools, one for design, the other for assessment, include both an assessment of environmental impacts. However, they also provide two different proposals on how to consider (the propensity for) rebound effects and (the potential for) utility maximization. The latter being a measure to predict the likelihood that the sustainable consumption activity indeed brings the expected satisfaction and may reduce the demand for additional (material) consumption. It is exactly this last purpose that remains so far a hypothesis awaiting further empirical evidence.

Checklist approach

The developed checklists for designing new or improving existing activities, products, or services allow to estimate need satisfaction, potential for happiness enhancement, propensity for rebound effects, and environmental impacts at reasonable costs and offer a proposal on how to condensate the information to indicators on different aggregation levels. This offers maximum transparency and may stimulate further improvements towards more sustainable consumption.

The whole checklist approach has the quality and purpose of a streamlined evaluation before all design, production and marketing parameters are fixed or even known. In addition to the major untested assumption already mentioned, there are a number of caveat that apply to the operationalization by the checklists. We do not know what limiting factors have the largest quantitative impact on the environmental impacts of consumption patterns. We do know they are relevant and we made further progress in quantifying all rebound effects together (Hofstetter & Ozawa 2005) but we have no factor analysis that indicates the relative importance of the single factors. We have accepted that all satisfiers listed by Max-Neef (1991) are equally important and that although subsistence is the most basic of all needs it should get equal weight to each others. The checklists did also assume a weighting of the factors that enhance happiness. The most critical and active factors from the happiness enhancing programs have been identified and deserve most attention when activities, products, and services are designed for sustainable consumption. However, the relative weighting remains a first subjective guess and we do not empirically know what happiness enhancing factors contribute most (and under what conditions). Further, we accepted that all six limiting factors have a multiplicative effect on rebound effects without having any empirical basis to support this assumption.

As a next step, applications and experiences will be needed to refine the tool and also get a better understanding on the importance of pseudo satisfiers, synergic satisfiers, and inhibiting satisfiers. Such insights may even help to prioritize activities, products, and services that should undergo a re-design procedure for more sustainable consumption.

CHap

Some of the caveat have been mentioned before. However, a major caveat seems to apply to the question of causality. Although we did use panel data and did not just rely on correlation analysis as most other empirical analyses, this may not be good enough for activities that are hardly the true cause for major changes in consumption patterns. The survey is filled in only once a year and for the month of September only. This may not be frequently enough to detect immediate and short term impacts on consumption in a causal way. However, this also means that mid and long term impacts may remain undetectable because there is just happening to many other relevant things during a full year.

Realizing how fast the large sample of more than 1000 households of young women melts if unaffected sub-groups are needed, the method may need to become more sophisticated by correcting for other independent factors rather than just excluding households that show other major changes. Although the chosen approach is rather transparent, it would require a much larger sample to take account of all relevant factors while still securing a sub-sample size that allows to detect statistically significant signals.

The obtained results for the three examples are also questionable because we found a reduction in household expenditure for all three examples. Especially the reduction in expenses in food and transportation looks suspicious. Sure, one can easily safe on eating out expenses in order to compensate for a luxury cloth dryer. But how is it possible that such substantial savings in transportation could be made? Or to say it bluntly: Would the purchase of a mobile phone causally lead to the reduction of 2.5 tons CO_2 per household as suggested in Figure 5, then NGOs and governments may consider to give away mobile phones for free being a very cost-efficient way to reduce traffic. The rebound factor of more than -10 would indeed be very promising for any sustainable consumption APS. In addition to the reasons mentioned, the CO_2-calculations relied on a small share of the household income that was spent on the available expenditure categories. Shifts in housing and other loan-related consumption (e.g., cars) has not been included. Therefore, our results would only apply if all these shifts had cancelled within the sub-samples.

Unfortunately, we did have household data for consumption but data on happiness only for one household member, the young women. Also, not all decisions are taken by the same person in a household. Therefore, what we see in the change on happiness in one person and the observed change in consumption of a complete household with typically four persons may be only weakly correlated (because the husband gets the full happiness from the personal computer).

These observations make it obvious that the used panel data is insufficient:

1) for analyzing more promising examples of sustainable consumption, and
2) for allowing a reliable quantification that withstands careful review with respect to causality and statistical significance.

In order to justify the additional efforts needed for more reliable data to calculate CHap we need to clarify, whether there is empirical evidence, that

3) at least some people that got happier in the course of several years indeed were able to do so without increased material consumption or CO_2-emissions, and
4) at least some people that followed a number of recommended sustainable consumption activities managed to get both, more happy and less carbon-intensive.

Only if we can falsify the underlying hypothesis that striving for more happiness can reduce environmental impacts in a convincing empirical analysis we should proceed in collecting more relevant panel data that is analyzed with more sophisticated methods. Point 3 seems to be more relevant in this respects and might be evaluated with the available JPSC data set.

For the time being where the mentioned work above still needs to be done we suggest to:

- Use the checklist approach to predict the likelihood that an activity increases happiness, satisfaction, and reduces rebound effects and environmental impacts. This approach can be used for both designing new and improving existing activities, products, and services.
- List probable consequences of suggested sustainable consumption activities and assess there impact. E.g., if a personal computer indeed requires to buy a printer, equip the house with broadband access, buy an office chair, and buy a carpet that withstands the rolls of an office chair then we should analyze, the use of the personal computer as well as all the other usually induced purchases. It could also be that the heating demand will increase because PC owners tend to sit long hours

with little movements requiring higher room temperatures to feel comfortable. In order to brainstorm on possible consequences and their probability one might use focus groups or survey techniques.

- Go ahead and promote the analyzed activity as sustainable consumption activity if both tests are satisfactory.
-

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Literature

Binswanger, M. (2001): Technological progress and sustainable development: what about the rebound effect? Ecological Economics 36:119-132

Diener, E.; Seligman, E. (2004): Beyond money, towards an economy of well-being, American Psychological Society, vol. 5, no. 1, 1-31

Diener, E., & Oishi, S. (2000): Money and happiness: Income and subjective well-being across nations. In E. Diener & E. M. Suh (Eds.). Subjective well-being across cultures. Cambridge, MA: MIT Press

Fordyce, M. (1993): A program to increase happiness: further studies, Journal of Counseling Psychology Vol. 30, No. 4, 483-498

Frey, B.; Stutzer, A. (2002): What can economists learn from happiness research? Journal of Economic Literature, vol. 40(2), 402-435

Gershuny, J. (2002): Web-use and Net-nerds: A Neo-Functionalist Analysis of the Impact of Information Technology in the Home. ISER Working Paper 2002-1. Colchester: University of Essex.

Greening, LA., Greene DL., Difiglio C. (2000): Energy efficiency and consumption - the rebound effect - a survey. Energy Policy 28:389-401

Hofstetter, P.; Madjar, M. (2003): Linking change in happiness, time-use, sustainable consumption, and environmental impacts; An attempt to understand time-rebound effects. Final report to the Society for Non-Traditional Technology, Japan/ BAO & Consultrix, Zürich

Hofstetter, P.; Madjar, M. (2005): How to increase happiness and support sustainable consumption? – A checklist for evaluation and design. Deliverable D4, BAO & Consultrix, Zürich.

Hofstetter, P.; Ozawa, T. (2005): CHap for cloth dryer, personal computer, or mobile phone, and major life events – an indicator that measures change in CO_2-emissions and happiness. Deliverable D6, BAO & AIST, Zürich

Hofstetter, P.; Ozawa T.; Sugai K.; Toyoda S. (2004): CHap – CO_2-emissions per unit of happiness: A new indicator for sustainable consumption that considers and minimizes rebound effects, Report of Phase 1, Zürich

Hofstetter, P.; Ozawa T. (2003): Minimizing CO_2-emissions per unit of happiness. The Second International Workshop on Sustainable Consumption. Tokyo, Japan, December 12-13, 2003.

Kasser, T. (2002): The high price of materialism, The MIT Press, Cambridge, Massachusetts

Madjar, M.; Hofstetter, P. (2004a): Relationship between using cloth dryers, personal computers or mobile phones and subjective well-being. Deliverable D1, Consultrix & BAO, Zürich

Madjar, M.; Hofstetter, P. (2004b): Literature research on characteristics and activities that enhance happiness. Deliverable D2, Consultrix & BAO, Zürich

Max-Neef, M. (1991): Human Scale Development. New York: Routledge

Montier, J. (2004): Global Equity Strategy, If it makes you happy, Dresdner Kleinwort Wasserstein Securities Limited (www.drkwresearch.com 17.06.04)

Myers, D.G. (2004): Excerpted from Psychology 7th edition, Worth Publishers, New York

Ozawa, T.; Hofstetter, P. (2004a): Use of Longitudinal Panel Data to Estimate the Effects of Adopting New Activities to Household Consumption Patterns and Happiness. The Third International Workshop on Sustainable Consumption. Leeds, UK. March 5-6, 2004.

Ozawa, T.; Hofstetter, P. (2004b): The Heterogeneity of Young Japanese Women's Life – A Consumption Perspective. Proceedings of the third international workshop on "Sustainable Consumption", October 21-22, Tokyo, SNTT/AIST/UNEP/METI

Ozawa, T.; Hofstetter, P. (2004c): Empirical re-analysis of the JPSC panel data to identify major factors that affect change of happiness and life satisfaction. Deliverable D3, AIST & BAO, Tsukuba

Ozawa, T.; Hofstetter, P. (2004d): Re-analysis of the JPSC data by forming more homogenous sub-groups in order to reduce the variance of consumption elasticities and enhancing the robustness of results. Deliverable D5, AIST & BAO, Tsukuba

Varughese, S. (2004): Seven steps to happiness, http://www.lifepositive.com/Mind/happiness/quest-for-happiness.asp (May 2004)

Veenhoven, R. (1993): Happiness in nations, World database of happiness, Erasmus University of Rotterdam

Vester, F. (2000): Die Kunst vernetzt zu denken – Ideen und Werkzeuge für einen neuen Umgang mit Komplexität, DVA, Stuttgart

Wiesemann, R. (2003): The Luck Factor, Century, London

Changing Lifestyles

Changing lifestyles and consumption patterns in developing countries:
A comparative study of India and China

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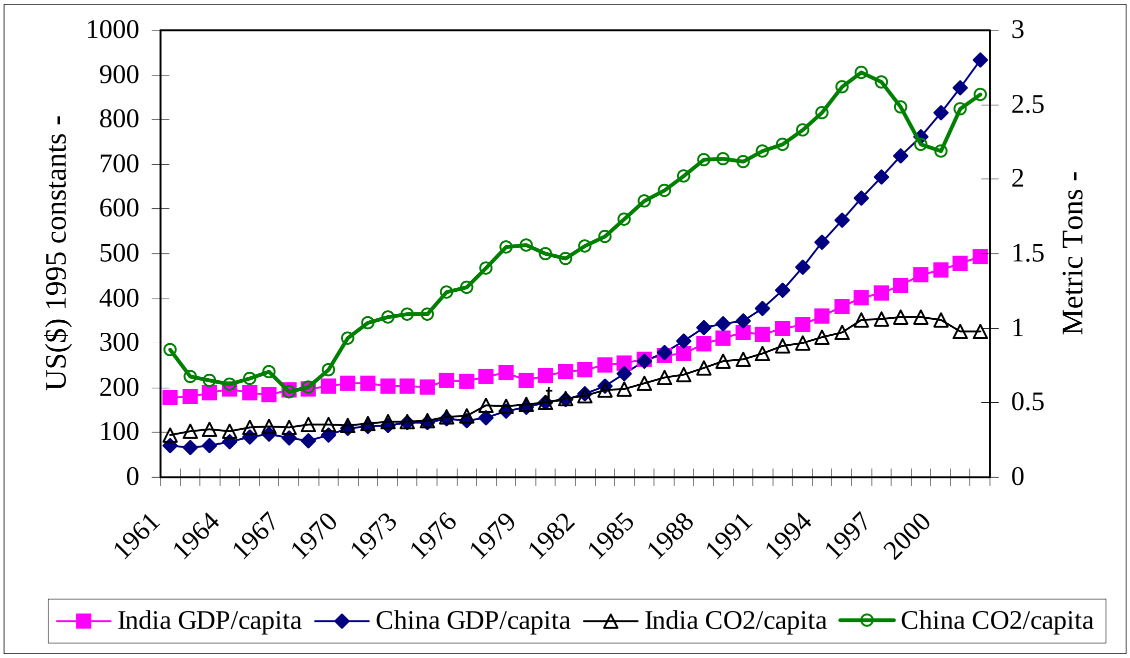
1 Catching up with the 'North'

Ever increasing consumption is putting a strain on the environment, polluting the Earth and destroying ecosystems (UNEP 2002). These are dangerous side-effect of the development model the North follows and the South emulates. Changing lifestyles and consumption patterns has been a common feature of all developing Asian nations, in recent decades. Increasing income provides these nations with more options in how they use it, and people's choices will largely determine what impact their economic growth will have on the environment. As nations develop and their economies grows, so too does the consumption of resources. The developing Asian nations have shown a steady growth in both population and in economic activity. Increasing population and more and better consumption are two interactive sides of man's impact on the environment. Over-consumption may be the result of too many humans competing over a limited resource base or an economic elite using that resource base excessively and abusively to the detriment of poor nations, future generations and other species (UNEP 2002).

While attempting to raise awareness regarding the changing lifestyles in almost all of the developing countries in East and South East Asia and its potential environmental implications, the paper will focus on the two largest nations in this group, China and India, in comparison to the industrialised nation Japan. India and China have teeming populations topping the billion marks; both experienced the transition from a closed economy to a more market–oriented engagement with the outside world in trade and investment; and both to date are in the processes of industrialization and modernization accompanied by a significant speed of economic growth in the world. In comparison, Japan will be used as a benchmark to show were China and India are situated in terms of economic growth, people's consumption patterns and environmental emissions (i.e. CO_2).

The figure below shows the 3 countries in terms of their GDP per capita levels over a time period of more than 40 years. In 1961, Japan's GDP per capita was a factor 50 higher than India's and about a factor 100 in relation to China's. The two developing countries have changed their relative positions but the gap has widened.

Figure 1. Comparison of GDP/capita, among China, India and Japan (1961-2003)



Looking at these figures the main question is of how the population of poorer countries can improve the quality of life without adopting the unsustainable consumption and production practices predominant in the 'North' often setting the global benchmark for lifestyle aspirations.

In this paper we are interested to take a back-mirror look and decompose this trend in CO_2 emissions and look at the contributing factors. We will apply a simple model of *Impact= Population x Affluence x Technology*, or *I=PAT*, in order to estimate the effects of population, affluence, and technology on CO_2 emissions in China and India, accompanying with the economic growth over the past 40 to 50 years. The *I=PAT* equation was often used to estimate the effects of human population, level of affluence and choice of technology on environmental impacts or to project future environmental change based on changes in these main driving forces. The study will compare the development of population growth, affluence and CO_2 emissions in India, China and Japan over a period of for more than four decades from 1960 to 2004. We will identify growth rates for per capita income levels (affluence) for these 3 countries and then look more specifically at 3 consumption items in China to exemplify lifestyle changes in developing countries.

2. Co-evolutions of Production Possibilities and Consumption Patterns

Economic development

The latter half of the 20th century was a period of the 'economic miracle' for Asian countries. Firstly, Asian countries including Japan, Koreas and Singapore achieved a high annual growth rate of GDP[4] per capita at an average of 8% during the 1960s – 1970s. They achieved industrialization, motorization and wealthy society in a short timescale of about 20 - 30 years while China and India were chartered as closed economy with central planning[5] and less engaged with the outside world in trade and investment. China initiated its economic reforms in 1978, accomplishing with a flying economic growth at an annual rate of 9.7 %. A decade later, India has followed a consensual democratic market model; GDP has expanded at 5.8 % a year since the economy was opened up in 1991. China and India have been recognised as the two largest and booming developing economies in the world, and China ranks as the second largest economy in term of GDP in PPP (purchasing power parity) dollars after the U.S. and sixth in real values. To date, together the two nations are home to more than one third of the world population and contribute 19.2% of world GDP - China 11.5% and India 7.7%. But also China and India are the second and the fifth largest contributors to world carbon emissions, respectively.

Lifestyle Changes

The most direct and significant result of economic growth is the amazing improvement in quality of life for people in both countries. China's population has experienced a transition from 'poverty' to 'adequate food and clothing'; today growing parts of the population are getting closer to 'well being' lifestyles. On the other hand due to the growth of population from 350 million to more than a billion today and the low level of economic development during 1940s -1970s, and despite significant efforts, a large number of people in India are surviving people with daily essentials. Uneven development between regions and poverty in rural areas do still exist in the two countries after the economic reforms were implemented. Although the governments have made great progress in poverty reduction, there are still approximately 100 million (8% of the total population) in China (Weiss 2002) and 260 million (26% of the total population) in Indian (Commission 2000) under the poverty line of one dollar per day at the end of last century. About 90% of this poorer population groups are living in rural regions.

Structural Economic Transformation

Meanwhile, we could also witness a gradual transformation of both countries' economic structure from a shifting dominance from agriculture to growing shares of industrial and service sectors, along with the availability of a wider range of products the consumption patterns changed. By 2003, China's second and tertiary industries contributed approximately 85% of the national GDP. While in India agricultural sector share in GDP has been declining from over 50% in the early 1950s to 26% in recent years and the shares of manufacturing, transportation and banking and service sectors have doubled. It is interesting to point out that secondary industries are dominant in China's economy from while tertiary industries contribute almost half of GDP in India. That may be the reason of that India produces less CO_2 emissions than China does (more discussion later).

[4] Gross Domestic Production (GDP)

[5] Before 1978, China was central planed. The government uniformly allocated materials and production activities. In India, agricultural activities were with private farmers but industrial investment was controlled through industrial licensing till 1991.

Carbon Dioxide Emissions

Economic growth induced CO_2 emissions to grow substantially in developing Asia between 1980 and 2001, rising by 151% -- 4.5% per year -- from 2,398 MMT[6] to 6,027 MMT. The bulk of the region's carbon dioxide emissions also come from India and China. In 2001, these two countries accounted for two thirds of all of Developing Asia's carbon dioxide emissions (EIA[7], 2004). China and India are the second and the fifth largest contributors to world carbon emissions, respectively. China's carbon dioxide emissions grew more slowly than India's between 1980 and 2001, rising 111%, or 3.6% per year, from 1,445 MMT to 3,050 MMT. During the same period, Indian carbon dioxide emissions more than tripled (annual growth of 5.4%), increasing from 303 MMT to 922 MMT (EIA, 2004).

Japan's per capita income as well as CO_2 consumption is much higher in comparison to India and China since 1960. Japan has been slow to take measures to cut emissions of CO_2 and other greenhouse gases. Under the Kyoto Protocol, which set emissions reduction targets, Japan is required to cut its annual average greenhouse gas emissions by 6% from its 1990 level between 2008 and 2012. In fact, Japan's emissions in 2002 increased by 7.6% from the 1990 level; so Japan will have to cut 13.6% altogether. The nation now finds itself hard-pressed to achieve the target.

3 Growing economy, population and technical change

As mentioned earlier, we employ the *I=PAT* framework to examine the contribution to CO_2 emissions of population growth, affluence or lifestyles and change in technologies China and India and compare it with developments in Japan.

The model was first proposed in the early 1970s (Ehrlich and Holdren 1971; Commoner 1972; Ehrlich and Holdren 1972), resulted from the efforts of population biologists, ecologists, and environmental scientists to formalize the relationship between population, human welfare, and environmental impacts.

The model has long dominated science and engineering oriented discussions of the pollution generation problem at the country and regional level. The original argument of Ehrlich and Holdren (1971, 1972) was that the population growth was the major threat to human welfare. They claimed that "whatever other factors were involved, population growth caused a disproportionate negative impact on the environment" (Ehrlich and Holdren, 1971). Commoner (1971) pointed out the economic growth and per capita consumption played an important role for contributions of pollution. Many discussions later concerned whether the increase in population and affluence can be balanced by improvements to the environment offered by technological systems[8].

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[6] Million Metric Tons (MMT)

[7] Energy Information Administration (EIA) online database, http://www.eia.doe.gov/emeu/international/

[8] These original contributions have sparked a wide discussion on the importance of the various contributing factors but also on methodological issues leading to reformulations of the original equations. For our argument this simple index calculation suffices and we refer to e.g.
York, R., E. A. Rosa, et al. (2003). "STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts." Ecological Economics **46**(3): 351-365..

Table 1: IPAT for China, India and Japan from 1960 - 2000

1960s		Population	Affluence	Technology
	China	1.27	1.53	0.71
	India	1.22	1.18	1.04
	Japan	1.10	2.19	1.08
1970s				
	China	1.20	1.53	1.05
	India	1.25	1.08	1.33
	Japan	1.12	1.38	0.80
1980s				
	China	1.15	2.11	0.67
	India	1.23	1.43	1.11
	Japan	1.06	1.41	0.78
1990s				
	China	1.12	2.33	0.44
	India	1.19	1.43	0.93
	Japan	1.03	1.12	0.96

Note: $CO2 = POP \times \frac{GDP}{POP} \times \frac{CO2}{GDP}$, where CO_2 is the impact *(I)*, *POP* is population *(P)*, *GDP/POP* represents affluence (*A*; consumption of goods and services per capita), and CO_2/GDP represents Technology (*T*; i.e. emissions per unit of output). Values in cells are calculated by dividing the endpoint of each decade by its initial value for the respective decade (e.g. I_{1990}/I_{1980}). All calculations are based on three datasets, population and GDP data is from World Bank, but we have to appreciate to Shilpa Rao, International Institute of Applied System Analysis (IIASA), Austria, for her great helps of data collection. The CO_2 emission data was collected from EIA, U.S.

The applied index calculation shows that for China, India and Japan over the observed time period of 4 decades the affluence factor showed the highest growth rates with the exception of India in the 1960s and 1970s where population growth dominated the overall contribution to CO_2. In India population grew by 22% in the 1960s, 25% and 23% in the 1970s and 1980s and still almost 20% in the 1990s. In comparison, affluence levels increased from an 18% growth rate in the 1960s to a 43% increase in the 1980s and 1990s. More dramatic differences but similar trends can be observed in China. While we could observe a 27% population growth rate during China's second baby boom, its subsequent one-child policy reduced population growth rates to around 12% in the 1990s. Affluence levels increased by more than 50% in the 1960s and 1970s and after the open-door policy n 1978 tripled in the 1980s and the 1990s.

On the other hand Japan had the largest growth in per capita affluence levels in the 1960s with a 119% growth in GDP per capita, which subsequently dropped to around 40% increase during the 1970s and 1980s and further dropped to a 12% increase in the 1990s. In comparison population growth dropped from a 10% increase to a 3% increase.

With national figures like this one has to be aware that there exist huge regional differences within the countries, for example, population growth rates and per capita income rates greatly differ in rural China as compared to urban populations and differences also exist between the poorer western parts and within regional areas. Similar gaps can be observed in India and is probably true for most of the developing countries.

But in order to understand which lifestyle changes are associated with these increases in income we will have to look at specific goods and services.

4. A case study for changes in energy consumption in China

The significant economic and lifestyle changes that have been taken place in China since 1978, Chinese have been requiring more and better quality of energy. People directly consume energy for lighting, cooking and other daily uses. But they also aspire to a 'higher-quality life' by purchasing fashionable goods and services, such as houses with air conditioning and other modern electrical household appliances and the weekly visit to the gym. All these products and services consume energy during their production processes. In other words, people also indirectly consume energy through purchasing these products.

Domestic energy production cannot meet anymore the rapid increases of consumption requirements on both domestic and industrial usages; hence China has become a net energy importer in 1993. China has been speeding up exploration and development of energy sources (at home as well as abroad, e.g. in Sudan) to support their fast growing economy.

In the following, we will show changing consumption with regards to three products indicative to the ongoing economic and lifestyle changes in China and India.

Housing

The outstanding increase of expenditure on housing shows people's willingness to improve their immediate living conditions. Many rural households rebuilt and extended their bungalows by using building materials of concrete bricks and tiles instead of marl and woods. At the same time, per capita living space expanded from 8.1 m^2 to 24.2 m^2, and the lifespan of houses increased by more than 20 years (State Statistical Bureau of China 2002).

In urban China, the problem of housing shortage was much more serious than in rural areas. The per capita net living space for urban residents was only 3.6 m^2 prior to 1978, mainly because of restrictions on private house ownership. In the early 1980s the Housing Reform Policy had been introduced to solve the problems of urban housing shortages and poor housing conditions. This policy encouraged commercialization of the housing sector and private ownership allowing people to buy their own apartments. Meanwhile, the government, state owned enterprises, domestic private companies and oversea developers invested significant funds into the urban housing development. (Lin 1991) estimated that the total housing investment between 1979 and 1990 was 6.74% of total GDP. As a result, city dwellers started to move from previously tiny bungalows or apartments to new multi-stories apartment blocks; thus effectively increasing per capita net living space. People's requirements on housing boosted the development of construction sector. Directly associated with this was the amount of energy consumption in the construction sector which increased from 7.89 Mtce[9] in 1980 to 145.3 Mtce in 2001.

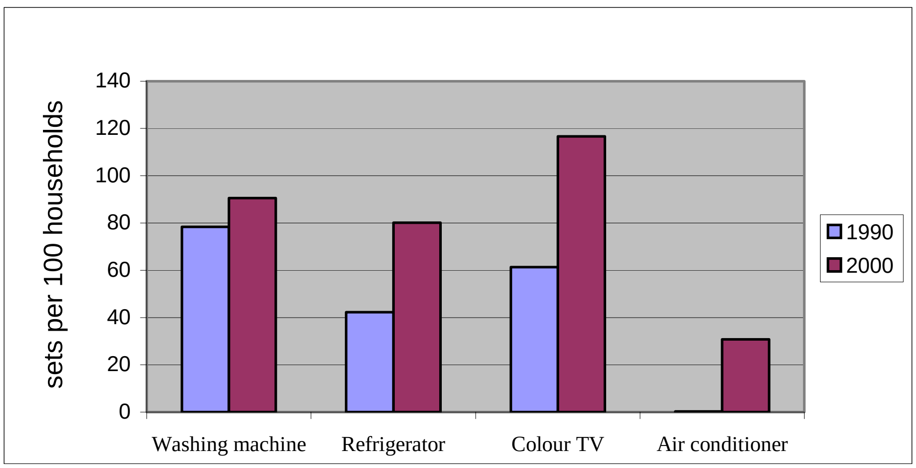
[9] Mtce: Million tons coal equivalent

Household Appliances

These more spacious living places allowed consumers to buy and store more household appliances and other durable goods. For example, since the 1980s, urban residents spent increasing amounts on large durable furniture (e.g. wardrobes, beds and sofas). Also in the late 1980s and 1990s the connection of a larger number of households to the electrical grid helped increase the sales for household electrical appliances. For example, purchases of refrigerator and colour TV in urban areas have doubled in 2000 as compared to 1990. Colour TVs have already covered over half of rural households, and other categories of electric appliances have been rapidly spreading throughout China (as shown in Figure 2).

Another example is air conditioners, previously a sign of the wealthy, which increased significantly to about 30 sets per 100 households (State Statistical Bureau of China 2002). The popularisation of household electronics enormously boosted the household appliance production. The electronic industry has become the largest industry in China, which contributed about 8-10% of GDP, and 30% of exports.

Figure 2: Urban Household Electrical Appliances



Data source: *(State Statistical Bureau of China 2002)*

Residential Energy Consumption

There are huge differences of types of residential energy consumption between rural and urban households in terms of quality and quantity. Until recently, non-commercial energy sources such as stalks and firewood still dominates rural residential energy consumption patterns and contributed approximate 85% of residential energy in 1980 (Zhou 1999). The overuse of biomass energy contributed to cultivated land degradation and destroyed forest resources. Since the policy of biomass energy conservation and forestation was established in the mid of the 1990s, the absolute amount of biomass energy consumption has fallen from 250 Mtce in 1995 to around 200 Mtce in 2000. However, the total amount of residential energy is continuously growing, with major increases from commercial sources. The total amount of commercial energy consumption grew remarkably by 3.6 times, from 41 Mtce in 1980 to 149 Mtce in 2000 (Pan 2002). Therefore, it is interesting to point out that the commercial energy for rural residential uses will gradually replace biomass energy and become the major energy source in the future. At the same time also coal consumption shows a descending tendency after 1988 due to the introduction of fuel-saving stoves. By the end of 1997, the fuel-saving stoves had been installed in 180 million rural households, which accounts for 89% of total rural households (Wang 1998).

Also urban household energy consumption has undergone significant changes. In terms of heating, most urban areas still keep the traditional way of heating by burning coal. The increase of per capita net living space is likely to result in more coal being consumed. However, the previous type of individual heating has been switched to large-scale central heating as people moved from bungalows to apartment blocks, which effectively enhanced energy efficiency. Furthermore, many richer cites (e.g. Beijing) have been installed the 'consumer control system' of heat supply to allow heat supply to best match demand. On the other hand, the government provides LPG (liquefied petroleum gas) or gas pipelines for people's daily cooking instead of traditional cooking by burning coal, to reduce urban coal consumption and associated pollution. Per capita coal consumption for urban residential use rapidly declined from 348.5kg/year in 1985 to 88.2kg/year in 1999. As the outstanding growth of household electrical appliances for urban households, the per capita residential electricity consumption increased more than four times during 1985-1999. Electricity became the dominant fuel in all Chinese cities, accounting for 59% of the whole household energy consumption (State Statistical Bureau of China 2002).

4 Sustainable Consumption in Developing Countries?

Since the economic reform both China and India have experienced significant economic growth accompanied by enormous environmental pollution and increasing income inequalities. At the same time the gap between the poorer and the richer countries has not significantly decreased.

In addition, national averages often obscure the similarities among different consumption classes across state borders. Acknowledging these differences within the countries, Alan Durning divided the world not by country but by consumption classes :

Table 2: World Consumption Classes, in 1992

Consumption Type	**High Consumers (1.1 billion)**	**Middle Income (3.3 billion)**	**Under-Consumers (1.1 billion)**
Diet	meat, packaged food, soft drinks	grain, clean water	insufficient grain, unsafe water
Transport	private cars	bicycles, buses	walking
Materials	Throwaways	durables	local biomass

Our case studies on energy use has shown that more and more people 'move up' the consumption ladder as a result of technical possibilities, increasing availability of infrastructures and availability of products and services. With expansion of the national electricity grid and improvement in living conditions and available space come naturally acquisition of electronic appliances and other consumption goods. Similarly improved transport infrastructure, i.e. roads and airports, together with increasing levels of available income will lead to more car and air miles. A trajectory of further increase in consumption and pollution levels can easily be described.

But a variety of consumption models for each of the consumption types exist. For example, in comparing income and consumption levels between Japan and the US one finds that despite relatively similar per capita income levels the average US consumes more resources etc as her fellow consumer in Japan. Examples of sustainable consumption and production patterns could therefore help the US to leapfrog to a higher level of wellbeing with lower pollution and resource consumption. This might be even easier for developing countries. Wasteful infrastructures, institutions and habits have not been developed to such an extent than in the resource addictive ‘North’. Similarly technological and institutional leapfrogging could help the under-consumers to achieve higher level of consumptions. But given the links or dependencies created through global trade, foreign direct investments and marketing in these emerging economies the possibilities for developing countries to successfully contribute to global efforts for sustainable consumption might be difficult.

5. References

Commission, I. P. (2000). India Planning Experience: A Statistical Profile. G. o. I. Planning Commission.

Commoner, B., Ed. (1972). The environmental cost of economic growth. Population, Resources and the Environment. Washington DC, Government Printing Office.

Durning, A. T. (1992). How Much is Enough? The Consumer Society and the Future of the Earth, W. W. Norton & Company.

Ehrlich, P. and J. Holdren (1971). "Impact of population growth." Science **171**: 1212-1217.

Ehrlich, P. and J. Holdren, Eds. (1972). Impact of population growth. Population, Resources, and the Environment. Washington DC, U.S. Government Printing Office.

Lin, J. (1991). "The Household Responsibility System Reform and the Adoption of Hybrid Rice in China." Journal of Development Economics **1991**(36): 353-373.

Pan, J. (2002). Rural Energy Patterns in China: A preliminary assessment from available data sources. Global Change and Economic Development Programme. Beijing, China, The Chinese Academy of Social Sciences.

State Statistical Bureau of China (2002). China Statistical Yearbook 2001. Beijing, State Statistical Publishing House.

UNEP (2002). Sustainable Consumption - A Global Status Report. C. Ryan. Lund University, Institute for Industrial Environmental Economics (IIIEE).

Wang, M. (1998). "Fuel-saving Stoves in China." Wood Energy News **3**(No. 3): 9-10.

Weiss, J. (2002). Explaining Trends in Regional Poverty in China, Asian Development Bank Institute.

York, R., E. A. Rosa, et al. (2003). "STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts." Ecological Economics **46**(3): 351-365.

Zhou, F. (1999). Study on Long Term Energy Development Strategies of China. Beijing, China Planning Press.

CO_2 Emissions from consumption in transition economy. Case of Slovakia

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1. Conceptualizing and measuring sustainable consumption in transition economies

Even though CO_2 emissions have decreased in Central and Eastern Europe (CEE) since the fall of the Iron Curtain, CO_2 emissions per unit of GDP are the highest among OECD countries. Considering the likely increase in income, and adoption of Western patterns of consumption and production, the emissions are expected to increase in the future. Unsustainable patterns of consumption and production are making it difficult for most of the OECD countries to fulfill even their rather modest Kyoto commitments. Thus it is likely that were such consumption patterns to be adopted on a large scale in CEE, despite gains in efficiency in production, it could harm the region's advantage not only in terms of the Kyoto protocol, but also the overall environmental situation.

The concept of Sustainable consumption started to gain political importance with the "Earth Summit[1]" in Rio de Janeiro (1992). Agenda 21, the main document to come from the summit recognized that "the main cause of the global environmental degradation is consumption and production, especially in the developed countries". The World Summit on Sustainable Development in Johannesburg (WSSD, 2002) has recognized the need for "changing unsustainable patterns of consumption and production" and initiated the 10-year framework of programs, which can facilitate the shift towards sustainable consumption[2] and production.

A number of tools have been developed to help operationalize sustainable consumption: life-cycle analysis (LCA), input-output analysis (IOA) and material flow analysis (MFA). They are based on the concept of demand driven environmental degradation, which assumes that most of the industrial activities take place to satisfy household demand for goods and services.

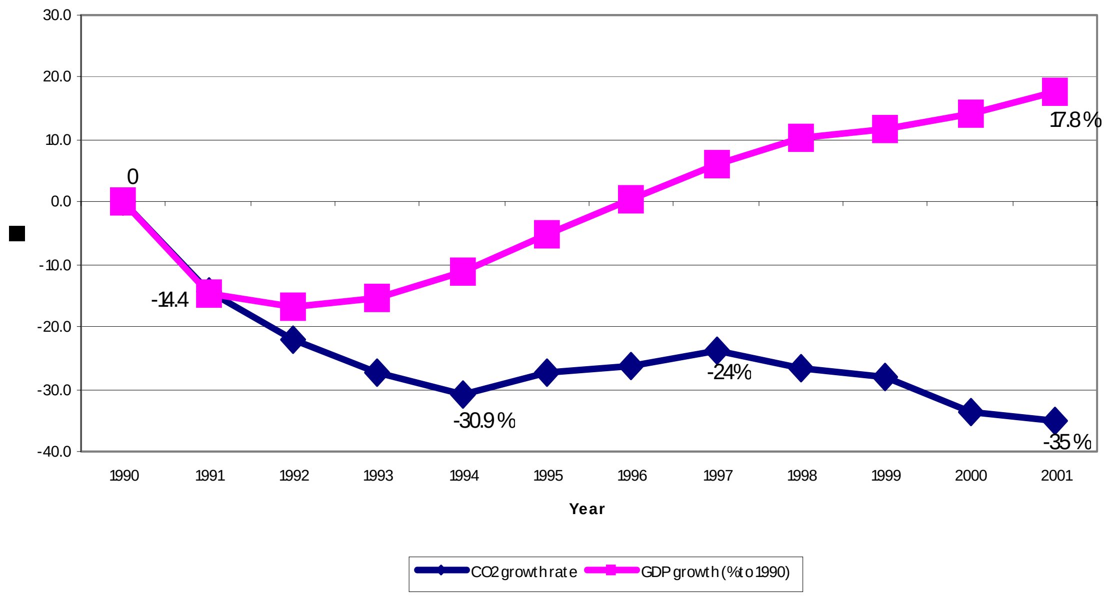
In this study we focus on measuring and evaluating environmental impacts from household consumption in Slovakia, one of the most dynamic transition countries in the Central and Eastern Europe (CEE).

[1] United Nations Conference on Environment and Development
[2] The sustainable consumption is defined as "the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life-cycle, so as not to jeopardise the needs of future generations".

2. Environmental aspects of economic development in transformation process: CO_2 emissions

In the period of shifting from the socialist system to a more market-oriented economy, like other CEE countries, Slovakia experienced decoupling of economic growth from environmental pollution[3]. In the period 1990-2001 the economic growth was growing (by almost 18%) without causing additional environmental pollution (which dropped in terms of CO_2 emissions by 35% - see Figure 1).

Figure 1: GDP and CO_2 development in Slovakia (1990-2001).



Source: IEA, 2003

With the reforms towards a market economy, the production and consumption patterns have been changing rapidly in Slovakia and other CEE countries. Demand rather than central planning is now driving production processes. The increase in income has allowed a larger share of the expenditures to be spent on (luxury) goods and services with higher CO_2 emissions.

Slovakia accounted for only 0.2 percent of global anthropogenic emissions in 2000 [The Third National Communication on Climate Change, 2001]. However, CO_2 emissions per capita are 7.7 t CO_2, which is well above the world average (approximately 4t CO_2 per capita)[4]. The emissions increased again in 2001 in line with a revival of industrial activity and increasing transport [ibid]. This decrease is much higher than the reduction of 8%

[3] Similar declines occurred in other CEE countries, with overall emissions of greenhouse gases (GHG) decreasing by 23% in the period from 1990 to 2000.
[4] The Third National Communication on Climate Change, SR, 2001. http://www.lifeenv.gov.sk/minis/ovzdusie/tns/tretia_narodna_sprava.pdf

GHG emissions, to which Slovakia has committed in Kyoto protocol[5]. This decrease is, however, not a result of effective environmental policies but of the shutdown of many heavy-industry facilities and the general economic slowdown [Huba, 2001].[6] The above highlights the importance of industrial restructuring as one of the key factors affecting energy consumption in transition economies.

Even though energy consumption and CO_2 emissions have decreased considerably in CEE, energy intensity and CO_2 emissions per unit of GDP in this region are the highest in the OECD[7]. Current energy intensity (energy consumption/GDP) in Slovakia is still three times higher than the EU average[8] [Huba et *al.*, 2003]. In this context, increasing consumption driven by increasing income can potentially contribute to a substantial increase in emissions.

3. Calculating CO_2 emissions from consumption in Slovakia by using input-output analysis

Methodology

Input-output analysis extended by environmental pollution coefficients measured in tons of CO_2, is used for allocating environmental impacts of upstream production to goods and services consumed by households. This allows identifying the most polluting consumption items and patterns.

The applied demand-side approach is based on allocating all the energy used throughout the production process to the final consumers - e.g. households, government and exports. This is called the indirect energy consumption, which includes all the energy needed for production of goods and services for final demand. In addition, we have direct energy consumption, which encompasses liquid, solid and gaseous fuel consumption for the purpose of transportation, and heating (and cooking) in houses and apartments.

Input-output (IO) analysis enables us to follow and calculate the energy flows between different sectors in the economy. Combining this information with environmental coefficients (CO_2 emissions per unit of output) allows the allocation of all emissions to final demand categories. In this analysis we combine monetary IO analysis with physical

[5] The Kyoto protocol was adopted by the Conference of parties (CoP) to the UNCCP in Kyoto in 1997. Most of the European countries committed to reduce their GHG by 8% by 2008-2012 compared to their 1990 emissions. Slovak republic ratified Kyoto protocol on 30 May 2002.

[6] Among others, contributors to the decline of CO_2 emissions were: introduction of natural gas for heating in municipalities as well as the increasing share of electricity generated by nuclear power plants.

[7] Slovakia holds the 3rd place (Poland is the first, Czech Republic 2nd and Hungary 9th). In the OECD countries an opposite trend can be observed: while the CO_2 emissions per unit of GDP have fallen by 30%, the absolute emissions increased by 9% [Huba et *al.*, 2003].

[8] In Czech Republic energy intensity is twice the EU average [Huba et *al.*, 2003].

energy and emissions data, and further improve previous work [Korytarova, 2004][9], by generating a more detailed IO table for Slovakia (47 sectors)[10].

We use the following data: the input–output table for the Slovak Republic for the year 1998 (SUSR, 2001); energy data from the Statistical office of the Slovak Republic (Energetika, 1998), carbon emission factors from the IPCC[11]; and the Consumer Expenditure Survey (CES) for the Slovak Republic 2002 (SUSR, 2003). In this extended IO analysis we apply a modified *Leontief* inverse formulation that takes advantage of the availability of both make and use IO tables for Slovakia[12].

Results

Figure 3 shows that Slovak households are responsible for 32% of the total CO_2 emissions caused by final demand in the SR (other final demand categories are exports, capital investments, change in stocks, and government expenditures). Out of this, indirect consumption, that is energy needed for production of goods and services consumed by households, makes up 83% of the households' contribution to CO_2 emissions in Slovakia[13]. Figure 3 also shows that export production is the largest consumer of direct and indirect energy and thus largest contributor to CO_2 emissions, accounting for 42% of total emissions. This large share can be explained by the fact that Slovakia is an export-oriented economy, with exports accounting for 72% of GDP [SUSR, 2001]. Furthermore, Slovakia exports many energy-intensive products, in particular basic metals (mainly steel). The third largest share of emissions is from Gross fixed capital formation, because of new investment in this rapidly developing country and the requirement for energy-intensive materials for the construction and manufacture of infrastructure and other long-lived capital assets (e.g. machinery).

Figure 2: Final demand contribution to CO_2 emissions

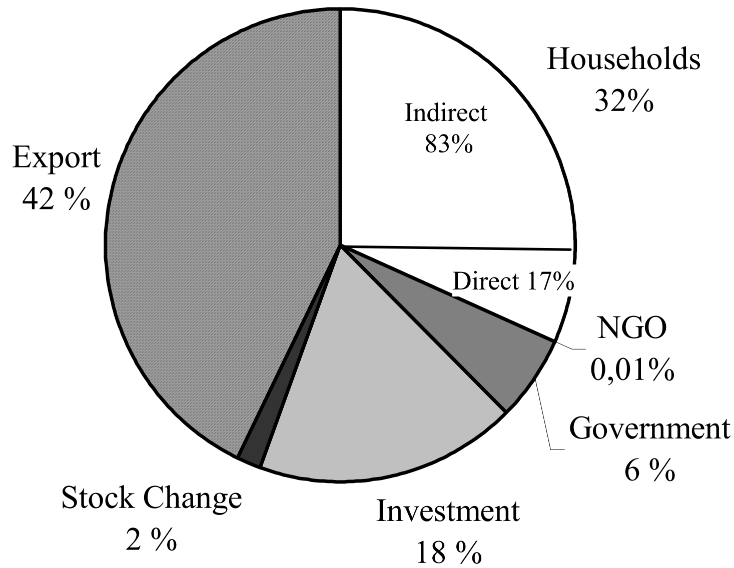
[9] The original Slovak IO table has 49 sectors in Make and Use Tables. [Korytarova, 2004] aggregated this IO table into 19 sectors using the energy data from IEA.

[10] Energetika [1998], the source of energy consumption data, includes energy data only for the whole service sector. Thus we disaggregated the service sector into 20 subsectors according to the information on Final demand expenditures from the IO Use table. For more detail [Korytarova, Forthcoming].

[11] IPCC - Intergovernmental Panel on Climate Change (1988) - http://www.ipcc.ch.

[12] *Leontief* formula: $X = (I - A)^{-1} * Y$, where X is total output, I is the identity matrix, A is the commodity-by-commodity matrix of technical coefficients, and Y is a matrix of various categories of final demand. The formula applied here:
$X = (B - A)^{-1} * Y$, where A is instead defined as the commodity by industry matrix of technological coefficient (based on the Use table), and B is the commodity by industry matrix of production technological coefficient (based on the Make table). For more detail see [Korytarova , Forthcoming]

[13] Note, that direct emissions from household energy constitute from natural gas for heating and cooking and petrol for private cars. Indirect emissions include emissions from household electricity and district heating and energy needed for producing other consumer goods and services.



The emissions embodied in imports to Slovakia (48.26 Mt) are much larger than the emissions produced domestically (45.08 Mt). This is partly because Slovakia is largely depended on imported raw materials and energy-intensive products. The high figures for imports imply that the consumption in Slovakia has negative consequences on the environment beyond its own borders[14]. However, determining accurately the emissions embodied in imports to Slovakia would require separate IO analyses for each country, from which Slovakia obtains imports[15]. Because this is extremely data intensive, we instead treat imported products as if they were produced by the same technology as in the corresponding sector in Slovakia, as well as the same energy mix[16].

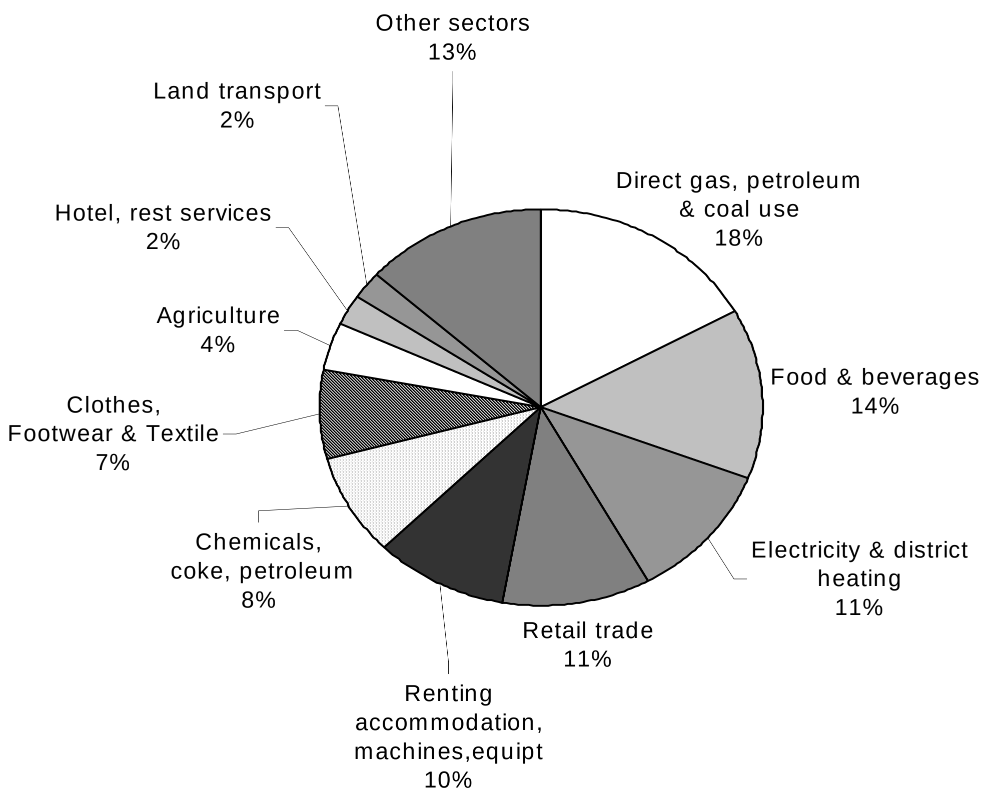
Households account for 35% of the total CO_2 caused by final demand. In Figure 3 the household sector is further divided into 83% indirect and 17% direct CO2 emissions. The households' contribution to direct CO_2 calculated as a share on the total FD, is relatively small: 5, 5%. This can be explained by two facts: 1. direct CO_2 from households includes only fuel for heating, cooking and driving (electricity, hot water and district heating are indirect), and 2. as a transition economy, a high share of the CO_2 emissions are caused by trade and new investment. Almost half of the CO_2 emissions caused by household consumption in Slovakia are produced abroad.
Within the household sector it is interesting to have a closer look at the consumption items. The commodities on which the households spend the most are: Food, beverages

[14] Note, that in this analysis, we examine carbon dioxide emissions embodied in both domestically produced and imported products. This is a different approach than applied in [Korytárová, 2004], which focused solely on CO_2 emissions from domestic production.
[15] i.e. a world IO model, such as the GINFORS model used in the EU-funded project MOSUS (Modeling Opportunities and Limits for Restructuring Europe towards Sustainability), www.mosus.org
[16] Although this approach is subject to error (increasing with higher share of imports to domestic consumption), it shows the additional domestic emissions that would arise if Slovakia were to produce its imports domestically and thus still provides valuable information on proxy proportion of emissions in the economy (see also [Machado et *al*. 2001])

and tobacco (32% of total expenditures), Renting of accommodation (7.9%), and Chemical products coke and petroleum (7.2%), Agricultural products (6.7%), Clothes (6.1%) and Textile (3.82%). Thus food and agricultural products account for almost 40% of household expenditures. Respectively, if we combine Clothes with Textiles and Footwear, together they account for 12.5% of the overall expenditures, this would make them the second largest item. Electricity constitutes only 3.8%, which can be explained as a result of relatively low prices, which are a result of subsidies in the past.

In comparison Figure 3 shows the commodities with the highest overall impacts (direct and indirect):

Figure 3: Emissions from household consumption, by commodity.



Direct gas, petroleum and coal use account for 18% of the total emissions. With regards to indirect emissions, Food, beverages and tobacco account for 14% of the total emissions. Electricity and district heating (11%), Retail trade (11%), and Renting accommodation and machinery (10%) individually make up for almost the same amount of CO_2 emissions. Similarly, the combined category of Clothes, footwear and textile (7%) has almost the same impact as the category Chemical products, coke and petroleum (8%). Again, if we combine Food, beverages and tobacco (14%) with Agriculture (4%), this combination represents a significant contribution to the total CO_2 emissions.

We found out that the 15 commodities with the highest CO_2 emissions per unit of final demand constitute only one fifth of the total CO_2 emissions in Slovakia from final demand. This highlights the importance of not only the emission coefficient, representing emissions per unit of output, but also the amount of household expenditures for certain commodities. For example, even though Food, beverages and tobacco have rather low emission factors (34 kg CO_2/thousand SKK[17]), their contribution to the total CO_2 emissions caused by households is very high (14%), due to the amount of expenditures that the households spend on Food.

On the other hand, the 20 commodities with the lowest CO_2 emissions per unit of final demand make up less than one third of the total CO_2 emissions. This whole group accounts for more than half (63%) of the total household expenditures. After excluding Food, beverages and tobacco, Clothes and Agriculture most of these commodities are services. Individually, the services are linked to rather small household expenditures. However, with the increase in average income the share of services is expected to rise in the future. Thus it is important that policies are developed to direct this shift towards those services, which have lower environmental impacts. Also shifts to services, which have a high impact per unit of final demand have to be analyzed closely (e.g. Retail and Wholesale trade).

4. Conclusions and further steps

In this paper we calculate the CO_2 emissions associated with the production of final demand of households, the government, capital formation, and the production of exports. With help of extended input-output analysis our study for Slovakia shows CO_2 emissions from indirect consumption, induced by the demand of households, which would otherwise go unnoticed using standard methods.

Even though the overall emissions have decreased significantly since the late 1980s, Slovak CO_2 emissions per unit of GDP rank among the highest within the OECD countries. In addition, final energy consumption per capita is expected to increase with growth in GDP and improvements in living standards [KWI, 2002]. The direct energy consumption is expected to rise from these reasons: 1. increasing energy consumption in households (heating, electrical appliances), and 2. increasing intensity in individual automobile transport (this is a result of continuing shift from public and rail transport to automobile and air transport, as well as increase in number of owned cars[18]). The indirect energy is assumed to further increase, since the increasing income will allow for more consumption of products and services. In order to study how changes in lifestyle will contribute to the predicted increase in energy consumption and to the related CO_2 emissions, we develop two types of scenarios: 1. Scenario based on income level – what happens if the income increases to the level of Austrian income (as a proxy for EU

[17] Compare with: Retail trade has 2302.2 kg CO_2/th. SKK, Electricity 236.7 kg CO_2/th. SKK, Chemical and petroleum products and coke 89 kg CO_2/th. SKK, Furniture 79 kg CO_2/th. SKK, Agriculture 44.7 kg CO_2/th. SKK, Clothes 18 kg CO_2/th. SKK.

[18] Number of cars in the Visegrad Group (Hungary, Czech Republic, Poland, Slovakia) has doubled in the period of 1990-2000 [Huba, 2001].

income)? 2. Change of consumption patterns – what happens if the income not only increases, but if Slovak income distribution and consumption patterns would more closely resemble Austrian expenditure patterns? The current income groups (classified by the Slovak Consumer Expenditure Survey) will represent proxy for the different lifestyles in Slovak society.

Acknowledgement

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Bibliography:

Energetika 1998. Energetika, priemysel a stavebníctvo. (Energy 1998. Energy, industry and building.) Bratislava, Štatistický úrad Slovenskej republiky: 1999.

Hertwich, E. Life Cycle Assessment for Sustainable Consumption. Paper for the SETAC-Europe Workshop "Life-cycle approaches to sustainable consumption: Scope and Feasability". Prague, 21 April, 2004.

Huba, M. Slovensko desať rokov po Riu. (Ten years after Rio) Spoločnosť pre trvalo udržateľný život v SR. Bratislava, Formát: 2001.

Huba, M., Hudek, V., Chrenko, M., Ira, V., Kováč, M., Kozová, M., Mederly, P. (ed.), Švihlová, D., Toma, P., Vilinovič, K. a kol.: Trvalo udržateľný rozvoj - výzva pre Slovensko (Sustainable Development - challenge for Slovakia). Bratislava, REC Slovensko: 2001.

Huba, M., Trebický, V., Ira, V., Novák, J., Stodulski, W., Eri, V., Hanušin, J., Hudek, V. Višegrádsky región desať rokov po Riu. (Visegrad region ten years after Rio) Ústav pre ekologickú politiku. STUŽ SR. Praha, Bratislava, Formát: 2003.

IPCC. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook. [online]
<http://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1wb1.pdf>

Korytárová, K. Meranie a hodnotenie udržateľnej spotreby s prihliadnutím na tranzitívne ekonomiky, osobitne Slovenskú republiku. (Measuring and Evaluating Sustainable Consumption, with a special focus on transitive economies, especially Slovakia.) Thesis. Ekonomická univerzita v Bratislave. Bratislava, 2004.

Korytárová, K. Calculating CO_2 Emissions from consumption in Slovakia by using IO analysis. Interim Report. IIASA. International Institute for Applied System Analysis. Laxenburg, Austria, IIASA. (Forthcoming).

KWI Architects Engineers Consultants and Energy Centre Bratislava. Development of a National Energy Efficiency Study for the Slovak Republic. [online] Final Report. Prepared for the World Bank and the Ministry of Economy of the Slovak Republic. Bratislava, 2002. <www.ecbratislava.sk>

Machado, G., Schaeffer, R., Worrell, E. Energy and Carbon embodied in the international trade of Brazil: an input-output approach. Ecological Economics, Vol. 39, pp. 409-424. 2001.

Rosenberg, M. et *al*. Vývojové tendencie svetového hospodárstva (Development trends of the world economy). Part III. Bratislava, Ekonóm: 2002.

SUSR. Komoditno-odvetvové tabuľky dodávok a použitia v SR za rok 1998. Supply and Use Tables By Commodities and Industries in the SR for the Year 1998. Bratislava, Štatistický úrad Slovenskej republiky: 2001. ISBN: 169/2001 – 300.

National Inventory Report. Greenhouse gas emission inventory in Slovakia 1990-2001. 2003 Annex I Party GHG Inventory Submissions. Bratislava, 2003. <http://unfccc.int/program/mis/ghg/submis2003.html>

SUSR. Príjmy, výdavky a spotreba súkromných domácností SR 2002. (Income, expenditures and consumptions of private households in SR.) Štatistický úrad Slovenskej republiky, Bratislava, 2003.

The third national communication on climate change. Ministry of Environment of Slovak Republic. Bratislava, 2001. <http://www.lifeenv.gov.sk/minis/ovzdusie/tns/tretia_narodna_sprava.pdf>

Model to Achieve on Sustainable Consumption in Asia

Uchita de Zoysa

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SC.Asia is coordinated by UNEP and is financially supported by the European Union's Asia Pro Eco Programme. The project is carried out in partnership with the Centre for Environment and Development (CED), Consumers International (CI), and the Danish Consumer Council (DCC). SC.Asia is responding to a call from Asian Governments and regional experts, as voiced in the Marrakech Process, to support Governments to identify and build capacity to promote best practices on sustainable consumption. The project emerged from a proposal made at the 1st Asia Pacific Expert Group Meeting on Sustainable Consumption held in Yogyakartha, Indonesia in year 2003.

The project is structured in four parts:

1. Review of best practices and conditions for sustainable consumption in Europe and Asia
2. Asia-Europe cross learning seminar where findings from above studies are synthesized
3. Development of guidelines on sustainable consumption implementation, published in five languages
4. Assistance to participating Asian countries to develop implementation plans for the part on sustainable consumption in the UN consumption guidelines

The Asian Review

The Asian Review on Sustainable Consumption was conducted by the Centre for Environment and Development under Mr. Uchita de Zoysa.

The 12 target countries for the Asian Review are Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, and Vietnam.

The main objectives of the Asian Review on Sustainable Consumption were;

1. Evaluate status of Sustainable Consumption achievements in Asia
2. Identify the status and readiness to implementing "Best Practices of Sustainable Consumption" in Asian countries
3. Identify "Best Practices of Sustainable Consumption" in Asian countries.

The research was supported by a Preliminary Survey Questionnaire, Interview Guide and Best Practices Questionnaire designed and circulated based on the following;

	Subject area of sustainable consumption action
A	**Recycling programmes for waste and products** would include recycling of aluminium cans, bottles, polythene products, paper, organic waste as well as vehicles, batteries, building material, electrical appliances, etc.
B	**Public & product information** such as statistics, indicators, databases of energy

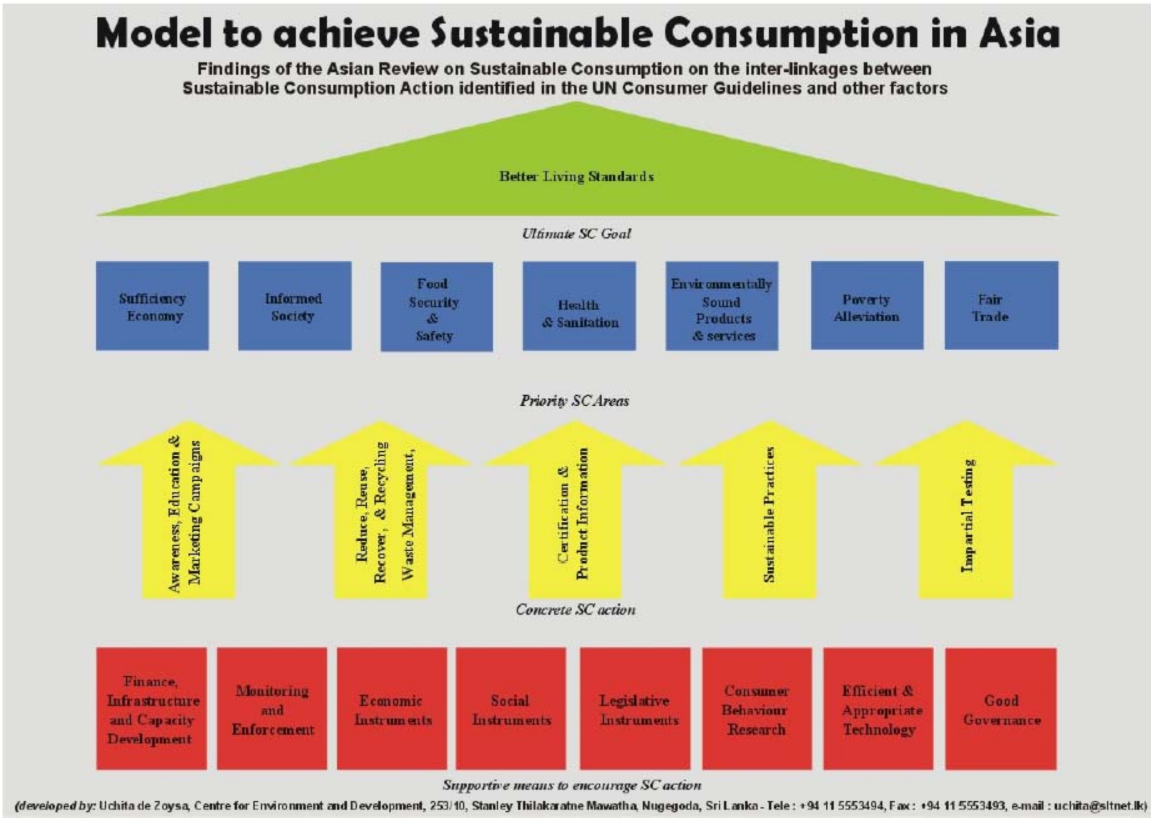
	consumption, waste water consumption, etc. Also would include marking of food items from genetically modified sources, eco-labelling, product certification, etc.
C	**Impartial testing of products** would include testing of the quality products on aspects such as performance, technical aspects, efficiency aspects, health aspects, environmental aspects, etc.
D	**Sustainable practices within organizational operations** such as green procurement, recycling schemes, low energy consumption measures, management skill development programmes to minimise negative impacts and enhance productivity, etc.
E	**Awareness and information campaigns** would include advertising & public relations campaigns to promote energy efficient products, water conservation, emission control etc. Also awareness creation programmes involving school children & communities, etc.
	Other: *E.g. stakeholder participation in policy development and implementing strategies (in areas such as land use, transport and housing), environmental health and safety standards, managing environmentally harmful uses of substances and encouraging the development of environmental sound alternatives, organic agriculture, sustainable tourism, fair trade, poverty alleviation, etc.*

	Supporting means
I.	**Regulatory mechanisms,** would include laws, acts of parliament, cabinet papers, national policy plans, government circulars, industry codes, self regulatory measures adopted, etc.
II.	**Economic instruments,** would include import/export taxes as control measures, tax reductions or removals as incentives and encouragement, subsidies and fiscal and internalisation of environmental costs to promote sustainable consumption, etc.
III.	**Research on Consumer behaviour,** would cover varies research programmes that are directly or indirectly related to the different economic, social, technological, and cultural aspects of sustainable consumption.
	Other *(E.g. social instruments, corporate social responsibility (CSR), life cycle approach, full cost accounting.)*

The Desk Research:
The desk research was conducted for all 12 countries mainly using internet search. The initial purpose of the desk research was to identify existing work and information related to the above areas of sustainable consumption action and supporting means. The initial search also provided CED lead information on organizations and projects to follow-up during the country visits. Also a post country visit desk research was adopted to strengthen the Asian Review.

Country Visits:
The Asian Reviewer of CED visited China, India, Indonesia, Thailand, Cambodia, Philippines and Bangladesh in its order and committed 60 days in these countries. The country visits had covered meetings with over 100 leading organizations involving high officials of government, NGO, academic organizations and some Business & Industry, as well as site visits to conduct experiential review. CED appointed focal points from Government and NGO sectors in each country that involved the leading organizations in the process. These focal points too were partners in the country reviews and played a key role in securing meetings with important authorities and sources, obtaining information and data and promoting the ideologies of sustainable consumption.

The Following Model was evolved for the 1st draft of the Asian Review on Sustainable Consumption.



Metabolism and Driving Forces of Chinese Urban Households

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Abstract: This study was aimed at developing a better understanding of environmental pressure of urban household consumption in China. First, we introduced the concept model of household metabolism. Using this model, we analyzed the changes of Chinese household metabolism during the last twenty years. Rather than taking into account all aspects of household consumption, we just focused on water and energy metabolisms. After exploring the clearly increasing trends of urban household metabolism in China, we identified the underlying driving forces as biological/physical factors, economic/marketing factors and demographic factors. In conclusion, we suggest that additional work must be carried out in a wider range of household activities and at more advanced research levels in China.

Keywords: Household metabolism; Water consumption; Energy consumption; Driving forces; Chinese urban households

1. Background

A lot of severe environmental problems occurred in the twentieth century are originated from human activities. Social responses to these problems have focused largely on the production side of economic activities: innovative technologies for material mining, energy supply and manufacturing. But facts show that environmental gains achieved by producers are being offset by trends on the demand side – population growth, higher standard of living and people's desires to consume products and services [1]. The eco-efficiency improvement towards a Factor 10 or 20 cannot be achieved without social innovation in lifestyle [2,3]. More and more people have realized that changing the unsustainable consumption patterns is as important as production for sustainable development. A sustainable society cannot be realized without a fundamental change in consumption patterns [4]. Recently, the focus has shifted more towards consumer activities as a starting point for setting up strategies aimed at environmental protection [5]. From Rio to Johannesburg, governments, NGOs, enterprises, trade unions, intergovernmental organizations and academic institutions have organized a number of international conferences and programs focusing on the challenge of sustainable production and consumption [6-10]. A lot of research has been carried out to analyze the consumption patterns and the underlying driving forces, as well as environmental pressure related to consumption behaviors, and a series of policies and instruments have been taken or proposed to promote sustainable consumption in the developed countries [11-13].

China is a developing country with a huge population and limited per capita resources. It is important for China to advance sustainable consumption and ensure sustainable development. In 1994, the Chinese government published its Agenda 21, in which Chapter 7 specifically focused on issues concerning sustainable consumption. This has been followed by a lot of activities. The government has played an important role in promotion organic food, ISO 14000 certification and Eco-labelling. China's Consumer Association, as a NGO, launched a 'Green Consumption' campaign on 15 March 2001 to implement the UN Guidelines. The Global Village of Beijing, a green NGO, hosted the first Chinese forum on sustainable consumption in May 2002. Some basic concepts of sustainable consumption have already been introduced to China by scientists [14,15]. In 2003, the Chinese Society of Environment held the first international forum on sustainable consumption and production of China.

Compared with developed countries, China still needs to do a lot of work to promote sustainable consumption and production patterns. It is therefore imperative for China to clearly understand its consumption patterns and its mechanisms. This is the basis to identify key areas to take actions and measures. In this paper, we first introduce household metabolism concept model. And then using water and energy as examples, we examine their metabolism process and determinates. The general objective of this study is to develop a better understanding of sustainability of Chinese urban households. Although the available data are too poor to for any precise analysis, this study will still provide an important reference for the government in the development of proper policies, and we hope this paper will contribute to further research on China's sustainable consumption.

2. Household Metabolism----Modeling the Environmental Pressure of Household Consumption

The word metabolism, which rooted in life science, refers to the process of organism's ingestion of energy-rich, low-entropy materials to provide for its own maintenance, and the process of excretion of degraded, high-entropy waste. It has been widely used as a metaphor to describe the interaction of human-dominated economic system with physical environment [16,17], in the way that the economic systems active like biological organisms in its processing and converting materials and energy. Households, as a kind of economic system, interact with environment to survive. In this process, households get resources from and give emissions back to environment. This integral pattern of natural resource flowing into and out of households is called household metabolism [18, 19]. It uses material cycles and energy flows as measures to quantify the environmental pressure of different lifestyle, since resource consumption is identified as a simplified and reliable presentation of trends in environmental burden generation [20].

Figure 1 is the model of household metabolism [18]. Three kinds of flows can be identified. Flows 1 to 3 represent the input process of household consumption, including energy, material and water. Flows 4 to 6 represent the output process of household consumption, including water emission, air emission and solid waste. Flows 7 to 9 represent the recycling process. Qualifying the environmental pressure of household consumption can be realized by investigating the direction, quantity and velocity of these flows. From this point of view, sustainable household consumption could be defined as follow: a sound lifestyle which can minimize the quantity and velocity of input and output metabolism process as well as maximize the quantity and velocity of recycling metabolism process.

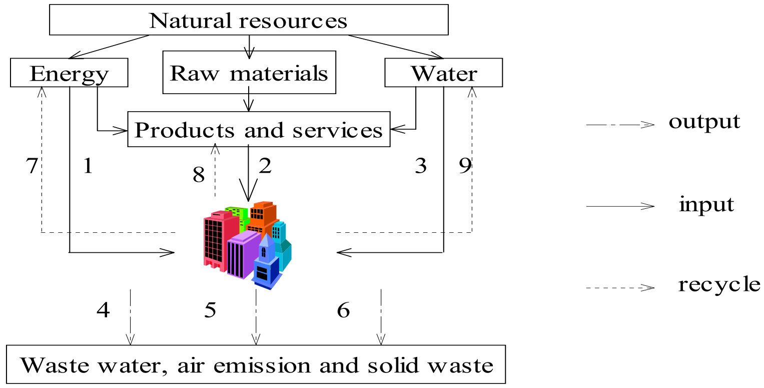

Figure1 Household Metabolism Model

In the following sections, we analyze the metabolism process of Chinese urban households by using this model. Rather than taking into account all aspects of household consumption, we only focus on water and energy metabolism, because developments in consumption are closely related to energy and water used by households and they are important parts of household metabolism.

3. Water Metabolism of Chinese Urban Households

The ratio of running water in city in 1949 was only 10.6%, most of urban population accessed to water through wells [21]. The situation began to change after China's implementation of the open-door policy. The ratio of running water increased from 44.0% in 1979 to 96.7% in 2000. Most of urban households now use tap water in daily life. In cities, residential water consumption is as important as industrial sectors these years, with the increasing urbanization level and the development of high-tech industries and the service sector. The contribution of industrial sectors to total urban water consumption decreased from 72.18% in 1990 to 48.6% in 2000. At the same time, residential water consumption grew 16.46% between 1990 and 2000, increasing from 26.18% to 42.64%. The average annual per capita residential water consumption increased steadily from 65 tons in 1990 to 95.5 tons in 2000. Households exceeded the public sectors, became the major users of residential water consumption. Table 1 shows the contribution of households to residential water consumption in Chinese cities. The percentage of household water consumption to total residential water usage keeps increasing from 65% in 1996 to 71% in 2001[22].

Table 1 Contribution of Household to Residential Water Consumption in Chinese Cities

Year	Residential water consumption (10^8m^3)	Household water consumption (10^8m^3)	Contribution of household to residential water consumption (%)
1996	168	109	65
1997	179	115	65
1998	181	120	66
1999	190	126	66
2000	200	132	66
2001	204	145	71
2002	212	150	71

Inside the households, water is used for different activities, including drinking, cooking, flushing, washing, showering and bathing. Details of the various usages of water is not available. A survey by the Chinese Ministry of Construction in 2000 shows that the main usage are for flushing, bathing and cooking, taking account of 29.1%, 28.8% and 21.5% of water consumption respectively. Figure 2, Figure 3 and Figure 4 show the different household water consumption of China (150 liters per capita per day), Japan (190 liters per capita per day) and America (308 liters per capita per day) [23]. Compared with developed countries, Chinese urban households use more water for cooking and less water for bathing and washing. This is influenced by Chinese traditional diet on one side and the low popularization level of water use equipment on another side. With the popularization of showers and washing machines, the water consumption pattern of Chinese urban households will unavoidably become similar to that of developed countries.

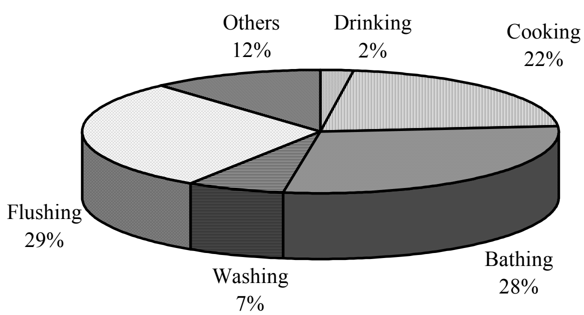

Figure 2 Water consumption pattern of Chinese urban households

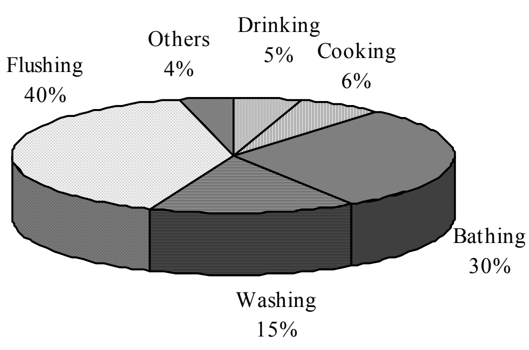

Figure 3 Water consumption of American households

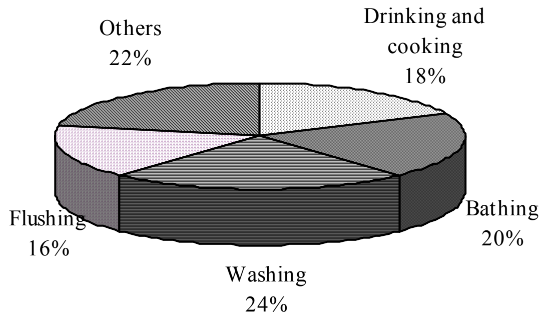

Figure 4 Water consumption of Japanese household

A main environmental pressure of urban household consumption is water pollution [24]. Households are becoming important contributors to the urban water pollution problems in China. Table 2 reflects the increasing trends of residential wastewater discharge, which is consistent with the growing need for fresh water. In the period of 1995-2000, the percentage of residential wastewater discharge increased from 32.19% to 53.22%. Chemical oxygen demand (COD) by wastewater from daily life was 0.61 million tons in 1995, but increased to 0.74 million tons in 2000; its contribution grew 23.68% (Table 3) [22].

Table2 Wastewater discharge in China

Year	Total volume of wastewater (million m^3)	Volume of wastewater discharged from daily life (million m^3)	Percentage of daily life discharge to total (%)
1995	41,530	13,370	32.19
1997	41,600	18,900	45.43
1998	39,530	19,480	49.28
1999	40,110	20,380	50.81
2000	41,510	22,090	53.22

Table 3 COD discharge by wastewater in China

Year	Total volume of COD by wastewater (million tons)	Volume discharged from daily life (million tons)	Percentage of daily life discharge to total (%)
1995	2.23	0.61	27.35%
1997	1.75	0.68	38.86%
1998	1.50	0.69	46.00%
1999	1.39	0.70	50.36%
2000	1.45	0.74	51.03%

Urban infrastructure development in China lags far behind the increasing water consumption. In 1979, the length of urban sewer pipes per 10,000 persons was only 1.6 kilometers. Although this number increased to 6.8 kilometer in 2000, only less than 20% of residential waste water could be treated [25]. This poorly developed wastewater collection and treatment system makes human excreta and phosphates from detergents the most significant source of anthropogenic origin in surface waters, hence a significant contributor to eutrophication.

4. Energy Metabolism of Chinese Urban Households

The residential sector ranked number two, after the industrial sector, in commercial energy consumption in China in the past two decades. Figure 5 shows the final energy consumption by sectors in China. The cleaner and more efficient energy supply contributed a lot to the dropping percentage of the residential sector to total energy consumption. Which kept decreasing from 17% in 1985 to 11% in 2000[26,27].

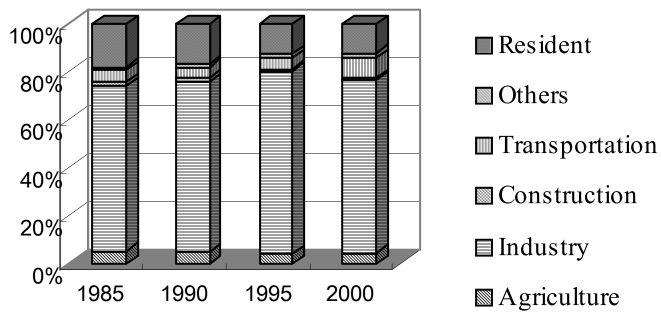

Figure 5 Consumption pattern of commercial energy in China

Figure 6 shows the fuel mix of Chinese urban households from 1990 to 1999. Household LPG and electricity consumption increased from 21.63 GJ in 1990 to 69.21 GJ in 1999, and their shares in household fuel consumption also went up from 10.32% to 42.45%. In contrast, coal consumption slumped from 179.11 GJ in 1990 to 71.70 GJ in 1999, cutting its share form 85.43% to 43.97%. Other fuels including town gas and natural gas, increased from 8.91 GJ to 22.14 GJ, and its share grew from 4.25% in 1990 and 13.58% in 1999. More than 90% of household energy in China was derived from the direct burning of coal before 1980. Since then, natural gas, LPG, town gas, and electricity gradually dominate the household energy budget. But coal still serves as the main fuel in urban households. In 2000, 84.2% of urban households used gas for cooking and hot water [28]. Living standard improvement and income increase have resulted in an influx of home appliances. The ownership of major appliances in Chinese urban households soared from near-zero in 1980 to 80-100% in 2000, and this is accompanied by a significantly increase in electricity demand.

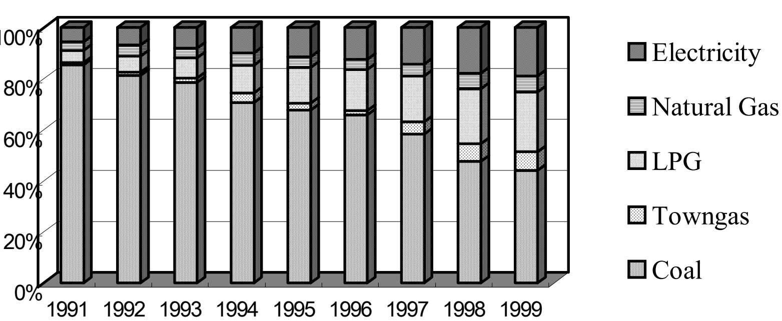

Figure 6 Energy consumption of Chinese urban households

Household energy consumption can be defined as the energy consumed in homes to meet the needs of family members. Major usages of energy in the households include heating, cooking, lighting, cooling, heating and power needed to operate a host of electrical appliances. Energy consumption patterns change with the energy supply structure. Table 4 reflects the household energy consumption patterns by end-use activities and fuel types in China of 1991 and 1995[29]. Heating and cooking take the largest proportion of urban household energy consumption, whereas cooling takes the smallest part. The most noteworthy features of Chinese urban household energy end-use is that cooking and heating fuel consumption dropped by 12% from 88% in 1991 to 76% in 1995; While energy used for lighting, cooling and electric appliances increased 12%, from 12% in 1991 to 24% in 1995. These changes reflect the transition of Chinese urban households from meeting basis needs to higher needs.

Table4 Household energy consumption patterns by end-use activities and fuel types

Year	1990				1995			
Energy consumption (GJ)	Total	Coal	Gas	Electricity	Total	Coal	Gas	Electricity
Heating	1069.82	989.91	73.47	6.44	990.79	895.66	77.57	17.56
Cooking	1241.93	1019.77	208.99	19.61	886.88	597.11	223.62	66.15
Lighting	77.57			77.57	140.50		0.00	140.50
Cooling	2.34			2.34	79.03		0.00	79.03
Electric appliances	212.21			212.21	363.24		0.00	363.24
Total	2603.86	2009.68	282.46	311.73	2460.44	1492.77	301.19	666.19

Pollutants such as CO_2, SO_2, smoke dust and coal cinders caused by household fuel (mainly coal) consumption have significant impact on the urban environment. They will cause acid rain, the emission of solid waste and the global climate changes. Compared with the industrial sector, the direct waste gases emitted by the residential sector are very low. In 1997, 98.8% of SO_2 and 83.56% of smoke dust were emitted by the industrial sources. Indirect gas emissions of household energy consumption mainly come form the electricity generating process. The coal-dominant power industry is one of the most important contributors to atmosphere emission in China. In 1998, 0.631 Mt SO_2, or about 55% of total, was emitted by the power industry [30].

5. Driving Forces of Chinese Urban Household Metabolism

Climate, economic development, household incomes, family sizes, living conditions, cultures and traditions, infrastructure of city and policies all influence the size and significance of household metabolisms. These factors can be categorized as biological/physical factors, economic/marketing factors and demographic factors. The extent of which we understand these underlying drivers behind consumption has an immediate and apparent implication for the design and implementation of more effective policies for sustainable consumption.

5.1 Biological/Physical Factors

China is one of the largest countries in the world with various physical geographical environment. This uneven dispersion of natural resources and climate conditions affect the consumption patterns of households. Generally speaking, households use more water in the south of China than in the north; this is consistent with the distribution pattern of water resources. For example, in Guangzhou city where water resources are abundant and bathing is more frequently, the per capita water consumption is 344 liters water on average. In contrast, in water shortage cities, like Dalian, only 248.1 liters will be used in household per capita. An analysis by Song [31] shows that in 2000, urban households in the south of China consumed an average of 199.5 liters water per capita per day, 1.88 times more than those in northern cities (106 liters per capita per day).

Different energy consumption patterns exit in the south and the north of China. Climate will decide whether space heating is needed in the winter months and whether air conditioning is necessary and used intensively in the summer months. According to results of a 2000 residential energy survey [32], coal is the primary form of energy in northern cities while electricity is the primary form of energy in southern cities. Figure7 shows the energy consumption patterns of Guangzhou and Beijing. Electricity accounted for 75% of household energy consumption in Guangzhou, as people use electricity for cooling and cooking (Figure 8). In contrast, coal, mainly used for heating, is dominant of Beijing's household energy use, taking account of 51% in total consumption. Space heating used 68% of energy in Beijing (Figure 9), since households need to heat their homes during four winter months per year and coal is the main form of energy for heating.

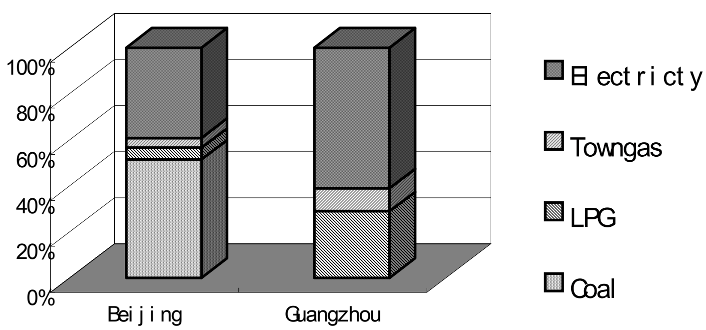

Figure7 Household energy consumption pattern of Guangzhou and Beijing

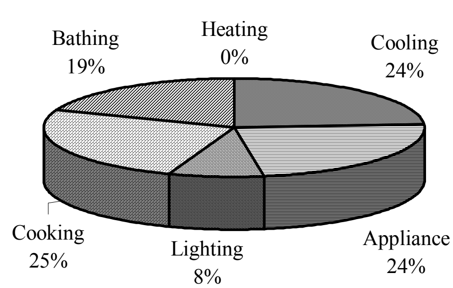

Figure 8 End-use of household energy in Guangzhou

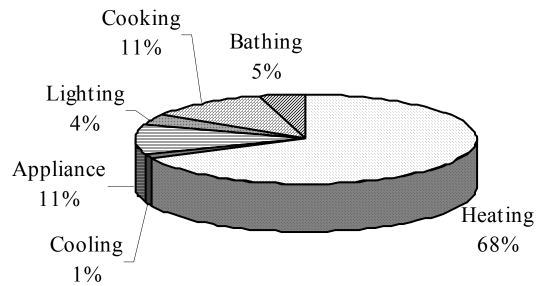

Figure 9 End-use of household energy in Beijing

5.2 Economic and Marketing Factors

The economic development and increasing disposable incomes of households appear to be one of the most important determinants of household metabolisms. Rapid economic development has taken place in China since its reform and opening-up in 1978. GDP growth averaging 9 % per year in the past 20 years has resulted in strong gains in household incomes. Disposable incomes of Chinese urban households increased 13.14 times between 1981 and 2000. Resources consumption and waste emissions increase with the growing of household incomes and living standard [33], because higher household incomes are linked to higher levels of ownership and more frequently use of water and energy consumption appliances. Figure 10 shows the number of electrical appliances in Chinese urban households from 1985 to 2000. The number of four major appliances (refrigerators, television sets, washing machines and fans) increased rapidly in urban households in the 1980s. The saturation of other appliances, such as the energy-intensive appliances of air-conditioning (A/C) and freezer, water use appliance-shower are growing rapidly in recent years. This trend together with China's population growth and overall demography puts considerable pressure on residential water and energy demand in the near future.

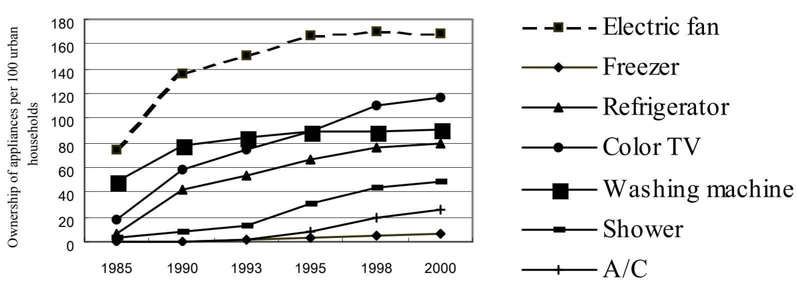

Figure10 Number of electrical and water consumption appliances in China

Price is a factor that affects household behavior as well as an important incentive to save energy and water. But the unreasonable residential resource price system of China does not promote water and energy conservation in households. A report of the Chinese National Bureau of Statistics reveals that in 2001, expenditure on electricity is 141 Yuan RMB, and the expenditure on other fuels is 118 Yuan, accounting for 0.04% and 0.02%

of household's disposable income (6860 Yuan RMB) respectively [34]. Convenience, instead of energy price, is now an important consideration in fuel choice in Chinese urban households. Water outlay in 2001 is 37 Yuan RMB, constitutes only about 0.01% of an average family's disposable income. Research results show that only when the proportion of water outlay exceeds 2% of household income, people will pay more attention to water conservation; when this proportion exceeds 10% of household income, water will be reused within households [35].

5.3 Demographic Factor

China's urbanization in the past two decades can be characterized by large-scale migration from rural areas to the cities accompanied by changes in life styles. For households, the adoption of a modern urban way of life means more water and energy consumption [36]. With the urbanization level increased from 19.6% in 1980 to 35.8% in 2000, urban population doubled from 196.22 millions to 456.34 millions. At the same time, the average size of household fell steadily from 4.24 to 3.13 people. Table 5 shows the percentage of households by average family size in China from 1995 to 1999. One to three-person households made up 52% of the households in 2000. That is an increase from 48% in 1995.

Table 5 Distribution of different household sizes (%)

year	One person	Two-person	Three-person	Four-person	Five or more persons
1995	5.89%	13.73%	28.42%	26.58%	25.37%
1996	5.93%	13.64%	28.70%	26.31%	25.41%
1997	5.97%	14.48%	29.81%	25.87%	23.87%
1998	5.89%	14.90%	29.84%	25.92%	23.46%
1999	6.32%	15.39%	30.20%	25.38%	22.71%

Population growth, together with a trend towards smaller household size, is contributing to a substantial rise in the number of households in Chinese cities. This is an important reason to promote sustainable consumption in China. These changes will be reflected in household's metabolism efficiency. Case study in other countries found that there is a negative relationship between household size and per capita energy consumption. A household metabolism analysis in Norway shows that a person in one-person household consumes almost twice the amount of energy compared to a person in a four-person household [37]. A survey of household electricity consumption in Beijing reflects the similar trend [38]. Table 6 shows the results of this survey. Electricity consumption per person declines as the household population increases.

Table 6 Electricity use per person per month for different household types

Household size	Electricity use per household (kW.h)	Electricity use per person (kW.h)
2 persons	138.5	69.25
3 persons	132.23	44.08
4 persons	146.5	36.63
5 persons	147.3	29.46

6. Conclusions and Discussions

In this paper, the environmental pressure of Chinese urban household consumption is investigated based on household metabolism model. The findings clearly indicate that the Chinese urban energy and water consumption and the resulting environmental pressure have risen remarkably in the past decades. The trend is likely to continue as the underlying driving forces, such as increasing incomes, declining household size and improved living conditions, are still at work. The growing intensity of urban household metabolisms will put great pressure on the realization of sustainable development in China. Therefore, it is urgently needed for the government to take actions to promote sustainable household consumption.

Our focus on the urban household is based on the following consideration: First, the rapidly urbanization process of China takes great environmental and ecological pressures. Urban household, as an important actor of economic systems, has strong capacity to influence the production process and the sustainability of society. Secondly, urban lifestyles are likely to be imitated by the rural population. With the urbanization process, a lot of rural people will migrate to urban area. They are likely to copy the lifestyle of urban people. Thirdly, people in cities have more access to information, so cities will be the strategic entry point for polices to promote sustainable consumption [36]. Fourthly, the statistic base of urban households is better than rural households. Most rural households in China access to water by well and use non-commercial fuel, which is not included in the National Statistic Systems.

In order to accurately understand the trends, patterns and mechanisms of household consumption in China, additional work must be carried out in a wider range of household activities and at more advanced research levels. Some key questions about the rebound effect of consumption and the integration of sustainable consumption and production should be answered. A series of our work concerning material metabolism and these key questions will be carried out in the future. By gaining a better understanding of dynamics of Chinese household consumption, including both urban and rural areas, more effective policies for promotion of sustainable consumption will be formulated and effectively carried out.

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References:

[1] United Nations Environment Programme. (2002). Proposal for a work programme on promoting sustainable consumption and production patterns. Paris: United Nations Environment Programme

[2] Ken Green & Philip Vergragt. (2002). Towards sustainable households: a methodology for developing sustainable technological and social innovations. Futures, 34, 381-400.

[3] Stephan Schmidheiny. (1992). Changing course: a global business perspective on development and the environment. London: The MIT Press.

[4] Bernd Hirschl, Wilfried Konrad & Gerd Scholl. (2003). New concept in product use for sustainable consumption. Journal of Cleaner Production, 11(8), 873-81.

[5] G.A. Rood, J.P.M.Ros, E.Drissen & K.Vringer. (2003). A structure of models for future projections of environmental pressure due to consumption. Journal of Cleaner Production, 11(5), 491-498.

[6] E.Geyer-Allely, A.Zacarias-Farah. (2003). Policies and instruments for promoting sustainable household consumption. Journal of Cleaner Production,11(8), 923-26.

[7] United Nations Environment Programme. (2002). Tracking progress: implementing sustainable consumption policies. Paris: United Nations Environment Programme.

[8] United Nations Environment Programme. (2002). Sustainable consumption-a global status report. Paris: United Nations Environment Programme.

[9] United Nations. (1999). Promoting sustainable production and consumption: five policy studies. New York: United Nations.

[10] L.Michaelis. (2003). The Oxford Commission on sustainable consumption. Journal of Cleaner Production, 11(8), 931-933

[11] Atsushi Inaba. (2002). Life-cycle approaches to sustainable consumption: In Edgar Hertwich (Eds.), Workshop proceedings of life- cycle approaches to sustainable consumption (pp.1). Laxenburg, International Institute for Applied Systems Analysis.

[12] Bas de Leeuw. (2004). Ten-year framework on sustainable consumption and production. In: Klaus Huback, Atsushi Inaba & Sigrid Stagl (Eds.), Proceedings of international workshop on driving forces and barriers to sustainable consumption (pp.8). Leeds, University of Leeds.

[13] Henri C.Moll & Klass Jan Noorman. (2003). Sustainable consumption at city level: evaluating and changing the household metabolism in five European cities. In: Abstracts from the second industrial ecology for a sustainable future conference (pp. 43-44). Michigan, University of Michigan.

[14] Yang, J.D & Qin, X.F. (2000). Introduction of sustainable consumption. Beijing: Economy Publishing House.

[15] Liu, J.L. (2001). Green life and our future. Beijing: Chemical Industry Press.

[16] Rober U. Ayres & Udo E. Simonis. (1994). Industrial Metabolism. Tokyo: United Nations University Press

[17] Marina Fischer-Kowalski & Walter Hüttler. (1998). Society's Metabolism: Review of the Intellectual History of Materials Flow Analysis Part II: 1970-1998. Journal of Industrial Ecology, 2(4), 107-136.

[18] K.J Noorman. (1998). Green households? domestic, consumers, environment and sustainability. London: Earthscan Publications Ltd.

[19] K.J. Noorman & Patrick Jolivet. (2001). Introduction. International Journal of Environment and Pollution, 15(2), 123-26.

[20] Sylvia Lorek & Joachim H.Spangenberg. (2001). Indicators for environmentally sustainable household consumption. Journal of Sustainable Development, 4(1), 101-120

[21] Urban Social and Economic Survey Organization. (1990). The forty years of urban development of China. Beijing: Co-published by China Statistical Information and Consultancy Service Center & International Center for the Advancement of Science and Technology Limited.

[22] Ministry of Water Resource of China. Chinese water resource reports (1997-2001).
[23] Li, F.X. (2003). Necessarily of supply water based on quality need. Economic Information Daily of China. July 20
[24] Organisation for Economic Co-operation and Development. (2002). Household energy & water consumption and waste generation: trends, environmental impacts and policy response. Paris: Organisation for Economic Co-operation and Development.
[25] Song, X.T. (2001). Development and strategies of China's water and wastewater. China Water & Wastewater, 16(1), 21-25.
[26] Department of Industrial and Transportation Statistics. (1998). China energy statistical yearbook (1991-1996). Beijing: China Statistical Publishing House
[27] Department of Industrial and Transportation Statistics. (2001). China energy statistical yearbook (1997-1999). Beijing: China Statistical Publishing House.
[28] Bureau of Statistics. (2001). China statistical yearbook. Beijing: China Statistics Press.
[29] Hu, X.L. (2001). Evaluation of technology and countermeasure for greenhouse gas mitigation in China. Beijing: Chinese Environmental Sciences Publisher.
[30] Wang, X.H. (2003). Energy consumption with sustainable development in developing country: a case in Jiangsu, China. Energy Policy, 31(15), 1679-1684
[31] Song.X.T. (2004). Water consumption efficiency of Chinese cities. China Construction Newspaper. March 19
[32] Brockett, Debbie, David Fridley, Lin, J.M.& Lin,J. (2002). A tale of five cities: the China residential energy consumption survey. In: ACEEE summer study on building energy efficiency. Lawrence Berkeley National Laboratory.
[33] China's Agenda 21: white paper on China's population, environment, and development in the 21st century. Beijing: Chinese Environmental Sciences Publisher, 1994
[34] Improving living quality of Chinese urban resident. (2003). In: a series of reports prepared for the 16th national congress of communist party of China. National Bureau of Statistics of China.
[35] SHI, X.C. (2002). An introduction of water price system in foreign countries. Report on forum of Chinese water price reform. Haikou (China).
[36]Ray,K. (1998). Promoting sustainable consumption in Asian cities. In: United Nations Centre for Human Settlements (Eds.). Promoting Sustainable Consumption in Asian Cities, Nairobi
[37] Harald Throne-Holst, Rene Benders, Henk-Jan Falkena, Henri Moll & Noorman K.J. (2002). Household metabolism: Norwegian national report. Lysaker: National Institute for Consumer Research
[38] Zhou, H., NIU, W.J.& JI, H.(2003). Analysis of residential power consumption in summer with various influence factors. North China Electric Power, 21(3), 12-14.

Development of benchmarking for the environmental impacts of different products, services and consumption patterns

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Abstract

The 2002 World Summit on Sustainable Development proposed developing consumer information tools to promote sustainable consumption. Life cycle assessment (LCA), which is a standardized method to determine the environmental impacts of products, was recommended as a basis for such tools. LCA has been recognized also in EU in the context of 'Integrated Product Policy' (IPP) as providing "the best framework for assessing the potential environmental impacts of products currently available." However, there is a need to develop ways to interpret and present LCA results for consumers. Against this background four Finnish research institutes started a study to promote the use of LCA-based product information in 2003. The first task of the study has been to develop benchmarks to which the LCA results of various products can be compared. This article presents the preliminary results about the benchmarks. The benchmarks are based on the average daily per capita environmental impacts of the whole economy of Finland and on LCA studies of several consumer products: rye bread, Emmental cheese, laundry, a two-bedroom apartment, and a car trip. The outcomes of the study can be used when informing citizens on the environmental impacts of products and consumption patterns. The benchmarking method will also help manufacturers and retailers to provide information about the environmental impacts of their products, and can also be valuable for policy development.

Keywords: benchmarking, consumption, environmental impacts, life cycle assessment, LCA, products, services, product policy, IPP

Introduction

The 2002 World Summit on Sustainable Development proposed developing consumer information tools to promote sustainable consumption (World Summit 2002). Life cycle assessment (LCA), which is a standardized method to determine the environmental impacts of products (ISO 14040 series), was recommended as a basis for such tools. LCA has been recognized also in the EU in the context of 'Integrated Product Policy' (IPP) as providing "the best framework for assessing the potential environmental impacts of products currently available." However, as noted by the EU, "the debate is ongoing about good practice in LCA use and interpretation." (EU Commission 2003).

Illustrative ways to present the results have often been addressed in the development of LCA tools and methods. It is common to benchmark the various effects against the total effects in an area or country, e.g., in the Eco-indicator method the environmental effects are normalized by the effects caused by the average European during a year (Goedkoop & Spriensma 2001). Further, the normalized results can also be weighted with the assumed seriousness of each effect: in Eco-indicator, these weights are determined by a panel method. After normalization and weighting, the resulting 'ecopoints' can be shown in illustrative forms, e.g., using the common column format. In addition, quite sophisticated presentation methods, using e.g. spheroids and addressing both the values and uncertainty of the various impacts, have also been used to increase the efficiency of visualization (e.g., Otto et a. 2003).

The normalization step is generally used to make the results of various impact classes more understandable and comparable with each other (Finnveden et al. 2002). Normalisation means the determination of the relative contribution of the studied product system to the environmental impacts of a reference system, which in many cases has been a country (economy). It converts the results of the characterization into numbers with a common unit. The reference system can be regarded as a benchmark, if that is easily understood and valued by consumers.

After normalization, a weighting step can follow. Weighting factors reflect the trade-offs between the impacts caused by the reference values. Thus it is clear that the normalization and weighting factors must be consistent (Seppälä and Hämäläinen 2001, Finnveden et al. 2002).

However, despite previous efforts there still exist an obvious need to develop methods to interpret and present LCA results for consumers. On the basis of research in, e.g., social representation theory (Wagner 2002, Joffe 2003), new concepts are adopted through "anchoring", i.e., understanding new information by constructing continuities to familiar things from the past. Thus, we assume that LCA results would be easier to understand if they were linked to a familiar frame of reference, and compared to an everyday object. Everyday consumer products and functions/services may offer benchmarks which bring the reference close to one’s own life. We expect this would help consumers and other information users to grasp the practical implications of the information for their everyday activities and decisions/choices for the environment.

Four Finnish research institutes started in autumn 2003 a study to promote the use of LCA-based product information, the objectives being: a) to develop benchmarks to which the LCA results of various products can be compared, b) to develop quality descriptions and criteria for the suitability of LCA studies to benchmarks, c) and to study how consumers understand the benchmarks (Figure 1, Nissinen et al. 2004). This article deals with the first objective, presenting the benchmarks.

Material and methods

Benchmark alternatives and types of presentation of the benchmarking

Two different kinds of benchmark alternatives were developed. Normalization using the average daily per capita environmental impacts of the whole Finnish economy was selected as a basis for the benchmarking. Another set of benchmarks was developed using LCAs of everyday products, which we thought would serve as a useful comparison point and allow consumer to “anchor” the novel information to a familiar context.

In order to illustrate the use of the benchmark method, a car trip was selected to serve as the product/service for which the benchmarks provide points of comparison, or serve as illustrations of the magnitude of environmental impacts. Later in the text this product is called 'illustrated product'.

Alternative presentation formats were developed for making the comparisons between the environmental impacts of the illustrated product (in this case a car trip) and the benchmarks. We named them types A to F.

In presentation format A, the various environmental impacts of the illustrated product are expressed as percentages of the average daily per capita environmental impacts of the whole economy of Finland. The well known and illustrative figure type with columns is used, in order to have a type of figure which is familiar to most consumers.

In presentation format C the figure type is similar to presentation format A, but the normalized effects of another product are shown beside the illustrated product. In the following, we call this other product the 'benchmark-product'. In fact, there are two benchmarks in this figure: the normalization and the benchmark-product.

Presentation format D is developed from presentation C, by additionally conducting a weighting of the different impact classes, and by aggregating the effects into one column, yet showing the contribution of each impact class.

The selection of the environmental impacts to be shown in the figures was based on the availability of methods to determine the impacts as well as on the availability of data on the impacts of the whole economy, needed for the normalization. Also the data availability in the surveyed LCA studies was considered. As a result, five impact categories were determined (abbreviations shown in parenthesis): climate change (CC), aquatic eutrophication (EA), acidification (A), formation of tropospheric ozone (O), and primary energy consumption (EN) (energy consumption relating to the depletion of non-renewable energy resources).

These benchmarks were presented in a brochure, which we plan to use to study how people understand the alternatives to benchmark the impacts (see Figure 1 about the tasks

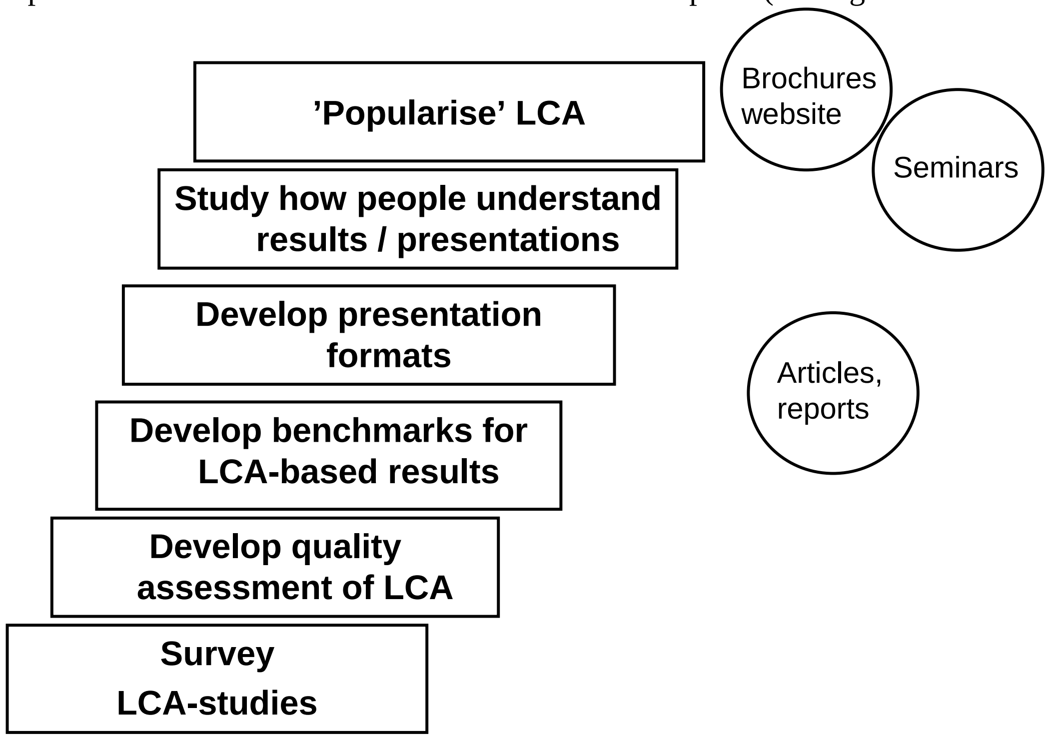


Figure 1. Tasks in the project to promote the use of LCA information in the context of consumption. This article deals mainly with the developing of the benchmarks and the presentation types.

and structure of the whole project). The drawback of having only a part of the essential impacts in the presentations was introduced in two ways in the brochures. Firstly, in connection with every figure it was told that the products have also other essential environmental impacts. Secondly, when describing the five environmental impact classes included in the figures, we also describe six other essential impact classes not included due to lack of data and/or methods.

The benchmarks were developed in a research group consisting of experts in LCA, IPP as well as consumer research. In addition stakeholder consultation was obtained in the project steering group and in two seminars open to experts and a wider audience.

Benchmark based on the environmental effects of the whole economy of Finland

Normalisation with average daily per capita environmental impacts of the whole economy of Finland was used as the first type of benchmark. Thus it was based on three factors, namely 1) the environmental effects of the whole economy of Finland in a year, including industry, agriculture, silviculture and communities (Finnish Environment Institute 2004), 2) the population of Finland which was 5.206 million at the end of 2002 (Statistics Finland 2004), and 3) the number of days per year.

Benchmarks based on the environmental effects of different products

The second type of benchmark was based on a number of common products. Two conditions were set for these products: 1) there must exist an LCA of the product which is of good quality, and can be updated and modified (if needed) to be relevant to the conditions of Finnish consumers, and 2) the product must be a familiar ’every-day’ product to Finnish consumers.

In order to screen suitable LCA-studies, a survey was conducted of existing LCA studies, using literature databases (e.g., Cambridge Scientific Abstracts). Tens of LCA-studies were pre-evaluated, and more than ten studies were thoroughly assessed. The assessments focused on the re-applicability of the study, so that the results of the selected LCA studies could serve as reliable benchmarks. It was important that the results should correspond to the environmental impacts of similar products in present-day Finnish conditions, or that the study could be modified to provide relevant results for Finnish consumers.

Finally, five LCA-studies were selected for further development (Table 1). Rye bread and cheese were the food products selected as benchmarks, largely due to the importance of food in everyday consumption and data availability considerations. Both make up only a small portion of the daily food intake, and thus also of a consumer’s total daily environmental load caused by food, but they provide an illustration of the environmental loads of commonly used products. Other benchmark products included in the study are a wash of laundry, a two-bedroom apartment and a car trip. However, one of the products, namely the car trip, was selected to be used at this stage as the illustrated product.

Some modifications and updating were needed to all of the selected LCA-studies (Table 1). A general modification was to use new data for the environmental effects of electricity and district heating, representing year 2003 and average values for whole Finland. For imported electricity, country-specific values were used. Product-specific modifications and updates are described below.

Rye bread is a staple food in Finland. The benchmark was calculated for the average daily consumption of rye bread (83 g) among those who use this food regularly (80% of the population). This amount corresponds to approximately two slices of bread. The benchmark for rye bread is based on a Finnish LCA-study (Grönroos and Seppälä 2000, Grönroos et al. 2001, Grönroos and Voutilainen 2001) of bread made of rye grown in Finland (and thus excluding the commonly used imported rye as a raw material). Some of the inventory analysis data used here has been updated.

In addition to the on-farm operations (cultivation, harvest processing), the product system of rye bread consisted of the production of materials and energy (fertilizers, pesticides, agricultural lime, fuels, electricity, salt, yeast etc.) and the processing of the bread itself (milling of the grains, baking). Also the transportations in and between the different unit processes were included to the system. Transportation of bread to the store was a final

Table 1. Product-benchmarks and their main LCA-information sources

Product/service	Main LCA and other main references	Modifications and updating to Finnish conditions
Rye bread	Grönroos and Seppälä 2000. Agricultural production systems and the environment. The Finnish Environment 431. (Only abstract in English).	Updated nutrient leaching & eutrophication of waters, electricity in Finland.
Emmental cheese	Voutilainen et al. 2003. Environmental impacts and improvement possibilities of Emmental blue-label cheese. Maa ja elintarviketalous 35. (Only abstract in English).	Updated nutrient leaching & eutrophication of waters, electricity in Finland.
Laundry	Saouter, van Hoof, Feijtel, Owens 2002. The effect of compact formulations on the environmental profile of northern European granular laundry detergents. Part II: LCA Int J LCA 7 (1) 27-38.	Consumption of electricity and water of typical washing machine, 40 C, Electricity and wastewater treatment in Finland.
Apartment	Koskela et al. 2002. Environmental impacts in assessing the ecoefficiency of buildings. The Finnish Environment 585. (Only abstract in English).	Updated electricity and district heating in Finland, electricity of appliances in the appartment not included.
Car drive	Schweimer and Levin, Life cycle inventory for the Golf A4. downloaded from www.volkswagen.-environment.de	Energy consumption and emissions of vehicles from a national model (www.lipasto.fi, made by VTT Technical Research Centre of Finland), EURO 3 norm. Fuel production (gasoline in Finland).

stage in the product system. A farm model was used to describe the on-farm operations in the rye bread product system. The farm model represent the typical conventional cereal farm growing rye in Finland in 2002. For other production stages, the emission and resource and energy use data were gathered directly from the industry, or, when it was not possible (e.g., emissions from the fields), by using scientific methods to estimate them.

Cheese was the other food product selected as a benchmark. In contrast to bread, it represents an animal-based product with a high nutritional energy content. The benchmark was calculated for the average daily consumption of cheese (30 g) among regular cheese users (80% of the population). This amount corresponds to approximately four thin slices of cheese. The LCA was made of Emmental cheese (Voutilainen et al. 2003), which is very popular in Finland. The results pertain to conditions in 2000-2001, and represent one third of the total production of Emmental cheese in Finland. The study encompasses the product chain from natural resource extraction to ready-made cheese on the market shelf. Milk production data and detailed feeding values were drawn from about 700 farms. Regarding uncertainty in the results, the eutrophication results are most uncertain, being especially sensitive to the model of phosphorus emissions from surface runoff in grass farming.

Laundry was selected to represent an everyday, familiar activity at home. Finnish families currently wash their laundry almost on a daily basis: 25 washing machine cycles are run every month, on an average. Of these washes, 55 % are cold (40°C) and 35 % warm (60°C), while the remaining 10 % are either hotter or colder. The benchmark for laundry is based on a European study (Saouter et al. 2002, case Sweden 1998).

We updated the data pertaining to energy consumption at the use stage and to waste water treatment to correspond to Finnish conditions (Tenhunen et al. 2000), and based our calculations on the washing temperature of 40°C. The washing machine performance data represent a relatively new and energy-efficient appliance with an energy-label class A.

A two-bedroom apartment was selected to represent housing, and the benchmark for housing is “one day of living in an apartment” per person. Many Finnish households (44%) live in apartment houses (blocks of flats), and the average living space per person is 36 m^2. Thus the benchmark apartment of 83 m^2 was selected as a fairly common housing type for 2 persons, with a living space per person of 41 m^2. In addition to living space, the environmental impact of housing depends on the type of housing: apartments require less space heating than single-family houses, for example.

The apartment benchmark is based on an LCA of a three-floor prefabricated apartment building (Vares 2001, Koskela et al. 2002), the data being supplemented by personal communication from Koskela. The useful life of the building was calculated as 100 years. The data encompass the production of construction materials and the energy consumption of the building during its use. The data on construction materials are mainly based on data collected from Finnish manufacturers in 1995-1999. The energy consumption of the building includes space heating using district heating (combined heat and power production) and the electricity use of the facility (i.e., electricity used in common spaces of the house, not within individual apartments). Thus, the housing benchmark does not include electricity used at home, e.g., for lighting, laundering or kitchen, or recreational appliances.

It is worth noting that there are a number of weaknesses in the LCA used for the housing benchmark. For some parts of the results, the data quality was difficult to evaluate due to lacking documentation. In addition, the LCA does not include data on interior surface materials (i.e., e.g., flooring, fittings), or on the repair and maintenance of the building. Furthermore, emissions contributing to eutrophication were excluded from the study (because they were assumed to be minor). On the other hand, the use stage is much more significant than the construction stage in terms of the other included impacts: the role of construction materials in these categories is less than 10% of the total. In spite of its shortcomings, we wanted to include the housing benchmark because housing is a very significant contributor to many environmental problems, and thus its inclusion is warranted in spite of the relatively large uncertainties in the data.

A car trip was the fifth benchmark calculated, and it was also used as the illustrated product. This benchmark is based on the average daily travel by car in the metropolitan area (21 km), which is also close to the national average. In the metropolitan area, most car trips are made alone; the average number of passengers is 1.2.

Most of the environmental impacts result from fuel use when driving the car. The data for fuel use are based on the Liisa database maintained by the VTT Technical Research Centre of Finland (www.lipasto.fi). In addition, the environmental impacts of fuel production were included in the calculation. The data on car manufacturing and maintenance were also calculated on the basis of a relatively new LCA on the VW Golf A4 (Schweimer and Levin), with the most recent data dating from summer 2000. This LCA was not, however, ideal in terms of the benchmark, as it assumed an average lifetime of 150 000 km for the car, whereas Finnish cars are driven for 350 000 km during their life, on an average. Thus, the results over-estimate the role of car manufacturing, which was 10-20% for most environmental impact categories when a lifetime of 150 000 km was assumed.

It is worth noting that automotive emissions have decreased significantly as engine technologies have improved, and certain emissions vary very much for different vintages of cars. In the present study, data for relatively new cars were used, and the car was assumed to fulfill the EURO3 requirements. Such cars have been available in Finland since 2000. The emissions of the brand new VW Golf in the LCA were lower than this EURO 3, but were not assumed to represent a typical car in the minds of a Finnish consumer. The changes have been especially large in emissions of nitrogen oxides (NOx) and hydrocarbons (HC), whereas the carbon dioxide (CO_2) emissions, which are related directly to fuel use, have changed less.

Life cycle impact assessment

In the study, the impact assessment methodology is based on the general phases of life cycle impact assessment (LCIA): selection of impact categories, classification, characterization, normalization and weighting (ISO 2000). The aim was to use the newest characterization factors that can describe the fate and exposure as far as possible. The selected impact categories and contributing emissions were:

1) climate change (CO_2, N_2O, CH_4),
2) acidification (SO_2, NO_x, NH_3)
3) tropospheric ozone formation (NO_x, NMVOC, CH_4)
4) terrestrial eutrophication (NO_x, NH_3)
5) aquatic eutrophication (NO_x, NH_3, N(w), P(w)).

The other impact categories such as human toxicity, ecotoxicity, particulate matter and effects of land use were not taken into account in this stage of the project because practical and/or reliable characterization factors are not yet available for those impact categories.

The GWP potentials applied in national emission inventories were used as characterization factors for climate change, whereas country-dependent characterization factors were used for acidification (Seppälä et al. 2005), tropospheric ozone formation (Hauschild et al. 2004), terrestrial eutrophication (Seppälä et al. 2005) and aquatic eutrophication (Seppälä et al. 2004). For normalization, the reference values for each impact category were calculated on the basis of the total Finnish emissions. As the reference system in normalization, we chose the Finnish economy, because Finland-specific weighting factors were available from a earlier study (Seppälä et al. 2001, determined according to the principles presented by Seppälä 1999).

Results

Using the presentation type A, it is easy to see that the various environmental effects of the car trip of 21 km are 1-12% compared with the average daily per capita environmental impacts of the whole Finnish economy (Figure 2). The climate change impact and energy consumption are the relatively largest impacts of the car trip. Aquatic eutrophication is relatively small (and caused mainly by the emissions of NO_x in the use of the car).

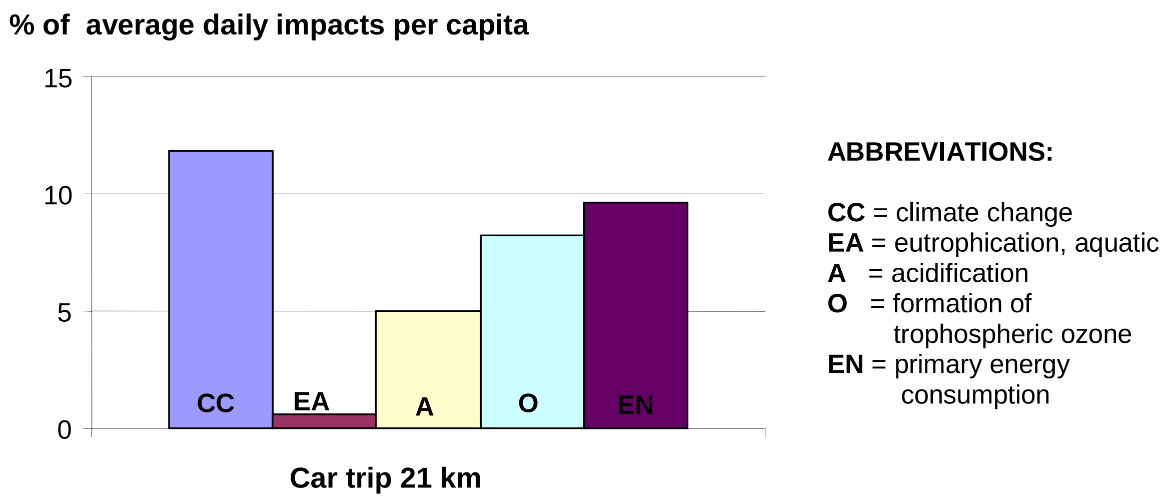
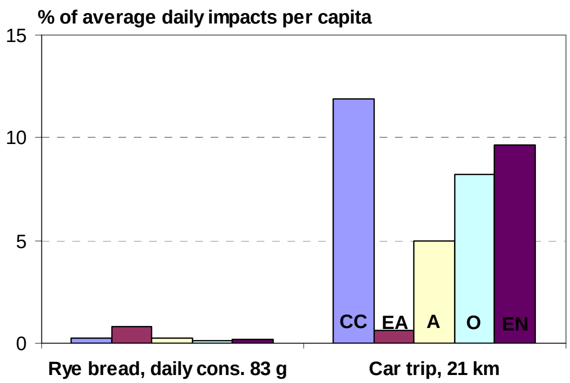


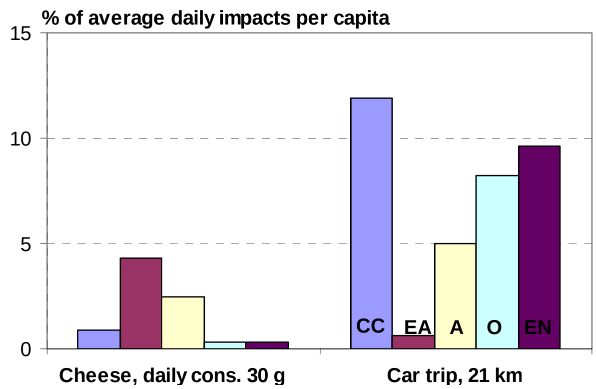
Figure 2. Illustrating the environmental impacts of a car trip using presentation format A, i.e., using the benchmark based on the average daily per capita environmental effects of the whole Finnish economy.

When an other product is brought into the presentation type A beside the illustrated product, this forms a supplementary possibility to 'scale' the effects (Figure 3). Looking at the benchmark-product 'daily used amount of rye bread', the car trip has manifold effects compared with it in all other impact categories except aquatic eutrophication. The same holds true for Emmental cheese and laundry. (Please note here, that the total daily use of passenger cars per capita is compared to the consumption of rye bread and cheese and not the total consumption of food per capita. The total contribution of food to the various environmental impacts may be rather large).

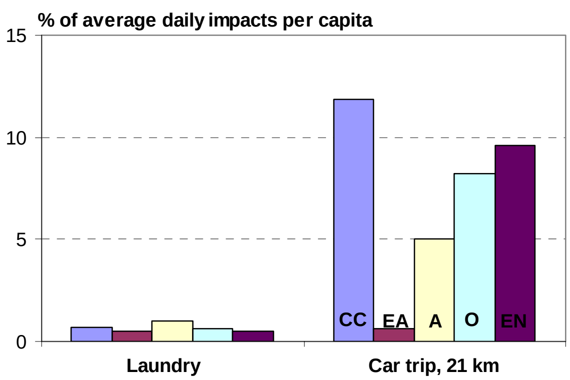
Both rye bread and cheese have large differences between the various impact categories. The eutrophication impact of the rye bread is 0.8% while the energy consumption is only 0.2% of the average daily impacts per capita. The corresponding values for cheese are 4% and 0.3% respectively.



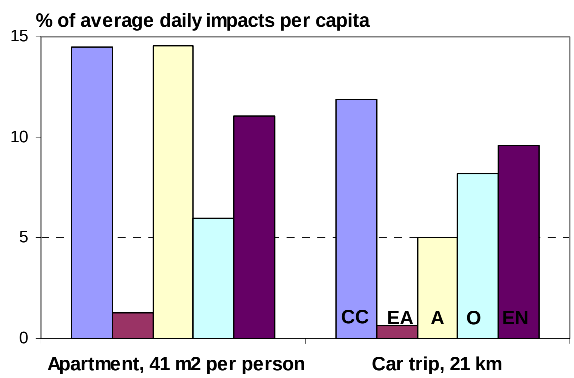
a) rye bread



b) cheese



c) laundry



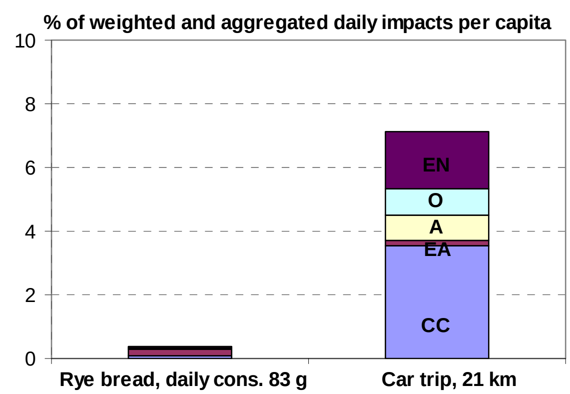
d) apartment

Figure 3. Illustrating the environmental impacts of a car trip using presentation format C, i.e., comparing and bench-marking to other products:
a) rye bread, b) Emmental cheese,
c) laundry, d) apartment.

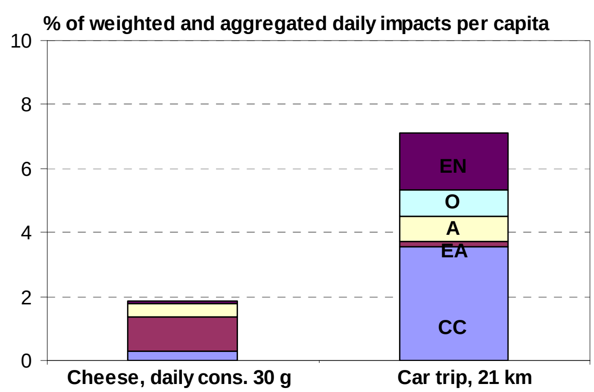
In addition, the figure also includes the benchmark 'average daily per capita environmental effects of the whole Finnish economy', used as the normalizing factor.

ABBREVIATIONS:

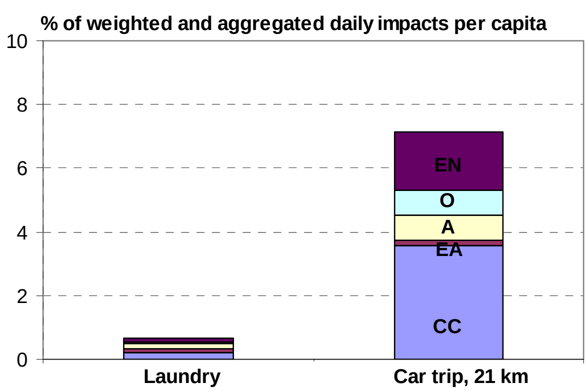
CC = climate change
EA = eutrophication, aquatic
A = acidification
O = formation of trophospheric ozone
EN = primary energy consumption



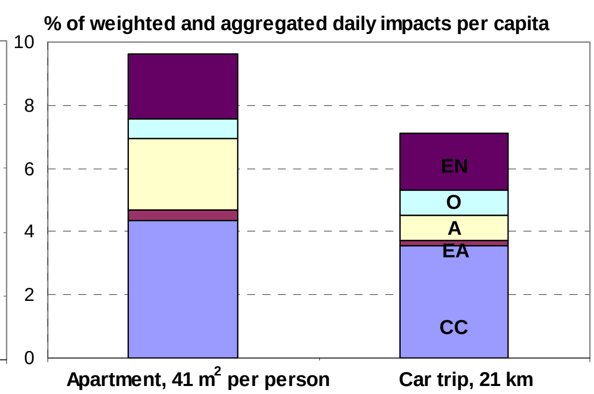
a) rye bread



b) cheese



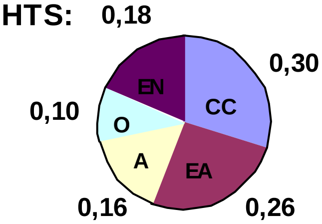
c) laundry



d) apartment

Figure 4. Illustrating the environmental impacts of a car trip using presentation format D, i.e., comparing and bench-marking to other products, using weighted impacts aggregated into one column:
a) rye bread,
b) Emmental cheese,
c) laundry,
d) apartment.

WEIGHTS:



ABBREVIATIONS:

CC = climate change
EA = eutrophication, aquatic
A = acidification
O = formation of trophospheric ozone
EN = primary energy consumption

Laundry has relative impacts of a similar size as rye bread and cheese, but the differences between the impact categories are much smaller. The smallest relative impact, eutrophication, is 0.5%, while the largest impact, acidification, is 1.0% of the average daily impacts per capita.

The apartment has large effects compared with the daily consumption of rye bread, cheese and laundry. Comparing the car trip to the apartment, the effects are of the same order of magnitude. The differences between the impact categories are large for both apartment and car trip. While daily per capita climate change impacts are 14% and 12% for the apartment and car trip, the corresponding value for eutrophication is 1% for both products/services.

Weighting gives the possibility to show the importance of the various environmental effects (impact categories), and gives the possibility to aggregate the effects into one column as in Figure 4. Here, both the aggregated effects and the importance of each impact category can be seen. In addition to the unit formed by normalization, also the aggregated effects of the benchmarking product can then be used as a ’ unit’ of the aggregated environmental impacts. Thus a car trip of 21 km corresponds to washing the laundry 11 times at 40°C.

Discussion and Conclusions

Presentation type A looks clear at first glance. However, when discussing it with stakeholders in the steering group and seminars, people responded that the normalizing factor 'average daily per capita environmental impacts of the whole Finnish economy' was not easy to understand, was not relevant for many of them, and was mostly out of their own control. Although we still think that it should have relevance for consumers as a benchmark, these views support the idea of bringing another benchmark into the same figure.

The benchmark-products differ a lot in many respects, but all fulfill well the condition of being ’common every-day products’ when Finnish adults are regarded (Table 2). Regarding similar sizes of effects in the various impact classes, which helps the users to remember the meaning/size of the benchmark in terms of the various environmental impacts, the laundry was superior compared with the other products. (Note however that this depends not only on the effects of the laundry but also on the normalising effects.)

The comparison is of course also affected by the size of the effects of the benchmark. The apartment and the car trip have large effects, and so the effects of most of the products (or their daily use) are small compared with these benchmarks. When using them as benchmarks, any product showing substantial effects beside them must be regarded as a very important contributor to the environmental effects of private consumption. Rye bread, cheese and laundry have much smaller effects, and so the effects of many products can be comparable in size, larger or even manifold compared with these benchmarks. Small benchmarks might thus be useful as ‘units’ of environmental impact.

Table 2. Properties of the different products as benchmarks

Product /service	**Is it familiar product to Finnish people?**	**Are the various impacts of the same size?**	**Are the impacts small or large (relating products to each other)?**	**International aspects: Is it familiar product to people in other countries?**	**International aspects: Would the emissions and energy use be similar in different countries?**
Rye bread	Yes	No, large differences	Small impacts	No (only in few countries)	No? (agriculture and conditions different)
Emmental cheese	Yes	No, large differences	Small impacts	Yes	No? (see above, however possibility to international brand)
Laundry	Yes	Yes, quite similar	Small impacts	Yes	No (electricity in use phase)
Apartment 41 m^2 in a block of flats	Yes	No, large differences	Large impacts	Yes	No (electricity in use phase)
Car drive	Yes	No, large differences	Large impacts	Yes	Yes

If we think of using the same product-benchmark (the inventory data) in several countries, some products are more ’international’ than others. Rye bread is not common outside the Nordic countries, white bread would be more suitable as a ’common every-day product’ for many countries. However, national modifications would be needed to LCA-studies, as there is no ’international white bread’. Emmental cheese could represent a ’common every-day product’ for many countries, and some brands may be known all over the Europe. Transport and storage in markets would have different effects for various countries, but these stages do not play a large role in the overall impacts of these products.

The car trip, which was not here presented as a benchmark but as the product/servce that was wanted to illustrate, could of course also serve as a benchmark. It is a possibility for an international benchmark, as, e.g., VW Golf is known everywhere, and the effects in the fuel production phase and from the emissions from car use are rather similar (although the climatic conditions of course have some effect for the emissions from use).

Products/services that use electricity or district heating in the use phase have different inventory values for each country due to different energy production profiles. This means that the inventory data for laundry and for the apartment from one country are totally unrepresentative of the situation in other countries.

The product renewal cycle is crucial for the longevity of the product-benchmarks 'passenger car' and 'washing machine', which products have rapid renewal cycles, and so any benchmark which would try to represent brand new products would be old quite soon. However, here relatively new (i.e. some years old) products were presented.

In addition to the presentation types A, C and D, three other presentation formats (B, E and F) were developed but not shown in this article. In short, in format B each environmental problem is in its own figure, and several products act as benchmarks. Thus the benchmarking is shown in altogether five figures (one A4 page). In types E and F comparisons are expressed in verbal form. Format E expresses the percentages of the average daily per capita environmental impacts of the whole economy of Finland, expressing verbally the same comparison that is expressed visually in format A. Format F expresses the comparison to the benchmark-products (i.e., a verbal form of presentation format C).

In conclusion, so far we propose that all the developed presentation types and benchmarks are suitable for informing consumers, and it is not obvious which presentation type and benchmark-product would be most suitable, each of them having both advantages and shortcomings. The next step in the whole project is to study how consumers understand the presentations and what suggestions for improvement they have (Figure 1). We use a consumer panel for this study, organizing 10 focus groups (each with about six consumers) to discuss our proposals for benchmarks presented in the brochure. The results of this ongoing work will be presented in later articles.

References

EU Commission 2003. Communication from the Commission to the Council and the European Parliament – Integrated Product Policy. Brussels, COM (2003) 302.

Finnish Environment Institute 2004. Statistics of the Finnish Environment Institute in Internet, www.environment.fi

Finnveden, G., Hofstetter, P., Bare, J.C., Basson, L., Ciroth, A., Mettier, T., Seppälä, J., Johansson, J., Norris, G. & Volkwein, S. 2002. Normalisation, grouping, and weighting in life-cycle impact assessment. In: Udo de Haes, H.A., Finnveden, G., Goedkoop, M., Hauschild, M., Hertwich, E.G., Hofstetter, P., Jollit, O., Klöpfer, W., Krewitt, W., Lindeijer, E., Muller-Wenk, R., Olsen, S.I., Pennington, D.W., Potting, J. & Steen, B. (eds.) 2002. Life-Cycle Impact Assessment: Striving towards Best Practise, p. 177-. SETAC, Brussels, 250 s., ISBN 1-880611-54-6.

Goedkoop, M. & Spriensma, R. 2001. The Eco-Indicator 99 – A damage oriented method for life cycle impact assessment. Methodology report. Third edition 22 June 2001. PRé Consultants B.V., Amersfoort, The Netherlands.
www.pre.nl/download/ EI99_methodology_v3.pdf (visited 20.1.2005)

Grönroos, J. & Seppälä, J. (Eds.) 2000. Maatalouden tuotantotavat ja ympäristö (Agricultural production systems and the environment, in Finnish with executive summary in English). Finnish Environment 431. Finnish Environment Institute, Helsinki. 244 p.

Grönroos, J. & Voutilainen, P. 2001. Maatalouden tuotantotavat ja ympäristö. Inventaarioanalyysin tulokset (Agricultural production systems and the environment. Results of inventory analysis, in Finnish). Mimeograph series of the Finnish Environment Institute 231. Helsinki. 64 p. Also available on the Internet:
http://www.environment.fi/publications

Grönroos, J., Seppälä, J., Seuri, P. & Voutilainen, P. 2001. Agricultural production systems and the environment. In: Proceedings of the International Conference on LCA in Foods (Gothenburg, Sweden 26-27 April 2001). SIK-Dokument 143. Pp. 131-135.

Hauschild, M., Bastrup-Birk, A., Hertel, O., Schöpp W., and Potting, J. 2004. Photochemical ozone formation. In Potting, J. and Hauschild, M. (eds.), Background for spatial differentiation in life cycle assessment – the EDIP 2003 methodology. Institute of Product Development, Copenhagen.

ISO (International Organization for Standardization) 2000. ISO 14042: Environmental management - Life cycle assessment - Life cycle impact assessment. International Organization for Standardization, Geneva.

Joffe, H. (2003). Risk: From perception to social representation. British Journal of Social Psychology 42 (1).

Koskela, S., Seppälä, J. & Leivonen, J. 2002. Environmental impacts in assessing the ecoefficiency of buildings. The Finnish Environment 585, p. 1-54. Finnish Environment Institute, Helsinki. (Only abstract in English).

Nissinen, A., Grönroos, J., Heiskanen, E., Honkanen, A., Katajajuuri, J.-M., Kettunen, J., Kurppa, S., Mäkinen, T., Seppälä, J., Silvenius, F., Timonen, P., Virtanen, Y., Voutilainen, P. 2004. Development of Benchmarks for LCA-Based Environmental Information on Consumer Products, Services and Consumption Patterns. 24th LCA Discussion Forum, 2.12.2004, in Lausanne, Switzerland. Abstract and presentation: http://www.texma.org/LCA-Forum/lca-forum.html (DF 24: Life-cycle Approaches for Sustainable Consumption)

Otto, H.E., Mueller, K.G. and Kimura, F 2003. Efficient information visualization in LCA. Int J LCA 8 (4) 183-189.

Saouter, E., van Hoof, G., Feijtel, T.C.J., Owens, J.W. 2002. The effect of compact formulations on the environmental profile of northern European granular laundry detergents. Part II: Life cycle assessment. Int. J LCA 7 (1) 27-38.

Schweimer and Levin. Life cycle inventory for the Golf A4. 40 p. Downloaded from www.volkswagen.-environment.de in August 2004.

Seppälä, J. 1999. Decision analysis as a tool for life cycle assessment. LCA Documents, Vol. 4. Eci-Informa Press, Bayreuth Germany.

Seppälä, J., Hämäläinen, R.P. 2001. On the meaning of the distance-to-target weighting method and normalisation in life cycle impact assessment. International Journal of Life Cycle Assessment 6(4): 211-218.

Seppälä, J., Knuuttila S. & Silvo, K. 2004. Eutrophication of Aquatic Ecosystems. A New Method for Calculating the Potential Contributions of Nitrogen and Phosphorus. Int J LCA 9 (2) 90-100.

Seppälä, J., Posch, M., Johansson, M., Hettelingh, J.-P. 2005. Country-dependent characterisation factors for acidification and terrestrial eutrophication based on accumulated exceedance as impact category indicator. Submitted to Int J LCA.

Seppälä, J., Silvenius, F., Grönroos, J., Mäkinen, T., Silvo, K. & Storhammar, E. 2001. Rainbow trout production and the environment (an LCA study). Helsinki, Finnish Environment institute. The Finnish Environment 529. 164 p. (In Finnish with an extended English summary).

Statistics Finland 2004. www.stat.fi, visited 22.12.2004.

Tenhunen, J, Oinonen, J. & Seppälä, J. 2000. Life cycle assessment of a water supply and wastewater treatment system – A case study of Tampere Water Works. The Finnish Environment 434. Finnish Environment Institute, Helsinki. 107 p. (In Finnish, abstract in English).

Vares, S. 2001. Environmental impacts of materials in an apartment building (translation by authors of the article). VTT Research Notes 2108. 49 p. VTT Technical Research Centre of Finland, Espoo.

Voutilainen, P., Tuhkanen, H.-R., Katajajuuri, J.-M., Nousiainen, J. & Honkasalo, N. 2003. Environmental impacts and improvement possibilities of Emmental blue-label cheese. Maa- ja elintarviketalous 35: 91 p. In Finnish, abstract in English. http://www.mtt.fi/met/pdf/met35.pdf

Wagner, W., Kronenberg, N. & Seifert, F. (2002). Collective symbolic coping with new technology: Knowledge, images and public discourse. British Journal of Social Psychology 41 (3).

World Summit 2002. World Summit on sustainable development. Plan of implementations. http://www.un.org/esa/sustdev/index.html (visited 20.1.2005).

The Cult of Nature and the Natural: Forms and Social Meanings Among French Organic Food Consumers

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“If we were really willing to change the way of production in the right way, and especially if we were desiring to feel comfortable with the world we will leave to next generations, let’s start by changing our eating habits, our overall lifestyles, which lead to eating less and better, wasting less and sparing more”. Opinions like this are currently pictured as typically epitomizing the nonconformist recurrent holistic worldview, consisting in exhortations of irenic and sustainable interactions between humans and the natural world.

This paper analyses the results of a consumer questionnaire survey undertaken among organic food consumers (n=859) in France in 1996, which was completed since with series of in-depth interviews: it seeks to show that where superficial analysis finds and speaks about food or health “faddism” or “quackerism”, serious sociological inquiry identifies evolving and persistent currents which history can be traced back to the end of the nineteenth century, and which are brought up by diverse sections of consumers, including well-educated people, often characterized by their critical mindedness. In addition to analysing critically the social definitions of the nature and the natural among the surveyed consumers, this paper will cling to replace the series of attitudes and practices one can find among them in the frame of the hygienic ideologies that are symptomatic of the present day intellectual and social environment.

Education for Sustainable Consumption
School EMS

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Musashi Institute of Technology
Faculty of Environmental & Information Studies
15th January 2005

1. INTRODUCTION

Within these three years, the research about Sustainable Consumption has been done from the different point of views like, Environmental efficiency index, time consumption, happiness and welfare etc. The main purpose of this research is about the practice of carbon dioxide curtailment action on the daily life of consumer and consumer behavior. However, it is not certain that the consumers will necessarily practice the action for carbon dioxide curtailment just because, an understanding to the information about environment, Green label, time consumption or happiness of people has been increased. Rather than, in some case people take action as Not In My Back Yard (NIMBY).

Here, I propose \`Education for Sustainable Consumption\`, to deepen the understanding of Environment and continuous practice of the curtailment of Carbon dioxide.

2. SCHOOL EMS

No matter how far the government and the companies will work hard for the sustainability of the resources and energy, the aim of saving the environment of the earth is impossible unless the life style of consumers are not changed into the sustainable life-style. This program is aimed to give education to the students in order to change their life-style into Sustainable life-style.

2.1. ME AND THE ENVIRONMENT

The things students A and B are learning:

- The use of electricity and the Petroleum products are the causes of the Global Warming.
- The materials used in Refrigerators and Air-conditioners are harmful to the Ozone layer.
- Natural environment is destroyed in order to produce the food and build the infra.
- Burning plastic produces dioxin.

Father:

- The cans after drinking are thrown in the streets.
- His company has gained ISO14001 certification and are doing effort on the conservation of energy , green purchase and using re-cycled paper.

Mother:

- Her office uses large amount of paper and re-cycling is very complex.
- The dustbins in her company are mixed with burnable and recyclable wastes.

The messages from the Municipality to the Citizens:

- To reduce the waste from the house-hold.
- To separate the varieties of waste and prevent the generation of dioxin beforehand.
- To send the waste which includes natural resources to Recycling stations.

To teach the students that, Main role on improving the Environment is of ‘Me’:
The common thinking about Environmental Problems are figured by assailants as the Manufacturing Factories and Victims as the citizens. But the environmental problems like Global Warming, Ozone hole, Deforestation and Acid Rain, which are spreading throughout the Earth are caused by the modern life-style of the people.
Such environmental problems are impossible to control and solve unless each of us would not change our life-style and be conscious that ‘I am the One to save the environment.’

Main things to do this Step:
Step1 is the starting line of School EMS. In this step, firstly, a high-school student A is given a main role with his family as an example in order to let compare the other students about their family life with the family of student A.
Secondly, to let the students fill two worksheets about the environment and their daily life, which will let them think about the relation between their life style and the environment.

Class flow:
To explain profile of the student A and secondly to let the other students think about the viewpoint of each family members of student A towards the environment. After that, to let each student to think and understand about their own family and let them fill the worksheets.

2.2. RE-CHECKING THE ENVIRONMENTAL PROBLEMS OF MY HOME

To get the knowledge about the relation between the environment and oneself. We have some knowledge about Environmental problems. But we don’t consider it much about how it affects in our life. Here, by letting the students write about Influence that their life exerts on environment, the students will understand that, ‘ Environmental problems exist in a familiar place’. Then, let the students think about, ‘ Why the action cannot be taken even they have knowledge about the environmental problems?’

2.2.1. Example of Frequently asked questions and correspondence

Questions: ‘Wisdom of living with an environment’ is not understandable. What is to be written in this part?
Correspondence: The lifestyle and the legend in old times are made to be thought.

(When I was child, my grandmother frequently used a word called, ‘***mottainai***’ to me, which meant ‘waste’. For example, I remember that she used to collect the clean paper I use to throw and fold it so that she can reuse it speaking the word, ’***mottainai***’. Now we are habituated in throwing things, but in Japan there are lots of words and wisdoms about not to make the natural resources to waste. Let’s think about it together!)

Questions: 'Isn't it useless even if working on environmental problems in the family? Group Discussion: What a family can do for environment might be less but is it really useless? Isn't there ways that we can reduce and reuse the waste!

2.3. EFFECTS ON THE ENVIRONMENT EXERTED BY DAILY LIFE

Student A thinks how the life style of his family is effecting the environment

affect on Environ-ment / Life act	The things which can be changed by an effort of family						The things which Cannot be changed Only by the effort of family
	Use of energy	Use of natural resources	Pollution of water and air	Disturbance to the neighbors	stain of landscape and scenery	Throwing the waste	
1. Wear wash	Washing machine	Water Detergent Electricity	Detergent	Noise produced by washing machine		Dirty water during washing	Ingredients of detergent Efficiency of washing machine
2. Eat Making fried chicken	Gas heater	Cooking oil Natural gas Food materials Electricity	Used cooking oil	Smell of kitchen garbage		Food waste	Low energy consumption Efficiency of cooker
3. Live Make cool	Air conditioner	Electricity	Chlorofluoro carbon (CFC)	Exhaust gas noise			Low energy consumption of air-conditioner Noise
4. Entertainment Go to drive	Vehicle	Petrol, diesel Mobil	Exhaust gas from the vehicle	Idling noise		Bottles, cans One time use Tiffin boxes	Exhaust gas Low fuel cost

The problem is solve by understanding the situation:

Understanding EMS is to understand the reality and the situation. Unless one does not understand the situation and bad points in their life, one cannot improve the situation in his/her life style. In step2-1" Perception of the present situation and analysis", relations with the environment are reviewed around the house life, which is very important. In this step, the life style of student A is given as an example to the students and then let them think about their own life style in their house. The students are asked to write in details as much as possible about their life style at their home so that they can understand and review their life style. This will tie to the practice of school EMS.

Main things to do in this step: In this step, "Effects on the environment exerted by daily life", the students will be filling a worksheet in which, their life style of school and home are separately analyzed and filled in the worksheet, so that the students can understand the effects on the environment. By this step students are supposed to understand that, "Their life style is widely affecting the environment". After the analyzing process, the students are let decide about "the environmentally important items" and "Necessary approach to the problems". After that the students are let think about the solutions to the problems.

2.4. "ENVIRONMENTALLY IMPORTANT ITEMS" AND "NECESSARY APPROACH TO THE PROBLEMS"

Important Items		Acts in life style to be approached
1	Use of electricity	Washing machine, gas cooker, refrigerator, lamps, television, air-conditioner
2	Use of water	Washing, cooking, bathing
3	Using detergent	Washing powder, kitchen, bathroom, cleaning car
4	Waste	kitchen waste, packing, cans, bottles, newspapers
5	Using gas	Driving a car

To let the students think what really is important for the environment:

As it will be difficult for students to think solving all the problems together, the students are let think about the most important things by using "priority order", method. It might be difficult for the students who have less knowledge about the environmental problems. Here the students are let think about the basic problems which will be easier for them to understand and think.

2.4.1. Correspondence to the frequently asked questions

Questions: What is meant by natural resources?

Correspondence example: To teach the students that `water, soil and air are also natural resources`. Natural resources indicate all materials that support our life. The cans and bottles we throw are also natural resources. Without water we cannot live, that's why water is also natural resource. The air, soil in which the plants grow are also valuable natural resources.

Questions: What do you mean by The things which Cannot be changed only by the effort of family?

Explaining with the examples: We put water and detergent in the washing machine and when we put the switch on, the washing machine starts washing. We can verify how much water to put and how much detergent to use while washing, but we cannot reduce the chemicals which pollutes water and we cannot let the washing machine consume less electrical energy while washing clothes. Only the companies can make washing machine of energy-saving model. This is an example to write in this space. Less write such kind of things.

2.5. ENVIRONMENT AND RULES AND LAWS

The rules and laws, the family of student A should follow. (Arrangement of other rules and agreements)

Rules and Laws of the Government:

Environmental basic law
Wild life protection law
Nature conservation law
Natural parks law
Containers and Packaging Recycling Law
Electrical appliances recycle Law

Rules made by ordinance:

cigarette butts and garbage are not to throw nearby the rivers, train stations, rivers and roads
refrain from the use of vehicle and stop the engine on idling stop
not to burn out the wastes which puts out stink nearby a park and open spaces
save water

Rules in Town: 10pm to 6am, not to make noise on street including street performances of music etc.
put out garbage on street only in the scheduled day and time, save the plants in the streets in order to save the beauty of the town
to participate on the cleaning activities of streets and parks

Assuming the rules of society as learning index: Even one says, "Good actions for the environment" , an appropriate target cannot be set only by a personnel conviction. It is possible to refer to the target making in the future only by knowing the rules that society is requesting from environmental measures. The most important thing in this step is to let know the fact to the students that," There are lots of rules to follow to save the environment in our surroundings." Then, the students are made conscious about that they should take actions according to the rules.

Class flow: We cannot expect that the students have knowledge about rules and regulations and laws of environment. In this step 3, we are to explain the students about the Basic environmental laws, rules and regulations in towns and street. If there is time, the students are given home works to study about laws, rules and regulations. After that the students are let think what they are supposed to do and what they are not, in order to follow the laws, rules and regulations.

Main things to do in this step: To let the students write,` Why the students should take steps and actions in order to save the environment?`. By letting the students write about the rules and laws which should be followed in the town and streets about the environment, the students will be conscious about that taking actions and saving environment is not others job, but their own. Social consciousness is the theme of this step.

2.5.1. Correspondence on frequently asked questions

Question: Where and how can we find the references?

Correspondence example: To let the students think themselves. Mainly 2 ways, those are internet and library. To visit the office of the government where the rules are made. To find the way and place where the students can find the references and information is also one of the task for the students.

2.6. ESTABLISHMENT OF FAMILY ENVIRONMENTAL CHARTER

The family of student A established family environment charter.

- Our family should give priority on saving the environment and each member of family should think about reducing the pressures on environment in their acts of daily life.
- Our family should follow the agreements, rules and regulations which are made to save the environment.
- Then, our family can slowly but surely, can save the environment and give good environment to the coming generation. For that, we will do the following kinds of efforts:

save water, electricity and gasoline

reduce the garbage, recycle the goods as much as possible

to think well, before buying the foods and furniture whether they are made with materials which are hazardous to environment or not, and while disposal in future after use, it is harmful to environment or not.

while going out to Vacation spots, not to do such things which will harm the environment

to give importance to the news about the environment which are good and bad, and imply it in our daily life, take part in the volunteer works of own area.

To give opinions about Environmental measures of the administration and product development of the companies and enterprises as a green consumer.

In this step, the students are let find the answers and establish a family environment charter by themselves, from the questions they have learned about all the environmental problem they discovered till now .

Class flow:

To make an environmental policy, the flow of current classes are arranged. Current STEPS are reviewed and only the necessary points are picked up from the current steps which are familiar and important. After that, it is brought together to observe with the rules and regulations in STEP3, in order to solve environmental problems.

2.6.1. Frequently asked questions an correspondence

Let the students express their will to save the environment: There is no perfect answer in the environmental policy. It is because the environmental policy differs regarding to individual ideas, environment of their home and environment of their school. Unless the strong will of students.

Questions: What and how much is to be written as answer to this question?

Correspondence: To let the students express their dream (Environmental policy is to express your feelings to everyone about, how you are going to evaluate the environment. That's why write as much as you like about your dreams and interests).

Questions: The itemized content is not understood well !)
Correspondence: To review and to derive:(In STEP2 we thought about the usual life. Did you feel which part of your life style should be mended in order to help save the environment! For example: Are we enough doing the recycle? If you think that its not enough then lets declare from now on that we are going to work hard on doing the recycle).

2.7. SETTING THE TARGET OF FAMILY ENVIRONMENT IMPROVEMENT

	Target theme	**Year 2005 Winter** (starting point)	**Spring** (expectation this year)	**Summer (**first year planning)	**Autumn** (2nd year planning)	**Year 2006 Winter** (goal)
1	To decease the consumption of electricity by 15%					
2						
3						
4						
5						
6						
7						

Sustainable Consumption American Style: Nutrition Education, Active Living, and Financial Literacy

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Abstract
The 1992 Earth Summit highlighted the critical role of consumption in affluent nations as a source of global environmental deterioration. While most developed countries have begun over the past decade to grapple with the difficult challenges of reducing household demand for energy and materials, sustainable consumption has yet to attract substantive attention in the United States. There exists, however, several strategic openings that American proponents of more environmentally benign household provisioning could exploit to launch a public dialogue about the environmental implications of contemporary consumption. First, public health professionals have in recent years begun to make significant strides publicizing the nutritional inadequacy of the American diet and the contributory role it plays in elevating incidences of chronic disease. Second, the rapid increase in the rate of obesity in the country is now coming to be understood as a health problem that is attributable to the prevalence of sedentary lifestyles. Finally, there is growing public concern in the United States over the accumulation of unprecedented levels of consumer debt and the epidemic of personal bankruptcies. The intent of this paper is to highlight the need to consider the personal dimensions of everyday life when formulating strategies to foster more sustainable consumption.

1. Introduction

During the past decade, sustainable consumption has emerged as a new political and academic domain for discussing the linkages between affluent lifestyles and environmental quality (Lafferty and Meadowcroft 2000; Cohen and Murphy 2001; Princen *et al* 2002). International institutions such as the Organization for Economic Cooperation and Development (OECD), the United Nations Environment Program (UNEP), the United Nations Commission on Sustainable Development (UNCSD), and the European Union (EU) have played key roles in raising the visibility of this issue (see, for example, OECD 1997, 1998, 1999, 2002; Manoochehri 2001; Bentley 2002; Heap and Kemp 2002; UNEP 2004). In addition, some national governments—most notably Sweden, Norway, and the Netherlands—have gradually begun to implement policy measures consistent with the aims of sustainable consumption and a global network of non-governmental organizations (NGOs) has coalesced to advance this agenda.

Despite the attention now being devoted to sustainable consumption in these settings, the issue has received little formal political acknowledgement in the United States. For instance, the President's Council on Sustainable Development (PCSD), launched by the Clinton administration in 1993, prepared several notable reports, but assiduously avoided any explicit consideration of consumption (see, for example, Sitarz 1998). President Bush has evinced even less interest in the matter. Campaigns to foster more environmentally benign household provisioning in the country remain largely confined to a relatively small band of activist groups (Maniates 2002; Cohen *et al* 2004; see also Grigsby 2004). The current official inattentiveness in the United States to the linkages among consumption, lifestyles, and environmental quality is arguably attributable to how this novel concept has conventionally been framed. More to the point, sustainable consumption is viewed as incompatible with prevalent public policy priorities that overwhelmingly favor the perpetuation of economic growth, the promotion of consumer sovereignty, the profligate utilization of energy, and the unrestrained accumulation of material goods (see Collins 2000).

For sustainable consumption to capture the attention of mainstream American policymakers it will be necessary, following an interpretation put forward by Dryzek *et al* (2003), to reconcile the issue with at least one of the core imperatives on which contemporary governmental legitimacy is premised (i.e., maintaining internal order, ensuring international competitiveness, raising public finance, and promoting economic growth). On first blush, sustainable consumption may seem to be wholly incompatible with any of these vital obligations and efforts to align them construed as hopelessly futile. However, recent studies in France and the Netherlands suggest that ample opportunities exist to adapt this policy discourse to fit within the contemporary constraints of governance (see Sanches 2004; Martens and Spaargaren 2004). In these instances, policymakers are coming to grips with the environmental impacts of heavily consumerist lifestyles on a largely inadvertent basis and without much cognizance of the political obstacles that impede the uptake of sustainable consumption as a workable concept. Moreover, in the French case there is ironically hardly any formal recognition of sustainable consumption per se, despite the considerable progress that the country has achieved in this regard.

The following discussion, by necessity, describes an instrumental approach for customizing sustainable consumption to the outwardly indifferent American political context. More specifically, this strategy seeks to identify pragmatic policy initiatives to which sustainable consumption could reasonably be joined. The rationale for proceeding in this manner resides in the fact that it is easier to motivate a recalcitrant public to adapt its consumption practices when the grounds for doing so are cast in terms of already established social problems. For instance, it is arguably more straightforward to reduce reliance on private automobiles by appealing to drivers' safety concerns than to their putative apprehensions about global climate change.

The subsequent sections outline three issues of current policy relevance to which proponents of sustainable consumption in the United States could purposefully tether their agenda: the growing problem of food overabundance, the poor physical fitness of certain demographic segments of American society, and the current anxiety that surrounds the increasing accumulation of consumer debt.

2. Nutritional Education and Sustainable Consumption

In discussions about sustainable development, interest in nutrition has tended to focus on the approximately two billion people—most of whom reside in developing countries—that lack consistent access to sufficient caloric resources. Accordingly, dietary issues were at the heart of both the Brundtland Report in 1987 and the proceedings of the Rio Earth Summit in 1992. Malnourishment and chronic diseases associated with food scarcity continued with good justification to garner prominent attention at subsequent international gatherings and one of the most forceful statements to date on the nutritional aspects of sustainable development—the Beijing Platform of Action—was adopted at the Fourth World Conference on Woman in 1995 (Briggs 1997). Nutrition was also an important issue during the World Summit on Sustainable Development held in Johannesburg in 2002 (Vorster 2002).

The dietary challenges that exist in the developed nations are, of course, drastically different. While inadequate nourishment continues to persist among certain demographic groups and within specific geographic locales, as a rule affluent societies today hardly face the same kind of food crises that frequently persist elsewhere in the world. In the United States, for instance, agriculture is so munificent that production in caloric terms is currently twice the biological needs of the population (even after exports have been accounted for) (Nestle 2002; see also Levenstein 1993). This massive surplus has created market conditions in which food in the country is amply available and quite inexpensive. Americans, on average, spend less than ten percent of their disposable income on food and this share is only slightly higher for other developed nations (see, for example, Putnam and Allshouse 1999). By comparison, in many developing countries it is common for households to spend upwards of 60 to 70 percent of their income on food (Seale *et al* 2003).

The great quantity of food that is generally available today in economically advanced societies has led to pronounced personal difficulties controlling body weight and to epidemic incidences of diabetes, hypertension, coronary heart disease, and other chronic health disabilities. Data collected in the United States by the Centers for Disease Control and Prevention indicate that 65 percent of American adults are either obese or overweight and the problem is becoming more prominent among children and adolescents. The percentage of overweight youngsters aged 6-11 has increased by 300 percent during the past 25 years and growth in this measure for teenagers is only slightly lower (see, for example, Eisenmann *et al* 2002; St-Onge *et al* 2003).

The problem is partly attributable to hyper-competitive market conditions in the food industry that require companies to resort to very aggressive practices to sell a vast surplus. For instance, producers have taken advantage of the frenetic pace of contemporary lifestyles to sell unhealthful fast foods, convenience foods, and snack foods. Especially clever purveyors have exploited the budgetary crisis in public education to vigorously advertise and dispense fat- and sugar-saturated products to school-age children. Education administrators now routinely agree to "pouring contracts" in which soft-drink vendors provide school administrators with cash kickbacks, electronic equipment, and athletic gear in exchange for exclusive distribution rights (Molnar 1996).

Creative food companies have developed a number of other innovative strategies. First, the marketing tactic of offering "more for less" has become increasingly popular in recent years (Crister 2003). This technique exploits the fact that satiety is a flexible feature of human physiology. A widespread perception is that satiation conforms to a fixed threshold; in other words, “fullness” from eating is achieved once hunger has been fully satisfied. However, by upgrading portion size (and calorie content) at nominal cost, it is readily possible to increase the point at which satiety becomes manifest in customers. Through the use of merchandising policies that increase portion size relative to price, fast-food restaurants have been able to conflate this physiological feature with consumers’ instincts to seek value and to thereby induce them to spend more money.

This so-called “supersizing” strategy has proven highly profitable because the incremental increase in the cost of commodity inputs such as beef and potatoes is insignificant in the overall scheme—especially in comparison to other factors such as labor and facilities. Major clothing retailers have also adapted this strategy. By outsourcing production to low-cost Asian countries and employing teenage sales clerks, these companies are able to sell goods in large quantities at prices that are, by virtually any measure, very cheap. The new garments marketed by these large retailers are often less expensive than their second-hand counterparts at charity shops. The ultimate expression of this strategy is, of course, the sport-utility vehicle (SUV) where for slightly higher costs of production automobile manufacturers are able to sell a vehicle that is substantially more profitable than a conventional car.

Second, restaurant meals have evolved for many families over the last three or four decades from occasional indulgencies to virtual necessities. In particular, for working parents with children, fast food is now an indispensable feature of daily life. An associated trend has been the increasing prevalence of frozen meals that are prepackaged for quick preparation. While consumers that rely on these products evince an apparent willingness to trade off money for convenience, such food also requires them, perhaps less eagerly and consciously, to surrender control over the ingredients used to produce them (Crister 2003). Food products designed to have a long shelf life or to be heated in a microwave oven invariably contain large amounts of fat, sugar, and salt to enhance their tastefulness. Without these ingredients, the meals would be utterly unpalatable.

Finally, agricultural interests and major food-processing companies have become highly adept at manipulating the regulatory system to their advantage (Nestle 2002; see also Sims 1998). Food producers routinely work to ensure that elected officials select political appointees to oversee dietary agencies that are sympathetic to their concerns and they invoke scientific uncertainty to obstruct administrative proceedings that might adversely affect their commercial interests. For instance, the Food and Drug Administration (FDA) has consistently resisted amending its guidelines to encourage consumers to reduce their overall food intake. Instead, the proffered recommendation is to “Choose a diet that is low in saturated fat and cholesterol and moderate in total fat” (OMB Watch 2004).

Increasing public awareness of these duplicitous practices has begun to meld with the efforts of public-health professionals and consumer-advocacy groups into a nascent social movement. Some of these alliances have grown out of the successful decades-long battle with the tobacco industry and attention is now turning toward the nutritional inadequacies and marketing practices that are common among food producers (see, for example, Hays 2004; Schlosser 2001; Vidal 1997). Indeed, one of the leaders of the current wave of anti-fast-food activism is legal scholar John Bazhaf who led the fight against the major tobacco companies. The rhetoric of anti-fast-food activism, by encouraging consumers to be more conscientious and by chiding producers to become more socially responsible,

calls upon several of the same claims advanced by proponents of sustainable consumption.
Current indications, however, suggest that it is improbable that this new public-health clash over fast food will provoke the same kind of bare-fisted litigious warfare that characterized the battle over cigarettes. The targets of this more recent campaign are unlikely to offer the same kind of steadfast resistance that was mounted by their counterparts in the tobacco industry. In fact, there are already indications that McDonald's, Burger King, and others are signaling a willingness to make swift compromises and have already begun to overhaul their offerings to include more nutritious menu choices.
While scholarship pertaining to sustainable consumption has considered the environmental impacts of dietary content and the energetic implications associated with the production and preparation of food, it has not taken up the issue of nutritional excess. This omission is in large part attributable to the divide between environmental policy and nutritional policy. Walton and Bridgewater (1999) describe the situation in the following terms:

Traditional ecologists have not devoted much attention to people and their domestic plants and animals. Human 'disturbance' was avoided. Conventional health scientists have largely excluded the wider environments in which people and their domesticated species live.

Although the two fields grew out of a common nineteenth-century vision of reform—and were initially closely aligned with the emergent social sciences—increasing professionalization prompted them to become more and more estranged from one another (Gottlieb 1993; see also Kamminga and Cunningham 1995). This rupture was regrettable because it gave rise to a widespread sensibility that environmental quality and nutritional well-being were wholly separable pursuits. Despite the important contributions of Rachel Carson (1962) and Francis Moore-Lappé (1971), the prevailing sense has been that human health and biospheric health have few common points of intersection. Based on this view, most developed countries created distinct regulatory systems and this trend has contributed to the fragmentation of responsibility, the reification of artificial administrative boundaries, and the generation of rampant public confusion. For instance, at the federal level in the United States, the Environmental Protection Agency (EPA) may under certain unique circumstances take an interest in food contamination in terms of, say, the public ingestion of PCB-tainted fish. However, nutrition is not typically one of its major concerns. Moreover, those governmental bodies that periodically evince an inclination to become engaged on issues at the intersection between the environment and nutrition are shunted aside by the politically potent Department of Agriculture.
There are now indications that this long-standing division is beginning to break down and the locus of human nutrition, ecology, and the social sciences has begun to attract academic attention (Leitzmann 2003; see also Schwenk and Hauber-Schwenk 2003; Honari and Boleyn 1999; Carlsson-Kanyama 1998). One of the most interesting expressions of this development is the emergence in Germany over the past twenty years of the field of "nutrition ecology." Coined in 1986 by Claus Leitzmann, the term nutrition ecology connotes a holistic and interdisciplinary view of the socio-environmental

nutrition system across multiple scales of analysis—individual, local, regional, national, and global with the aim of improving human quality of life. More concretely, nutrition ecology is attempting to link together issues and perspectives that are relevant to nutrition scientists, public health professionals, epidemiologists, environmental scientists, sociologists, and others. This mode of inquiry provides a means to unshackle the study of nutrition from its customary scientistic and reductionistic moorings and to incorporate an appreciation for how regulatory practices, social systems, and political considerations interact to influence human access to food.

Nutrition ecology furthermore adopts a normative view with respect to sustainable consumption. As Leitzmann (2003) observes,

From a nutritional point of view, sustainability also deals with the fair distribution of food through ecological and preventive eating behavior. To achieve sustainability, a comprehensive rethinking of common values is needed to attain a new understanding of the quality of life.

Intellectual developments currently taking place around the notion of nutrition ecology are roughly comparable with those occurring with respect to industrial ecology (see, for example, Graedel and Allenby 1995; Ehrenfeld 2002). On one hand, industrial ecologists conceive of the productive economy as a closed system and study the various impacts that occur throughout the entire life cycle of manufactured goods. On the other hand, though much less prominent at present, self-styled nutrition ecologists are seeking to understand the food system in all of its dimensions: production, harvesting, preservation, storage, transport, processing, packaging, trade, distribution, preparation, consumption, and waste disposal (Leitzmann 2003). As such, the field of nutrition ecology provides a practicable approach for beginning to validate the symbiotic relationship between human health and global environmental well-being.

3. Sustainable Consumption and Sustainable Active Living

The plentiful caloric content of the average American diet has combined to devastating effect with an increase in sedentariness among large segments of the public. The tendency has been to attribute this growing trend toward physical inactivity to personal indolence and poor discipline. However, public health officials have begun to redefine the problem in social terms and to draw attention to the cultural and infrastructural factors that contribute to a declining pattern of muscular exercise (see, for example, Nestle and Jacobson 2000). In particular, the general lack of fitness in the United States can be attributed to the low regard for physical education in school settings, the advent of widespread automobile dependency, the prevalence of television (and other electronic modes of leisure and recreation), and the societal preoccupation with ease and comfort.

First, moderately strenuous exercise has fallen out of favor in formal educational settings in the United States. While a select number of capable student-athletes continue to compete on school teams, comprehensive fitness programs for the general student population have suffered from a lack of financial commitment, a tendency to disparage activities that emphasize self-expression and creativity, and a desire to insulate students from the travails of poor performance (Crister 2003). In wealthier communities around the country, declining public support for school-based physical education has been offset by the creation of pervasive extra-curricular sports programs that operate on an independent funding basis and often rely on parental voluntarism. However, less prosperous locales have not evinced the same inclination and capacity to launch initiatives that substitute for terminated school offerings (Lareau 2003).

Second, school administrators have eviscerated physical education from the curriculum over the last few decades while American society has become increasingly automobile reliant (Duany *et al* 2000; Kay 1997). More than half of the country's population resides in suburbs where access to a car is an inescapable necessity of daily life. Most communities constructed during the post-World War II era have been built on the supposition that every resident would have access to a private vehicle. Cities in the southern and southwestern regions of the country—most notably Atlanta, Houston, Las Vegas, Los Angeles, and Phoenix—are especially prominent examples of this design strategy. At the same time, the country's older metropolitan areas have experienced robust population growth over the past five or six decades on their suburban and exurban peripheries and this situation has, in combination with other factors, led to a hollowing out of central cities and the dispersal of people across wide geographic areas. Such circumstances have resulted in land-use patterns in which more recently constructed schools and other public facilities are inaccessible on foot or by bicycle. There are indications now surfacing that the growing prevalence of low-density settlement in the United States is contributing to the epidemic incidence in weight gain (Jackson 2003; Jeffery and Utter 2003; Welch 2003; Nestle and Jacobson 2000; see also Stein 2004).

Third, critics of television have long alleged that the medium contributes to anti-social behavior and sedentary lifestyles (see, in particular, Mander 1978). However, these charges—vociferous though they may have been at times—did little to slow the popularization of this form of leisure activity. Over the past two decades, electronic recreation has become even more pervasive with the advent of video-cassette recorders, digital-video discs, video and computer games, and the Internet. A sizeable segment of the American public now spends more than twenty hours per week watching television or passively viewing one or another kind of electronic media (see, for example, Gordon-Larsen *et al* 1999).

Today, social commentators are not the only voices censuring the intensive public penetration of television and other electronic pastimes. Medical researchers are beginning to identify strong statistical associations between these leisure activities and chronic health disorders, most notably pediatric obesity and type II diabetes (see, for example, Hu *et a*l 2003; Crespo *et al* 2001). Moreover, the number of hours devoted to television viewing and related pursuits is closely correlated with other factors that exacerbate caloric imbalances such as inadequate physical exercise and soft drink and snack food consumption (Giammattei *et al* 2003; Robinson 2001).

Finally, the continual upgrading of standards of comfort and convenience has undermined physical fitness by substituting technology for human exertion (Shove 2003; Crowley 2001). While few people would freely forsake fuel-powered tractors in favor of hand plows or revert from automatic clothes washing machines to washboards, an important reason for the retention of surplus body weight is that many routine activities no longer require tiresome inputs of raw muscle. A somewhat more circumspect eye, however, reveals that "ease of living" has become a sacrosanct objective of the contemporary era and a prominent feature of marketing appeals. When indoor temperature can be readily maintained by dialing an electronic thermostat, the cutting and hauling wood is viewed, at best, as an anachronistic practice. The point here is that the costs associated with today's remarkably high levels of comfort and convenience are often ignored and many people actively avoid arduous labor. As a general rule, there is a powerful and paradoxical tendency to extend high levels of social prestige to occupations and lifestyles that require relatively low levels of physical exertion, despite the fact that they may be clearly unhealthy from a fitness perspective.

To overcome the dilemmas created by the lack of energetic activity and to foster more wholesome lifestyles, some scholars and organizations have begun to advocate for more "sustainable active living" (IUCN 1991; Lake *et al* 2001; Mariethoz and Bokonyi-Moeschler 2003). One of the most comprehensive statements on the issue is provided by Lake *et al* (2001) who describe sustainable active living as "the integration of physical activity into daily life in order to improve the quality of human life while living within the carrying capacity of supporting ecosystems."

Discussions regarding sustainable consumption to date, by stressing the need to achieve ambitious technological efficiencies in materials and energy use, have failed to consider the potential value of individualized initiatives that emphasize physical exercise and healthful living. In their effort to avoid treacherous political waters, proponents of this agenda have needlessly overlooked modest advances in how people manage their personal well-being.

Aside from its direct health benefits, sustainable active living can potentially provide an effective channel for encouraging values that are consistent with sustainable consumption—cooperation, fairness, participation, and reflexivity. Unfortunately, because of the battering to which physical educators have been subjected in recent decades, what was once deemed a noble vocation has lost much of its stature. There is sound reason to question whether recruits to the field have sufficient background and training to take up the challenges that would be part of a professional commitment to sustainability. Moreover, there may be a real intellectual deficit as physical education does not presently foster the kind of critical outlook that would be necessary for it to make a meaningful contribution to the realignment of contemporary lifestyles. Despite the general thrust of the foregoing assessment, there are hopeful signals that a more socially and environmentally responsive mode of thought may be emerging among physical educators (Humberstone 1998; Rovegno and Kirk 1995; Sage 1993; see also Csikszentmihalyi 1990 and McKibben 2000).

At the same time, environmental educators have a role to play in reaffirming their commitment to physical activity. Environmental education as taught in schools has typically been presented in a science format despite the fact that it has long been recognized that outdoor pursuits—particularly hiking, rock climbing, and cross-country skiing—are important components of a comprehensive curriculum. One way, therefore, for environmental educators to overcome this bias is to become more actively engaged with their colleagues in physical education (Humberstone 1995).

The poor level of physical fitness among members of the American public is beginning to come to the fore and these developments should be of considerable interest to proponents of sustainable consumption. Colorado, in particular, is one state that has taken concerted action to promote more active lifestyles. Local public health officials were galvanized into action in 2002 when it was revealed that the state's residents, after decades as the leanest Americans, were falling victim to the same upward trends in obesity and inactivity as the rest of the country. The issue took on special prominence because the state had come to rely on its healthful and youthful image as an outward marketing theme. Physical educators and elected officials launched a novel program known as "Colorado on the Move" that seeks to increase the number of steps people in the state take each day by 2000 strides. School administrators have also been enlisted to develop ancillary programs to encourage children to walk to school. However, the most comprehensive effort in the state to date involves the redevelopment of Denver's former Stapleton Airport into an "active recreational" community. The project, designed to accommodate an eventual residential population of 30,000 people, contains a dense network of cycling paths, walking trails, and parks, as well as neighborhood health clinics that emphasize nutrition and exercise (Johnson 2004).

Sustainable active living also entails efforts to resist the urge to sit down in front of a television, video game, or computer. A national program run under the auspices of an organization called the TV Turnoff Network (TVTON) encourages both children and adults to spend a week each year without the apparent luxury of television. TVTON distributes customized curricula to schoolteachers and encourages community groups to arrange programs to divert public attention away from passive forms of electronic entertainment. Other overt expressions of anti-television activism have included efforts to ban the airing of television programs in schools and campaigns to limit advertising aimed at young children (see, for example, Cohen 2004; Molnar 1996; Fox 1996). This antipathy stems in large part from initiatives to force educational administrators to cancel their contacts with Channel 1, a proprietary network that broadcasts a daily digest of news and commercials to schools around the country.

4. Sustainable Consumption and Consumer Debt

Virtually all developed countries have experienced large increases in outstanding consumer debt over the past decade. The upwelling in non-mortgage credit has been particularly sizeable in the United States where the amount of so-called "revolving debt" has doubled from approximately $1 billion to $2 billion (Braunstein and Welch 2002). This category of consumer credit comprises primarily credit card debt that remains unpaid and "rolls" over, along with finance charges and fees, from one month to the next. Some commentators have attributed this trend to an especially crass form of unchecked consumer exuberance. More reflective analysis, however, highlights several structural changes in the financial services industry and the ways in which consumers negotiate the obstacles of everyday life have been at the center of these phenomena (Leyshon *et al* 1998; Evans and Schmalensee 1999; Calder 1999; Manning 2000; Cohen 2004). For instance, banks previously generated their revenue by dispensing loans to a largely local clientele, but this traditional business practice has been outpaced by a process of modernization. The financial services industry today employs the tools of modern marketing and database management to assess from a distance the credit worthiness of a much wider circle of prospective borrowers. By utilizing geographical information systems (GIS) to recruit new customers and networked credit-reporting consortia to verify financial histories, banks are no longer confined to recruiting proximate borrowers. The advent of toll-free call centers (and more recently the Internet) has substituted technology for face-to-face interaction and a staff of centralized operators can now cost-effectively manage the accounts of a very large pool of dispersed customers.

These new arrangements have stripped away the banking industry's customary coziness and collegiality. Contemporary financial service providers now intensively compete with one another and this new situation has given rise to the use of a broad assortment of aggressive promotional practices. For example, at one time banks were unenthusiastic about clients that were poor credit risks, but today they actively pursue customers that have customarily lived outside of the formal banking economy. To compensate for the added exposure of novice customers it is common to impose onerous interest rates on their accounts. College students, because they are prone to use credit cards imprudently have proven to be an especially lucrative market (Norvilitis *et al* 2003; Hayhoe *et al* 2000).

At the same time, the growth in consumer credit has paralleled the general swelling in size of the consumer economy in recent decades and retail transactions now account for nearly two-thirds of the economy in the United States. Under such circumstances, access to a near-cash payment tool—one that has the advantage of being virtually universally accepted—becomes an important piece of equipment for living. In addition, access to readily available consumer credit serves a number of other useful functions. For instance, cardholders can draw credit advances during times of financial duress and this may be, for any number of reasons, a more suitable alternative than informal assistance from friends of family members (Warren and Warren-Tyagi 2003).

Ample personal credit also provides what some observers might consider to be a more frivolous form of flexibility in that it enables consumers to upgrade, at least for a time, their material standard of living. In a society where cultural standards of outward presentation are continually ratcheting upward, credit becomes an indispensable means to maintain social appearances at a relatively low cost (Schor 1998). Moreover, in the United States there are few prohibitions on product promotionalism and under such permissive conditions it can be challenging for people to maintain their psychological health (Wachtel 1983; Jacobson and Mazur 1995; Kasser and Kanner 2004). The use of readily available credit to acquire goods provides a convenient safety valve with which to ensure one's social standing.

Nonetheless, the growth in consumer debt in the United States, and the accompanying rise in personal bankruptcies, has made it difficult for the financial services industry and governmental authorities to avoid the social costs of an economic system that affords relatively unfettered access to credit. To fend off calls for new controls on their lending activities, banks have sought to define the problem of insolvency in terms of inadequate financial literacy and the industry has launched a series of educational programs to improve public understanding of topical issues. One of the leading initiatives has been developed under the auspices of the Jump$tart Coalition, a consortium of 140 corporations, government agencies, education associations, and nonprofit organizations.

Financial literacy has also been an area of vibrant political activity. In addition to Congressional hearings, Federal Reserve chairman, Alan Greenspan, has been a forceful spokesperson on the issue (Greenspan 2002; see also U. S. Treasury Department 2002; USGAO 2001). In terms of institutionalized responses, the Treasury Department has created an Office of Financial Education and participates in the federal government's newly established Financial Literacy and Education Commission. As for direct involvement by the White House, the Bush administration has amended its flagship education program, No Child Left Behind, to encourage schools to develop curricular content pertaining to financial literacy (Strauss 2004).

This profusion of activities by mainstream political and economic institutions represents a very considerable effort to address the untoward affects of unaffordable personal debt. To be certain, these initiatives have not shed much light on the broader social and environmental dimensions of rampant credit-card usage. However, the accumulation of unprecedented levels of consumer debt is surely coming to be understood as a social problem that requires a public policy response. As this process proceeds, new opportunities will avail themselves to proponents of sustainable consumption to open up the discussion beyond merely the “wise” use of credit and to advance a more expansive critique of contemporary consumerism (see, for example, Durning 1992; Dominguez and Robin 1999; de Graaf 2001).

5. Conclusion

Portions of global society have been engaged for nearly two decades in seeking to foster pathways toward more sustainable development. Numerous celebrated documents have been prepared and a long list of international gatherings has been convened. One of the most remarkable outcomes of the Earth Summit in 1992 was a formal declaration that the consumption practices of the most economically advanced countries of the world were contributing to climate change and exacerbating declines in biodiversity. Such claims were departures from an earlier era during which global environmental deterioration was solely attributed to rapid population growth in developing countries.

Despite this reversal, there is a palpable sense that the political approach for pursuing sustainable consumption (as well as sustainable development more generally) is fraught with numerous insurmountable obstacles. Moreover, with China and India both experiencing unprecedented economic growth and lackluster commitment among most key nations it appears that the modest interest that governments had demonstrated for this task during the 1990s has faded as other issues have pressed for space on the international agenda. Even those countries that embraced Agenda 21, the flagship project put forth by the Rio proceedings, seem to have lost much of their enthusiasm. The emerging sensibility is that the foremost approach for working toward sustainability, with its emphasis on the role of high politics and elite institutions, has broken down.

An important outcome of this nascent awareness is that engineers are beginning to rise to the challenge of sustainable consumption. There is a growing recognition among technology educators, as well as within the engineering community more generally, that headway reducing greenhouse gas emissions and tackling other global environmental threats will require a redoubled commitment to technical innovation (see, for example, Thomas and Graedel 2003; Hirschl *et al* 2003).

While it would be foolhardy to discount entirely the improvements that can accrue from enhancing energy and materials efficiencies, history suggests that technologists tend to overestimate the potential of these gains. Concomitantly, in the absence of fundamental changes in materials and energy utilization it is likely that unanticipated rebound effects will swamp engineered interventions. It is therefore essential that developed countries such as the United States pursue a balanced portfolio of strategies to limit the environmental impacts of contemporary consumption practices. To be certain, part of the attractiveness of the technological path derives from the fact that it circumvents difficult political choices and places responsibility in the hands of presumably competent experts. However, as the preceding discussion outlines, it is possible to advance social policies that support sustainable consumption without compromising existing political imperatives. Moreover, it remains quite plausible that a public that is adequately nourished, physically fit, and financially stable will, over time, develop greater empathy toward large-scale environmental problems and become more supportive of determined efforts to address them.

6. Bibliography

Bentley, M. 2002. *Tracking Progress: Implementing Sustainable Consumption Policies: A Global Review of Implementation of the United Nations Guidelines for Consumer Protection*, London: Consumers International and UNEP.

Braunstein, S. and C. Welch. 2002. “Financial Literacy: An Overview of Practice, Research, and Policy,” *Federal Reserve Bulletin*, November:445-322.

Briggs, C. 1997. “The Beijing Platform for Action and Nutrition Education,” *Journal of Nutrition Education* 29(5):281-288.

Calder, L. 1999. *Financing the American Dream: A Cultural History of Consumer Credit*, Princeton: Princeton University Press.

Carlsson-Kanyama, A. 1998. “Climate Change and Dietary Choices: How Can Emissions of Greenhouse Gases from Food Consumption be Reduced?” *Food Policy* 23(3-4):277-293.

Carson, R. 1962. *Silent Spring*, Boston: Houghton Mifflin.

Cohen, M., A. Comrov, and B. Hoffner. 2004. “The New Politics of Consumption: Promoting Sustainability in the American Marketplace,” *Sustainability: Science, Practice, and Policy*, in press.

Cohen, M. 2004. “Financial Literacy, Consumer Credit, and Sustainable Consumption: Toward a New Agenda for Eco-Consumer Policy and Education,” Paper presented at the European Roundtable for Sustainable Production and Consumption, Bilbao, Spain, May 12-14.

Cohen, M. and J. Murphy, eds. 2001. *Exploring Sustainable Consumption: Environmental Policy and the Social Sciences*, New York: Elsevier.

Collins, R. 2000. *More: The Politics of Economic Growth in Postwar America*, New York: Oxford University Press.

Crespo, C., E. Smit, R. Troiano, S. Bartlett, C. Macera, and R. Andersen. 2001. “Television Watching, Energy Intake, and Obesity in US Children: Results from the Third National Health and Nutrition Examination Study, 1988-1994,” *Archives of Pediatrics and Adolescent Medicine* 155(3):360-365.

Crister, G. 2003. *Fat Land: How Americans Got to be the Fattest People in the World*, Boston: Houghton Mifflin.

Crowley, J. 2001. *The Invention of Comfort: Sensibilities and Design in Early Modern Britain and Early America*, Baltimore: Johns Hopkins University Press.

Csikszentmihalyi, M. 1990. *Flow: The Psychology of Optimal Experience*, New York: Harper Perennial.

de Graaf, J. 2001. *Affluenza: The All Consuming Epidemic*, San Francisco: Berrett-Koehler.
Dominguez, J. and V. Robin. 1999. *Your Money or Your Life: Transforming Your Relationship with Money and Achieving Financial Independence*, New York: Penguin.
Dryzek, J., D. Downes, C. Hunold, D. Schlosberg, and H-K. Hernes. 2003. *Green States and Social Movements: Environmentalism in the United States, United Kingdom, Germany and Norway*, New York: Oxford University Press.
Duany, A., E. Plater-Zyberk, and J. Speck. 2000. *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*, New York: North Point Press.
Durning, A. 1992. *How Much is Enough: The Consumer Society and the Future of the Earth*, New York: Norton.
Ehrenfeld, J. 2002. "Industrial Ecology: Coming of Age," *Environmental Science and Technology* 36(13):281A-285A.
Eisenmann, J., R. Bartee, and M. Wang. 2002. "Physical Activity, TV Viewing, and Weight in US Youth: 1999 Youth Risk Behavior Survey," *Obesity Research* 10(5): 379-385.
Evans, D. and R. Schmalensee. 1999. *Paying with Plastic: The Digital Revolution in Buying and Borrowing*, Cambridge: MIT Press.
Fox, R. 1996. *Harvesting Minds: How TV Commercials Control Kids*, Westport, CT: Praeger.
Giammattei, J., G. Blix, H. Marshak, A. Wollitzer, and D. Pettitt. 2003. "Television Watching and Soft Drink Consumption: Associations with Obesity in 11- to 13-Year Old Schoolchildren," *Archives of Pediatrics and Adolescent Medicine* 157(9):882-886.
Gordon-Larsen, P., R. McMurray, and B. Popkin. 1999. "Adolescent Physical Activity and Inactivity Vary by Ethnicity: The National Longitudinal Study of Adolescent Health," *Journal of Pediatrics* 135(3):301-306.
Gottlieb, R. 1993. *Forcing the Spring: The Transformation of the American Environmental Movement*, Washington, DC: Island Press.
Graedel, T. and B. Allenby. 1995. *Industrial Ecology*, Upper Saddle River, NJ: Prentice Hall.
Greenspan, A. 2002. "Financial Literacy: A Tool for Economic Progress," *Futurist* 36(4):37-41.
Grigsby, M. 2004. *Buying Time and Getting By: The Voluntary Simplicity Movement*, Albany: State University of New York Press.
Hayhoe, C., L. Leach, P. Turner, M. Bruin, and F. Lawrence. 2000. "Differences in Spending Habits and Credit Use of College Students," *Journal of Consumer Affairs* 34(1):113-133.
Hays, C. 2004. *The Real Thing: Taste and Power at the Coca Cola Company*, Random House.
Heap, R. and J. Kent. 2000. *Towards Sustainable Consumption: A European Perspective*, London: The Royal Society.
Hirschl, B., W. Konrad, G. Scholl. 2003. "New Concepts in Product Use for Sustainable Consumption," *Journal of Cleaner Production* 11(8):873-881.
Honari, M. and T. Boleyn, eds. 1999. *Health Ecology: Health, Culture, and Human-Environment Interaction*, New York: Routledge.

Hu, F. T. Li, G. Colditz, W. Willett, and J Manson. 2003. "Television Watching and Other Sedentary Behaviors in Relation to Risk of Obesity and Type 2 Diabetes Mellitus in Women," *Journal of the American Medical Association* 289(14):1785-1791.

Humberstone, B. 1995. "Bringing Outdoor Education into the Physical Education Agenda: Gender Identities and Social Change," *Quest* 47(2):144-157.

Humberstone, B. 1998. "Re-creation and Connections in and with Nature: Synthesizing Ecology and Feminist Discourses, and Praxis," *International Review for the Sociology of Sport* 33(4):381-392.

International Union for the Conservation of Nature [IUCN]. 1991. *Caring for the Earth: A Strategy for Sustainable Livin*g, Geneva: IUCN.

Jackson, L. 2003. "The Relationship of Urban Design to Human Health and Condition," *Landscape and Urban Planning* 64(4):191-200.

Jacobson, M. and L. Mazur. 1995. *Marketing Madness: A Survival Guide for a Consumer Society*, Boulder, CO: Westview Press.

Jeffery, R. and J. Utter. 2003. "The Changing Environment and Population Obesity in the United States," *Obesity Research* 11 (Supp):12S-22S.

Johnson, K. 2004. "Colorado Takes Strides to Polish Thin and Fit Image," *The New York Times*, February 1, Sect. 1, p. 12.

Kamminga, H. and A. Cunningham, eds. 1995. *The Science and Culture of Nutrition, 1840-1940*, Atlanta: Roclopi.

Kasser, T. and A. Kanner, eds. 2004. *Psychology and Consumer Culture: The Struggle for a Good Life in a Materialistic World*, Washington, DC: American Psychological Association.

Kay, J. 1997. *Asphalt Nation: How the Automobile Took Over America and How We Can Take it Back*, New York: Crown.

Lafferty, W. and J. Meadowcroft, eds. 2000. *Implementing Sustainable Development: Strategies and Initiatives in High Consumption Societies*, New York: Oxford University Press.

Lake, J., G. Stratton, D. Martin, and M. Money. 2001. "Physical Education and Sustainable Development: An Untrodden Path," *Quest* 53:471-482.

Lareau, A. 2003. *Unequal Childhoods: Class, Race, and Family Life*, Berkeley: University of California Press.

Leitzmann, C. 2003. "Nutrition Ecology: The Contribution of Vegetarian Diets," *American Journal of Clinical Nutrition* 78(Supp 1):657S-659S.

Levenstein, H. 1993. *Paradox of Plenty: A Social History of Eating in Modern America*, New York: Oxford University Press.

Leyshon, A., N. Thrift, and J. Pratt. 1998 "Reading Financial Services: Texts: Consumers, and Financial Literacy," *Environment and Planning D* 16(1):29-55.

Mander, J. 1978. *Four Arguments for the Elimination of Television*, New York: William Morrow.

Maniates, M. 2002. "In Search of Consumptive Resistance: The Voluntary Simplicity Movement," pp. 199-235 in T. Princen, M. Maniates, and K. Conca, eds., *Confronting Consumption*, Cambridge: MIT Press.

Manning, R. 2000. *Credit Card Nation: The Consequences of America's Addiction to Credit*, New York: New York Basic Books.

Manoochehri, J. 2001. *Consumption Opportunities: Strategies for Change—A Report for Decision-makers*, Geneva: UNEP.
Mariethoz, E. and M. Bakonyi-Moeschler. 2003. “Role of Physical Activity in Health Promotion and (Individual) Sustainable Development,” *International Journal of Sustainable Development and World Ecology* 10(3):221-224.
Martens, S. and G. Spaargaren. 2004. “The Politics of Sustainable Consumption: The Case of The Netherlands,” *Sustainability: Science, Practice, and Policy*, in press.
McKibben, B. 2000. *Long Distance: A Year of Living Strenuously*, New York: Simon and Schuster.
Molnar, A. 1996. *Giving Kids the Business: The Commercialization of America’s Schools*, Boulder, CO: Westview Press, 1996.
Moore-Lappé. F. 1971. *Diet for a Small Planet*, New York: Ballantine.
Nestle, M. 2002. *Food Politics*, Berkeley: University of California Press.
Nestle, M. and M. Jacobson. 2000. “Halting the Obesity Epidemic: A Public Health Policy Approach,” *Public Health Reports* 115(1):12-24.
Norvilitis, J. P. Szablicki, and S. Wilson. 2003. “Factors Influencing Levels of Credit-Card Debt in College Students,” *Journal of Applied Social Psychology* 33(5):935-947.
OMB Watch. 2004. “Industry Influence Weakens USDA Dietary Guidelines,” *OMB Watcher* 5(20) [Available at http://www.ombwatch.org /article/articleview/2435/1/291/].
Organization for Economic Cooperation and Development [OECD]. 1997. *Sustainable Production and Consumption: Clarifying the Concepts*, Paris: OECD.
Organization for Economic Cooperation and Development [OECD] 1998. *Towards Sustainable Consumption Patterns: A Progress Report on Member Country Initiatives*, Paris: OECD.
Organization for Economic Cooperation and Development [OECD]. 1999. *Education and Learning for Sustainable Consumption*, Paris: OECD.
Organization for Economic Cooperation and Development [OECD]. 2002. *Towards Sustainable Household Consumption? Trends and Policies in OECD Countries*, Paris: OECD.
Princen, T, M. Maniates, and K. Conca, eds. 2002. *Confronting Consumption*, Cambridge: MIT Press.
Putnam, J. and J. Allshouse. 1999. *Food Consumption, Prices, and Expenditures, 1970-97*, Statistical Bulletin No. 965, Washington, DC: U.S. Department of Agriculture, Economic Research Service.
Robinson, T. 2001. “Television Viewing and Childhood Obesity,” *Pediatric Clinics of North America* 48(4):1017-1025.
Rovegno, I. and D. Kirk 1995. “Articulations and Silences in Socially Critical Work on Physical Education: Toward a Broader Agenda,” *Quest* 47(4):447-474.
Sage, G. 1993. “Sport and Physical Education and the New World Order: Dare We Be Agents of Social Change,” *Quest* 45(2):151-164.
Sanches, S. 2004. “Sustainable Consumption *à la française*? Conventional, Innovative, and Alternative Approaches to Sustainability and Consumption in France,” *Sustainability: Science, Practice, and Policy*, in press.
Schlosser, E. 2001. *Fast Food Nation: The Dark Side of the All-American Meal*, Boston: Houghton Mifflin.

Schor, J. 1998. *The Overspent American: Upscaling, Downshifting, and the New Consumer*, New York: Basic Books.

Schwenk, M. and G. Hauber-Schwenk. 2003. “Nutritional Ecology: Chances of Public Health Services to Shape Procedures,” *Gesundheitswesen* 65(Supp 1):S26-S30.

Seale, J., A. Regmi, and J. Bernstein. 2003. *International Evidence on Food Consumption Patterns*, Technical Bulletin No. TB1904, Washington, DC: U.S. Department of Agriculture, Economic Research Service.

Sitarz, D., ed. 1998. *Sustainable America: America's Environment in the 21st Century*, Carbondale, IL: EarthPress.

Shove, E. 2003. *Comfort, Cleanliness, and Convenience: The Social Organization of Normality*, New York: Berg.

Sims, L. 1998. *The Politics of Fat: Food and Nutrition Policy in America*, Armonk, NY: M. E. Sharpe.

St.-Onge, M., K. Keller, and S. Heymsefield. 2003. “Changes in Childhood Food Consumption Patterns: A Cause for Concern in Light of Increasing Body Weights,” *American Journal of Clinical Nutrition* 78(6):1068-1073.

Stein, R. 2004. “Car Use Drives Up Weight, Study Finds,” *The Washington Post*, May 31, p. A2.

Strauss, V. 2004. “Schools Investing in Fiscal Literacy: Credit Unions Help Students Learn Finance,” *The Washington Post*, February 17:A12.

Thomas, V. and T. Graedel. 2003. “Research Issues in Sustainable Consumption: Toward an Analytical Framework for Materials and the Environment,” *Environmental Science and Technology* 37(23):5383-5388.

United Nations Environment Program [UNEP]. 2004. *Ten-Year Framework of Programmes on Sustainable Consumption and Production: The Marrakech Process*, Paris: UNEP.

United States General Accounting Office [USGAO]. 2001. *Consumer Finance: College Students and Credit Cards*, Washington, DC: Government Printing Office.

United States Treasury Department [Office of Financial Education]. 2002. *Integrating Financial Education into School Curricula*, Washington, DC: Government Printing Office.

Vidal, J. 1997. *Mclibel: Burger Culture on Trial*, New York: The New Press.

Vorster, H. 2002. “The 2002 World Summit on Sustainable Development: A More Holistic Approach for Public Health Nutrition,” *Public Health Nutrition* 5(6):707-708.

Wachtel, P. 1983. *The Poverty of Affluence: A Psychological Portrait of the American Way of Life*, New York: Free Press.

Walton, D. and P. Bridgewater. 1999. “Heath and Conservation: Shared Values,” pp. 59-78 in M. Honari and T. Boleyn, eds., *Health Ecology: Health, Culture, and Human-Environment Interaction*, New York: Routledge.

Warren, E. and A. Warren-Tyagi. 2003. *The Two-Income Trap: Why Middle-Class Mothers and Fathers are Going Broke*, New York: Basic Books.

Welch, G. 2003. “Spending in the US on Advertising for Fast Foods, Sodas, and Automobiles: Food for Thought Regarding Type 2 Diabetes Epidemic,” *Diabetes Care* 26(2):546-547.

Consumer Behaviour II

Consumption of Energy and Transport in Urban Households: The role of urban planning vs. 'green consumerism' in promoting sustainable consumption

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Abstract

The increasing environmental impact of private consumption represents a major challenge in achieving sustainable development. In a recent study of the consumption of energy for housing and transport in urban households in Oslo (SusHomes), ProSus explored two major assumptions: (1) that a large part of household consumption is influenced by the physical-structural living situation, i.e. the type of housing and location within the city; and (2) that individual attitudes towards environmental issues form a solid basis for achieving more sustainable consumption at the household level.

Eight residential areas in the Greater Oslo Region were investigated to see how household consumption of energy for housing and transport (both everyday and long-distance leisure-time travel) varies as to physical living conditions (i.e. type of housing, distance from city centre and local service centre, housing density and transport situation). In total 941 households were surveyed by Gallup Norway AS, including a group of households participating in Norway's leading 'green consumer' network (the Norwegian Environmental Home Guard), a widespread initiative which engages and advises average citizens and families on more eco-friendly lifestyles.

The results indicate that there are few significant relationships between individual environmental values/attitudes and the consumption of energy and transport. An exception here is that 'green households' actually appear to travel *more* by airplane. The second major finding was to demonstrate significant relationships between land-use characteristics and consumption patterns. These findings raise serious questions as to the notion of the 'compact city' as a particularly sustainable urban form. In general the findings indicate that physical structures – the nature and location of dwellings – pose serious barriers for 'green consumerism'.

The paper concludes by discussing potentially decisive land-use factors for the consumption of energy and transport, and the implications for local policy-making and urban planning. Suggestions are also put forth for further research efforts.

Introduction

The resource use and environmental impacts of private household consumption are identified as key aspects of sustainable development. However, not *every* consumption activity necessarily represents a problem. A number of studies point towards three distinct consumption categories as the major problem areas: housing, transport and food (Hille, 1995; National Consumer Agency of Denmark, 1996; Holden, 2001; Lorek and Spangenberg, 2001; Aall and Norland, 2002). These three categories account for as much as 80 % of the direct and indirect environmental impacts caused by households.[i]
Questions for research are related to how a more sustainable consumption pattern could be promoted.[ii] The project “Sustainable consumption of energy and transport in Norwegian households (SusHomes)” is designed to generate knowledge about the state and driving forces of Norwegian households’ energy consumption and use of transport.[iii] The overall aim of the project is to obtain new empirical and theoretical knowledge about the relation between environmental values, physical urban planning and household consumption. This knowledge provides a platform for discussing principles and practises for the achievement of national and international sustainability goals.

The project is based on three main assumptions:

- *that significant and increasing environmental damage due to private household consumption presents a major challenge in achieving sustainable development;*
- *that environmental values form a solid basis for achieving a more sustainable consumption practice in household; and*
- *that a large part of the private household consumption appears to be influenced by our physical living situation, e.g. type of housing and location within the city.*

Based on the empirical results of a survey of 941 households in eight residential areas in the Greater Oslo Region (see below and Holden and Norland, 2004), the current paper focuses on the relationships between households’ energy consumption and: 1) *individual attitudes* towards environmental issues; and 2) *urban form* (land-use characteristics). We will also discuss the implications of the findings for perspectives on national and local efforts for the reduction of households’ energy consumption.

The measurement of energy use focuses on heating, general electricity use in households, and transport. Transport is split into “everyday travel” (covering all means of transport) and “long-distance leisure-time travel” (by car and/or plane). Thus, four consumption categories are studied (measured in kWh/cap/year): (i) energy use for housing (includes energy use for heating and operating the house); (ii) everyday travels; (iii) travels by car (long-distance leisure-time travel by car); and (iv) travels by plane (long-distance leisure-time travel by plane). Throughout the paper, these four consumption categories are referred to as “household consumption”.

Attitude-behaviour consistency

At least two research lines can be distinguished in the *study of attitudes* (Pieters, 1988). First, much attention has been focussed on the question of attitude-behaviour consistency. If attitudes do not direct, or at least precede, behaviour, one of the elements of the utility of the attitude concept would be absent. Second, behaviour change via attitude change has been and still is a prominent research line. First of all, the attitude-behaviour consistency question lies behind this study.

The "IS"-questions can be called the first generation of attitude-behaviour consistency (Pieters, 1988); is there a connection between attitudes and behaviour? The second generation of research questions deals with the *conditions* upon which attitude-behaviour consistency can be observed. Such questions can be referred to as the "WHEN"-questions. Fazio and Zanna (1981) stress the importance of such questions, recommending that, rather than asking whether attitudes relate to behaviour, we should ask "under what conditions do what kinds of attitudes of what kinds of individuals predict what kind of behaviour?" (p.165).

The third generation of research questions deals with the processes underlying the mediating effects. These questions can be called the "HOW"-questions. Here the paper raises two types of initial question:

- *Is* there a connection between attitudes and household consumption? That is, do attitudes relate to household consumption?
- *When* is there a connection between attitudes and household consumption? That is, under what conditions do attitudes relate to household consumption?

The third type of question will be addressed in the concluding discussion of the paper:

- *How* can attitudes guide changes in household consumption practices? That is, which processes lead to attitude-consumption consistency?

Thøgersen (1999) shows that broader attitudes towards, e.g., environmental issues are of little help in predicting any one specific action towards the issue. This does not imply, however, that such attitudes are of no concern. Based on basic principles of action identification as set out by Vallacher and Wegner (1987), Thøgersen (1999) suggests that: "a seemingly heterogeneous bunch of visible acts share a common identity in the mind of an actor" (p.10). Hence, it is indeed meaningful to study attitudes towards environmental issues with the development of change strategies for a given behaviour category in mind. The appropriate measured attitude may in many cases turn out to be a valid measure of the disposition to act, favourably or unfavourably, towards the behaviour category. However, when deciding which option to chose among available action alternatives (within the behaviour category), people chose the one(s) they find most appropriate under the given circumstances. Hence, the general attitude towards the target of environmental action is not very predictive of specific actions (Thøgersen, 1999).

The term "attitude" will be used here to refer to a positive or negative feeling towards a specific behaviour. Possible antecedents, consequences and correlates of an attitude are excluded from its definition. Concerning behaviour, Fishbein and Ajzen (1975) explain that when studying behaviour four elements can be distinguished: (i) the action, (ii) the target at which the action is directed, (iii) the context in which the action is performed, and (iv) the time at which the action is performed. On the basis of these specification elements, Pieters (1988) recognises two types of behaviour: *single acts* and *behaviour categories*. A single act is a specific behaviour where all four specification-elements are defined. A behaviour category is a set of single acts that are similar in at least one specification element, usually the target. Buying a low-flow shower head is a single act. This single act can be an element of the behaviour category "energy saving", to which other single acts, such as turning off lights when leaving a room, belong. In this behaviour category, all single element acts are aimed at the same target: saving energy.

The paper focuses on sustainable household consumption, which must be considered as a broad behavioural category. The four consumption categories can be viewed as single acts within this category.

Urban form

Within *planning research* it is commonly assumed that the design and location of residential areas have important consequences for households' consumption of energy for housing and transport. It is believed that physical planning and design make it possible to achieve a more sustainable consumption pattern. This view has received increased attention since 1987 when 'the sustainable development imperative... revived a forgotten, or discredited idea: that planning ought to be done, or can be done, on a big scale' (Breheny, 1996, p. 13). According to Breheny (1996) the use of the planning system seems to be a common solution for achieving major environmental improvements, and particularly for achieving sustainable development.

However, according to Boarnet and Crane (2001), this whole issue must be treated as a *hypothesis*, rather than a fact, and therefore, the relationship between travel patterns and the built environment should be regarded as a subject for research. While relating energy use for housing to housing design is a quite straightforward task (Næss, 1997), studying the relationship between travel and the built environment is a much more complex matter. While most studies have investigated how commuting is influenced by urban form, some studies have given attention to the correlation of everyday non-work-related travel and urban form (Titheridge et al., 2000). However, little attention has been paid to the possible relationship between long leisure-time travel by car and plane, and the design and location of residential areas within the city.

The following questions are addressed in this paper:

- Do land use characteristics influence energy use for housing and everyday transport, and if so, how?
- Is it possible to identify a correlation between land use characteristics and the residents' long leisure-time travel?

There are two dominant and contradictory theories about sustainable urban form: *the compact city and the dispersed city*. The main principle in the compact city theory is high-density development close to or within the city core with a high mixture of housing, workplaces and shops. This implies densely and concentrated housing development, which favours semi-detached and multifamily housing. Under this theory, development of residential housing areas on (or beyond) the urban fringe, and single-family housing in particular, are banned. Furthermore, central, high-density development supports a number of other attributes that are favourable to sustainable energy use: low energy use for housing and everyday travel, efficient remote heating systems, proximity to a variety of workplaces and public and private services, as well as a highly developed public transport system. Although the supporters of the compact city theory (e.g., Jacobs, 1961; Newman and Kenworthy, 1989; CEC, 1990; Elkin et al, 1991; Sherlock, 1991; Enwicht, 1992; McLaren, 1992) believe that the compact city has environmental and energy advantages, as well as social benefits, the main justification for the compact city is the low energy-intensive activity pattern. The supporters of the dispersed city suggest the *green city*, i.e. a more open type of urban structure, where buildings, fields and other green areas form a sort of mosaic-like pattern (Næss, 1997), and more attention is given to aspects such as quality of life, social structures etc.

As in other countries, the perspectives of the 'compact city' discourse are being adopted in policies for sustainable development in Norway, in national environmental urban policies (MoE, 2002; Skjeggedal et al., 2003). Also in the City of Oslo, arguments supporting new inner city development projects are increasingly based on this approach to sustainable urban form.

The paper will also discuss the so-called 'compensatory mechanism hypothesis', discussed by, e.g., Vilhelmson (1990), Næss (1997), Holden (2001), Holden (2004) and Næss (2005). This hypothesis suggests that people who live in densely populated urban areas (in flats in inner cities) and who have limited need for everyday transport, tend to undertake longer travel in their leisure time as a compensation for limited access to green/outdoor areas. If such compensatory effects apply, this could have major consequences for physical planning practices: why strive for urban planning practices that reduce the need for everyday transport if it results in more extensive travel during holidays and leisure time?

The paper is organised in four sections. First, we present the methodological approach we used in the empirical study. Second and third, we present the results of the survey in Greater Oslo Region, on the relationship between households' energy consumption and *individual attitudes* (Holden, In Prep.) and *land use characteristics* (Holden and Norland, Submitted) subsequently. Finally, we will discuss the importance of individual attitudes towards environmental issues compared to land use characteristics (and the socio-economic position), and the possible implications of our findings for urban sustainable development and sustainable consumption policies and strategies.

Methodology

In the project's first phase we have conducted surveys in eight residential areas in the Greater Oslo Region, and used bivariate and multiple regression analyses. Figure 1 illustrates the possible causal relationships between the physical and non-physical characteristics of households and the houses in which they live, and their consumption behaviour studied in this project.

Concerning research design, as our units of analysis we have chosen households within a limited number of residential areas within a city region. In contrast to studies that base their analysis on surveys of cities and city regions as a whole, this approach allows us to better control for key contextual factors such as local density, access to public transport, and socio-demographic characteristics, and thereby also the respondents' representation within each area. Eventually, this enables us to discuss in more detail the possible effects of different housing models, locations and transport systems on household consumption in an urban region.

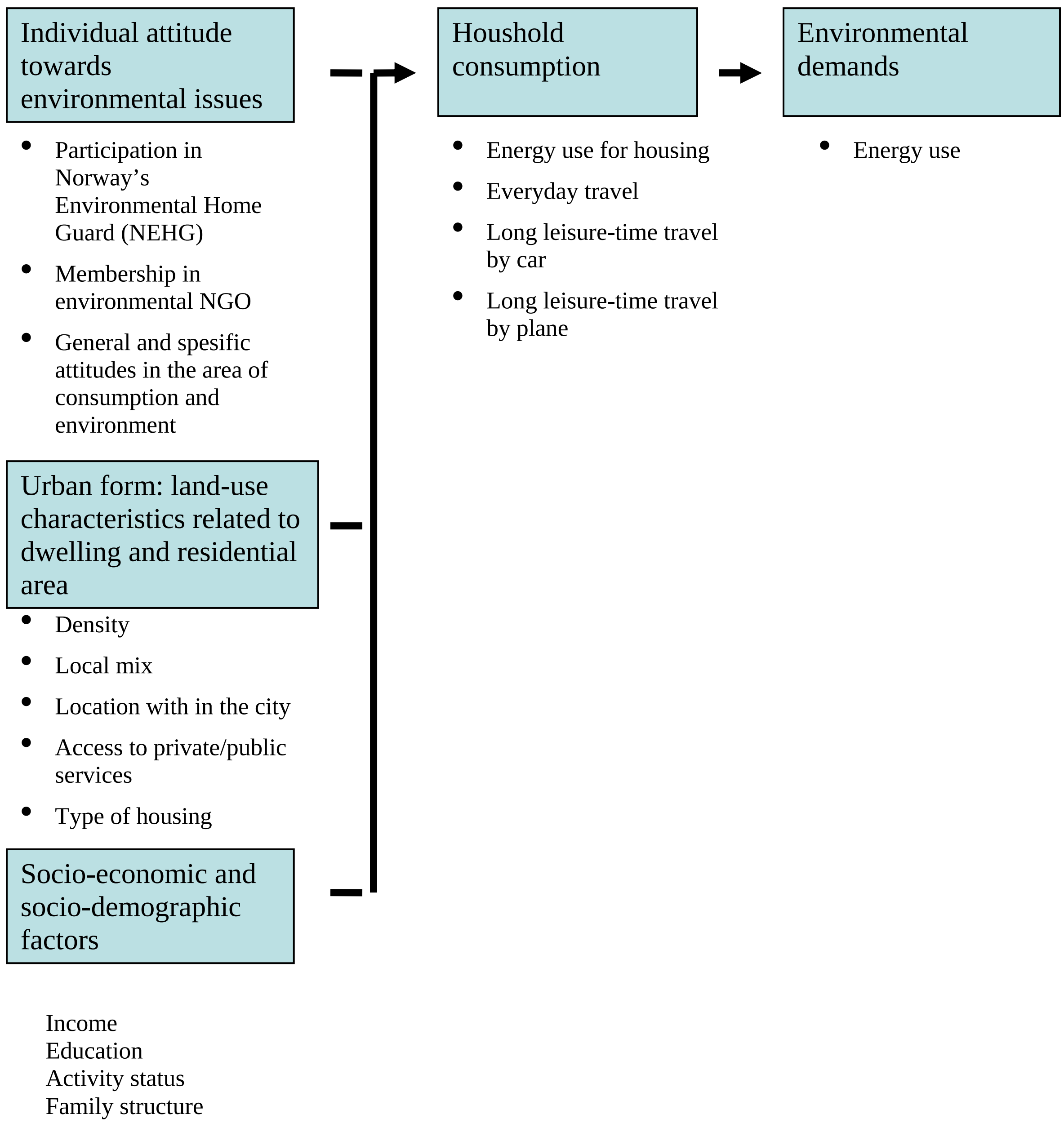

Figure 1: *Assumptions on causal relationships between individual attitudes, urban form, consumption and environmental demands (impacts)*

The study group

The survey was conducted in March-April 2003, and questionnaires were sent to 2500 randomly sampled individuals above the age of 17. With a response rate of 40 percent, we averaged 120 respondents per area. While the questionnaire was sent to individuals within households, they responded on questions regarding their own and the household's consumption of energy and transport, as well as family structure, income and housing facilities.

The selection of residential areas is based on a set of criteria representing key land use characteristics, and on more specific aspects expected to represent possible causal factors effecting consumption at the household level: i) *type of housing* (single-family, row or multifamily housing)[iv]; ii) *housing density* (number of housing units per area unit); iii) *location relative to the city centre*; iv) *access to public transport* (distance to tram/subway station); v) *distance to local sub-centre*; and vi) *local mix* (to what extent the area is homogenous with respect to type of housing and/or mix of housing, business and services). The eight residential areas represent different reflections of the six criteria, as illustrated in Table 1.

Table 1: *Key characteristics of the eight residential areas* (Holden and Norland, 2004)

Area / Criteria	Bjørndal	Grünerløkka	Holmlia	Hovseter	Rykkinn	Sandvika	Silkestrå	Vålerenga
Type of housing	Single family/row housing	Multifamily housing	Multi-family/row housing	Multifamily housing	Row housing	Multifamily housing	Row housing	Mix
Relative housing density	Low	High	High	High	Low	High	High	Medium
Relative location from city centre	Distant	Close	Distant	Medium	Distant	Distant	Medium	Close
Relative distance to tram / subway	Distant	Close	Close	Close	Distant	Close	Close	Distant
Relative location from local sub-centre	Distant	Close	Close	Medium	Close	Close	Close	Medium
Local mix	Low	High	Low	Medium	Low	High	Low	Medium

Our objects of study are also the participants of the Norwegian *Environmental Home Guard* (NEHG)[v]. NEHG is a Green Consumers network established in 1991 and includes 67 000 registered participating households in Norway, representing about 107 000 individuals. It can be characterised as a "new social movement", pointedly referring to itself as a "*dugnad*" (an ad hoc cooperative effort) rather than an "organisation". The purpose of the network's campaign is to mobilize and educate the average citizen and family in the everyday facts of ecological living (NEHG, 2001). The participants initiate their activity by signing off on a checklist of daily tasks or commitments to improve household and community lifestyles in a more ecologically friendly direction. NEHG focuses on two major types of change: 1) A general reduction in the level of consumption; and 2) changes in consumption patterns towards more environmentally friendly alternatives, both with regard to products and services.

The study group within each residential area includes both participants of NEHG and "ordinary" families; enabling us to study to what extent the energy consumption and the extent of every day and leisure transport within these so-called "green households" differ from the overall consumption pattern of the local households. Our sample includes 133 respondents that are members of the NEHG equally spread out on the eight residential areas.

Multiple regression analysis

Our purpose in using multiple regressions is to learn more about the relationship between several independent or predictor variables, and a dependent or criterion variable. In general, multiple regression analysis allows the researcher to ask (and hopefully answer) the question: What is the best predictor of ...? Correlations identified by initial bivariate analysis might not represent real explanatory relationships, since most phenomena result from multiple causes. Multiple regression analysis therefore enables us to integrate the variation in several variables into the same analysis, and isolate the effect of single independent variables or influencing factors. Unimportant factors can then be left out of the overall interpretation of the results.

The dependent variables

Household consumption includes consumption of energy for housing, everyday travel and long-distance leisure-time travel by plane and car.[vi] All data are taken from the questionnaire. Energy use for heating and operating the house includes the use of electricity, paraffin, fuel oil, wood[vii], and remote heating systems. Based on the respondent's best estimate, a yearly consumption is stated.

When filling out the questionnaire, the respondents stated the daily distance travelled by car, bus, tram and train in the preceding week (Monday to Sunday). This estimate is used as a measure for everyday travel. Thus, travel to work, travel to shops, schools and kindergarten, as well as short leisure-time travel on evenings and in the weekends are all defined as everyday travel. Business-related travels are, however, not included. Only those respondents who have reported their travels as being "typical" for an everyday week are included in the analyses.

Finally, the respondents have stated the number of long-distance leisure-time travels by plane and car carried out during the last 12 months to different destination categories.[viii] An average travel length is estimated for each destination. The average travel length is calculated as the distance to the most visited destination within each destination category. All household consumption data are transferred into a yearly energy use per household member.

Energy use per household member for heating and operating the house is measured as the household's total yearly energy use divided by number of household members. Weekly energy use for everyday travel is calculated as the typically distance travelled for private purposes by each modes of transport per week (car, bus, tram, and train) multiplied by a corresponding specific energy coefficient.[ix] Yearly energy use for everyday travel is calculated as weekly energy use multiplied by 47 weeks.[x]

Energy use for long-distance leisure-time travel by car and plane is calculated as the yearly kilometres travelled by each mode multiplied by a corresponding specific energy coefficient. Different energy coefficients are used for domestic and international plane travels. [xi]

The independent variables

Attitudes are measured at different "levels" reflecting whether the attitude is directed towards a higher level of generality (household consumption as a behaviour category) or rather is addressed towards specific items within the category (e.g. everyday travel). At the same time the attitude-levels reflect to what extent social and personal norms are internalised by the individual. A total of four different attitude-levels are identified.

At the highest level of generality of attitudes and internalisation of social and personal norms, membership in *Norway's Environmental Home Guard* (NEHG) has been used as an attitude measure.[xii] As NEHG's participants have voluntarily signed off the organisation's tasks and commitments, they are assumed to have highly positive attitudes towards environmental issues both in general and related to specific consumption practices. They are, through their commitment to the organisation's goals, assumed to have internalised both the social norms from the organisation and the other members. Furthermore, personal norms related to a moral obligation to act in an environmentally responsible way are held to be important.

At the second attitude-level respondents were asked whether they are registered membership in one or more environmental organisations or not. It is assumed that being member of environmental organisations is an expression of a positive attitude towards environmental issues in general. Furthermore, it is assumed that membership is in accordance with a personal norm to comply with the requirements of environmentally responsible behaviour. We do not, however, believe that the expectations from the other members of the organisation – that is the social norms - are as high as for members of the NEHG.

At the last two attitude-levels attitudes are brought into the analysis by way of a Likert scale (Hellevik, 1991).[xiii] Thus, attitudes are based on the respondents' expression of agreement or disagreement with statements (scale items) on household consumption in general and consumption of particular items like energy for housing and transport. To comply with the principle of correspondence between attitudes and behaviour, two different attitude measurements were established. The calculation of *general* attitudes is based on six statements of which all relate to different aspects of household consumption. When calculating the *specific* attitudes, only those statements that particularly concern the household consumption item in question are included. Thus, it has been possible to investigate the relationship between on the one hand household consumption / particular consumption items and on the other hand general versus specific attitudes.

Throughout this paper, reference is often made to a "green" household member when referring to respondents that are members of NEHG or any other environmental organisation. The “green” label is also applied to individuals with a high score on the index-based attitude measurement. Non-members and individuals with low score on the index-based attitude measurement are commonly refereed to as “ordinary” people.

Data regarding *land use characteristic* are divided into two groups. The first group of data is related to physical-structural characteristics of the *house*, including type of housing[xiv], size, age, and access to private garden. These data are taken from the questionnaire. The second group of data is related to physical-structural characteristics of the *residential areas*, including location (distance from the house to the city centre and nearest sub-centre), housing density (number of houses per daa), and local mix (percentage of developed area that are attributed to housing within the residential area). These data are taken from national/local data bases and map sources.

Socio-economic and demographic factors of the household include the respondent’s sex, age, education and income as well as the household’s income, car ownership, and access to private holiday house. Data are taken from the questionnaire.

Household consumption and individual attitudes

Is **there a relationship between attitudes and household consumption?**

Figure 2 shows how household consumption varies between members of NEHG or other environmental organisation and non-members.

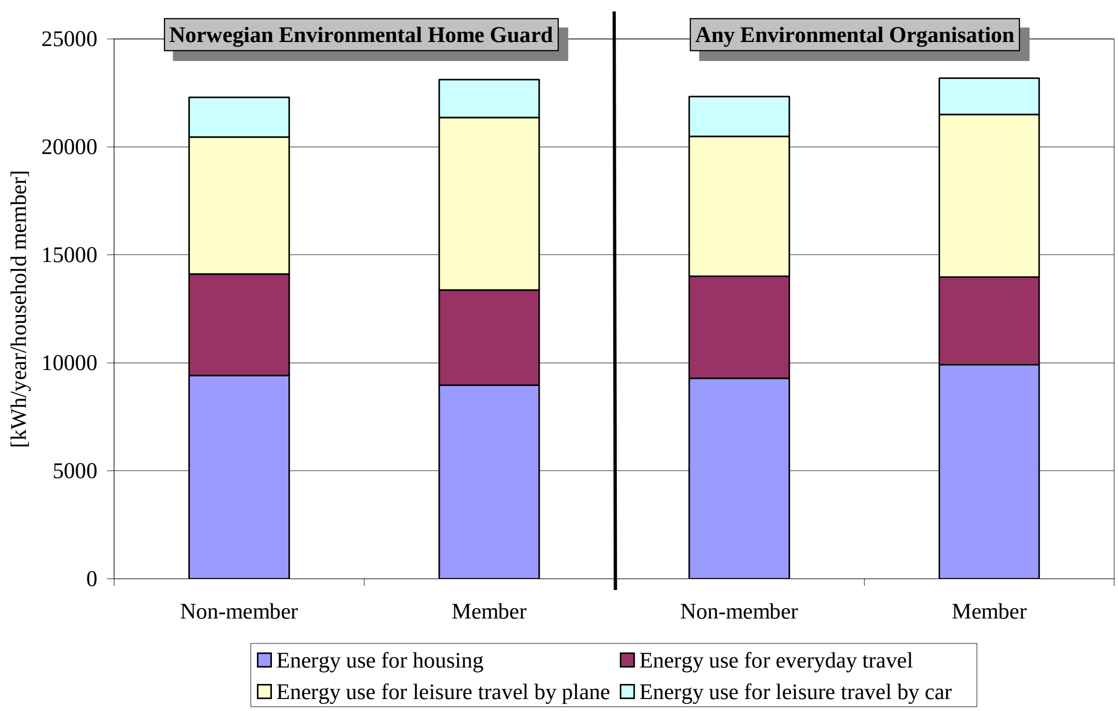

Figure 2: *Household consumption in members of NEHG, other environmental organisation and non-members*. N = 445 (Holden, In Prep.)

The difference in average yearly energy consumption per household member between the four groups is not large. Energy consumption varies with less than five percent between the high- and low-energy groups. Those who are member of an environmental organisation (NEHG or other) have *higher* energy consumption than non-members. This might come as a surprise, considering the NEHG's commitment to the goal at "a general reduction in the level of consumption. It is the frequent and long travels by plane for leisure that causes energy-trouble for the members.

The bivariate correlation analysis confirms the results indicated in Figure 2. First, even though the relationship is not significant, membership and increased household consumption seem to go hand in hand. Second, the relationship between being a member of NEHG or any other environmental organisation and energy use for plane travels is significantly positive. However, members are more likely to behave environmentally responsible on their everyday travels.

The correlation between total household consumption and the index-based attitudes are not significant. However, at least the correlation coefficient is negative, implying that high household energy consumption is correlated with negative attitudes, and visa versa. Furthermore, the index-based measurements of attitude are negatively correlated with everyday household consumption items such as energy for housing and everyday travel. Finally, the correlation between attitude and leisure-time travel is weak and not significant.

Three conclusions can then be made from the bivariate analyses. First, there are small differences in total household consumption between "green" and "ordinary" individuals. To the extent there is a difference, it is not in favour of the green individuals. Namely, the results indicate that green household members use more energy than ordinary ones. Second, having high score on an index-based *attitude* is a better indicator on a low-energy individual than simply being a *member* of an environmental organisation. Third, whereas green individuals are more environmentally responsible in their everyday life, they cast aside their environmental concern when travelling for leisure. To further investigate the relationship between attitudes and household consumption, multiple regressions are needed.

When **is there a relationship between attitudes and household consumption?**

The multiple regression analyses reveal to what extent the above identified correlations are statistically significant[xv] or not. Four regressions have been run for each household consumption category, in order to take into account the influence of the four attitude-levels. [xvi] Very few significant relations, however, were found between attitude and consumption. Even so, some interesting relationships between attitudes and consumption do appear in the material.

First, *specific attitudes* directed towards specific acts are by far the best predictor of sustainable household consumption. Respondents with positive specific attitudes use less energy for housing, everyday travel (significant) and travels by plane. The literature gives theoretical grounds for believing that specific attitudes are negatively related to the specific consumption item in question (Moisander and Uusitalo, 1994; Thøgersen, 1999). *General attitudes* do not, as suggested in the literature (ibid.), seem to be strongly related to any of the specific household consumption items. Thus, our material confirms the fallacy of using general attitudes to explain or predict specific acts.

Second, *membership in NEHG or any other environmental organisation* does not seem to be a good predictor of sustainable household consumption. Rather, our material would suggest the opposite. Membership is positively related to both total household consumption and the specific consumption items (except energy for housing). Particularly, the relationship between being a member of an environmental organisation and the energy used on travels by plane is strong. Thus, the multivariate regression analyses indicate that strongly committed individuals cast aside their green ambitions when travelling for leisure. At least this seems to be the case when travelling by plane.

Third, the two first points above imply that *index-based attitudes* are better predictors for sustainable consumption than attitudes based on membership in an environmental organisation. This is particularly the case when the attitude is directed towards a specific act. Simply speaking, it is more effective to increase people's attitudes towards limited consumption items, than encouraging them to join an environmental organisation.

Forth, *total* household energy consumption is not at all affected by attitudes. However, it should be noted that the analysis implies that green households use more energy on this field than other.

Household consumption and urban structures

In contrast to the above, the multiple regression analyses identify several significant relationships between household consumption of energy and land-use characteristics.

Housing and everyday travels

Energy use for housing is strongly influenced by land use characteristics, and four factors have a significant and isolated effect upon this consumption: type of housing, size and age of the house, and the housing density of the residential area. Large and old single-family houses represent the highest energy use per family member. In high-density areas the energy use for housing is lower than in less developed areas.

We find that two significant land-use characteristics, both related to distance, affect *energy used for everyday travel*. First, it seems that the distance to the city centre is important. The longer the distance, the more energy is used for transport. Second, the distance to the local sub-centre correlates with the extent of everyday travel. Thus, proximity to a centre – with corresponding accessibility to private and public services – is favourable regarding energy use. However, neither density nor local mix has significant effect on the energy used for everyday travel. Density and distance are, however, strongly correlated, but it can be difficult to separate their respective effects. As such, high density and high local mix must be combined with proximity to a centre offering everyday services to bring about a reduction in energy use for everyday travel. Furthermore, a low-educated man with high income uses more energy that a high-educated female with more moderate income. Not surprisingly, having daily access to car and paid work outside the house lead to a higher energy use.

Challenges for "the compact city"

The above results are in line with findings in other studies, both in Norway and internationally (e.g. Næss, 1996; 2005; Holden, 2001; Owens, 1992; Djupskås and Nesbakken, 1995; Aall et al., 2003). Low energy use correlates with high-density housing located a short distance from a centre, and offering a range of private and public services. This is an interesting observation in itself, as confirming findings strengthen our own results. The results support the 'compact city' as a sustainable urban form when energy use is set as the critical factor. Densely and central housing development can provide a reduction in energy use for housing and everyday travels.

Others (e.g. Næss 2005) have indicated that there exist relations also between land-use planning and long leisure-time travels by plane. We have sought to link this consumption to specific physical-structural characteristics.

Long leisure-time travels by plane

The relations between residential area density, everyday travels and plane travels are presented in Figure 3. We see that higher density housing in the residential areas corresponds to higher energy use for travel by plane. At the same time, we identify a reverse correlation between density and the extent of everyday travels. Our study thereby seems to support the above mentioned 'compensatory mechanism hypothesis'. It is possible to identify a relationship between everyday travels and long plane travels in context of density of the residential area.

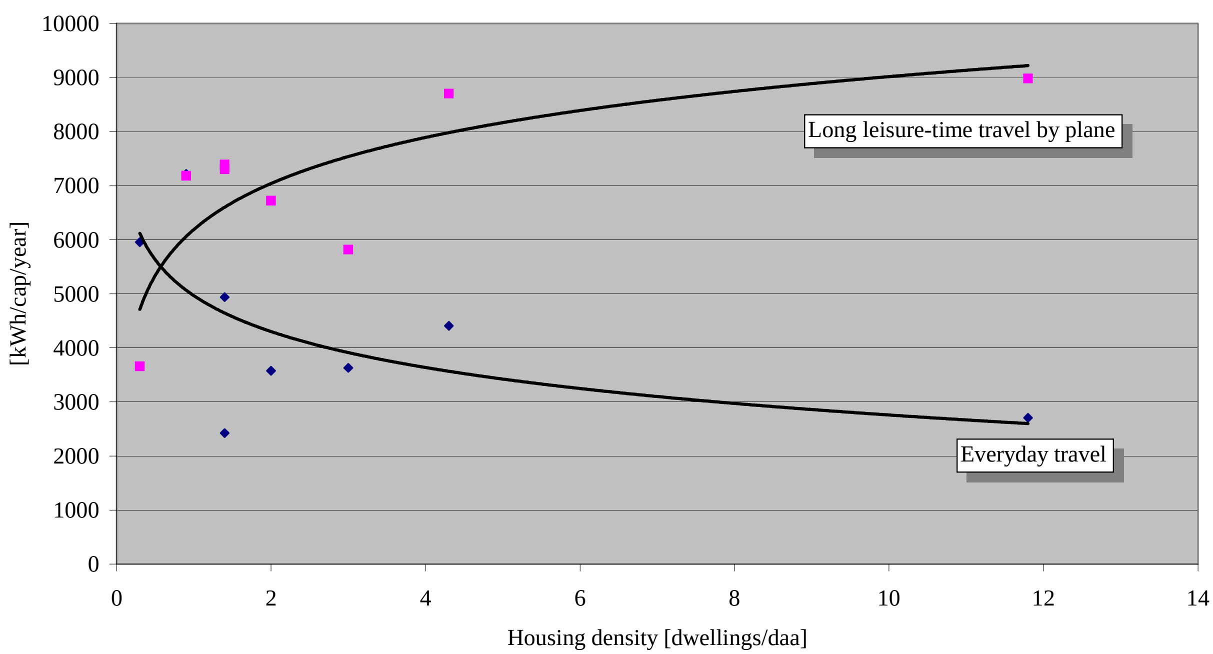

Figure 3: *Energy use for everyday travel/long leisure-time travel by plane and housing density*[xvii] (Holden and Norland, Submitted)

But there could be other possible explanations for this pattern. The residents in the densely developed urban areas might simply use for leisure travel the money they save by using little energy in everyday travel. However, high living expenses characterize these two residential areas (especially Grünerløkka) and the savings might also be used for such expenses. Another possible explanation might be that travel by plane is an integral part of the urban lifestyle of these residents. A more thorough, qualitative oriented analysis is needed to understand the correlation between travel by plane and living in areas of high-density housing. We will, however, state that density seems to have indirect impact, at least, on the extent of plane travels among the inhabitants.

Access to private garden

Another challenge for the compact city theory is the apparent reduction in leisure-time travel when residents have access to a private garden. When relevant socio-economic and attitudinal factors are controlled for, residents having access to a private garden use on average 1,000 fewer kWh annually for long leisure-time travel by car and plane than do residents without such access. Although the differences in yearly energy use for leisure-time travels are not dramatic, they are statistically significant and we find this difference across the different types of housing. The above finding holds even for residents living in flats. In other words, access to a private garden reduces travel by residents of *all* types of housing.

This might not come as a surprise. It is reasonable to expect that they spend time in their garden, both for relaxation and necessary gardening. However, the causal mechanism is not evident - such residents might not travel less *due* to their access to a private garden, but rather they might have a garden because they want to spend time in such an environment. This is an interesting issue for a qualitative follow-up study. Whether such facilities need to be private, or whether collectively shared gardens create the same correlations, are also interesting questions for further investigation.

The important point is that access to a private recreation area seems to relate to a reduction in leisure-time travel. As our findings indicate an importance of available nearby recreation facilities, even in areas of high-density housing, these perspectives should be integrated in discussions on the compact city and densification.

Energy for housing

The yearly energy use for housing differs substantially with the *type of housing*. In our empirical material, the per capita average energy consumption for single-family housing, row houses and multifamily housing is approximately 12,000; 9,000 and 8,000 kWh, respectively. Thus, residents in single-family housing use about 50 percent more energy than residents in multifamily housing.

However, considering housing built after 1980, the picture changes. The difference in per capita energy use between the three types of housing is reduced, as can be seen in Figure 4. The difference in energy consumption between single-family housing and multifamily housing is reduced by 50 percent. This pattern is confirmed in a similar study in the Greater Oslo Region (Holden, 2001; Aall et al., 2003). Thus, there has been a significant reduction in the energy use per capita in single-family housing built after 1980 compared to housing built earlier. We do not find a corresponding reduction in energy use for row houses and multifamily housing. Energy use per square meter in row houses has been reduced by almost 30 kWh annually over the last decades. In the same period, energy use per square meter in multifamily housing has increased.

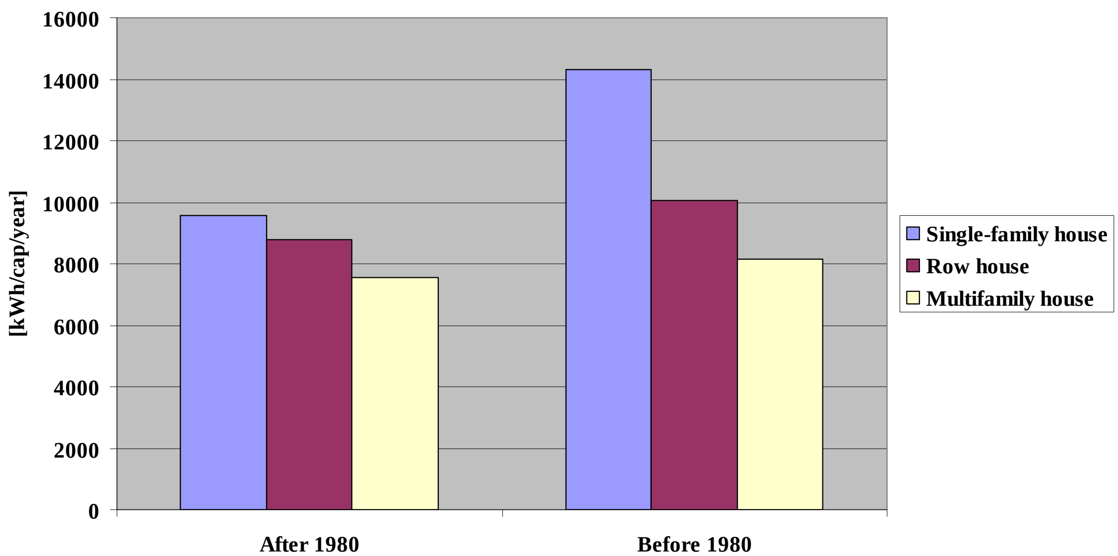

Figure 4: *Annual energy use for housing as a function of housing type and the age of the house*

Three factors might explain this pattern. First, in the last decades there has been, through public information campaigns, increased focus on the reduction of energy use in single-family housing. Households in single-family housing have caught up with more energy efficient households living in multifamily housing by investing in energy saving equipment. Second, recent public regulations on energy use in new buildings (e.g. standards for insulation) have reduced energy use for heating relative to the overall energy consumption for housing. While in older housing energy use for heating accounts for approximately 60-70 percent of total energy use, in new housing it is 50 percent, and even less in 'low-energy housing'. This implies that the importance of housing type is reduced. Finally, household size matters. We found that in single-family housing built after 1980, family size is larger than family size in older single-family housing. This also contributes to lower energy use per household member, which can be seen in Figure 4. At the same time, family size in multifamily housing of all ages is about the same. This tendency cannot necessarily be regarded as a tribute to single-family housing; rather it is a possible consequence of complex socio-demographic tendencies in our society. Even so, it explains some of the apparent harmonization in energy use across all types of housing.

Still, our material shows that living in multifamily housing *is* more favourable than living in single-family housing as far as energy consumption is concerned. If this development continues, this phenomenon might present a challenge to promoters of the densely and concentrated urban form, and the negative characterisation of less dense housing structures in urban areas should be reconsidered. It also indicates a potential for energy savings in the compact housing structures.

Other determinants

Controlling our sample of households for the socio-economic and socio-demographic factors listed in Figure 1, we find a number of other determinants that have substantial and significant effect on household consumption. As seen above, *energy use for housing* is strongly influenced by land use characteristics. Furthermore, there is an economy of scale present in large households as the energy use can be shared among more people. The income of the households is also a significant factor; a high-income household represent a slightly *lower* energy use for housing per family member! There can be several explanations for this. It could be that high-income households buy more energy efficient devices and apparatuses, or it could be related to a higher educational level as this correlates with higher personal income. Concerning *energy used for everyday travel*, a low-educated man with high income uses more energy than a high-educated female with more moderate income. Not surprisingly, having daily access to car and paid work outside the house lead to a higher energy use.

In the leisure time sphere we find a very different picture. In addition to housing density, access to a private garden and membership in an environmental organisation, both age and personal income are found to have a significant effect on *energy use for travel by plane*. Energy use for such travels decrease by a rising age. Young people travel more extensively by plane for leisure. This also holds for high-educated and high-income respondents. As seen above, access to a private garden also influences energy use for *travel by car*. Other determinants are age, education, occupation and access to car and holiday house. Young people, in high-income households with regular access to private car and holiday house are those who travel most by car for leisure.

Finally, a few words about *total* household energy consumption. High-energy using households share four common characteristics: (i) they live in a single-family house; (ii) they have at least one car; (iii) there are few people living in the house; and (iv) the household's income is high. It is important to notice that neither of the attitude variables do influence total household energy consumption.

The multiple regressions analyses give us an overview of the relationship between the different measures of attitude and the households' consumption of energy and transport, when taking into consideration demographic, socio-economic and physical housing situations. Thus, it is important to recognise that the above relationships between e.g. attitudes, density, access to a private garden and travel by plane or car are statistical correlations. This approach is not sufficient for identifying *causal mechanisms* with regard to the variables and the consumption patterns. More in-depth knowledge about the residents' motives and leisure-time preferences is needed to understand these relationships, and can only be obtained by in-depth interviews.

Policy implications

From the point of view of national and local authorities, different strategies and conditions might lead to change in household consumption patterns. Such conditions include: *economic incentives* (e.g. taxes and subsidies), *regulations* (laws and other types of standard), *physical infrastructures* (e.g. the public transport system and urban layout) and *information* (i.e. information campaigns to increase individual awareness and attitudes). These are all conditions that potentially constrain or enable behaviour and subsequently consumption. In the present paper we have focused on the possible effects of the two latter policy perspectives.

The results of the survey in eight residential areas in the Greater Oslo Region indicate that, with respect to the consumption of energy for housing and transport, individual attitudes towards environmental issues have considerably less impact on behaviour than land-use characteristics. The analysis supports the hypothesis that there *is* a connection between land-use characteristics and household consumption of energy and transport: a connection which further implies that planning clearly *does* matter.

The study fails, however, to produce any significant relationship between participation in the "Environmental Home Guard" or with membership in other environmental organisations, and household consumption of energy. The findings indicate to the contrary that members of such organisations appear to represent a higher level of energy consumption than 'ordinary', non-active citizens. It seems that environmentally involved individuals fail to acknowledge (or adjust) the negative environmental consequences caused by air travel (at least in their leisure-time). It also appears that the environmental organisations (such as the NEHG) fail to address the more 'unpleasant' aspects of global environmental problems.

In general the findings indicate that physical structures pose serious barriers for 'green consumerism'. In an earlier study, Holden (2001) registered a feeling of 'powerlessness' and frustration among 'green' families and individuals with regard to their possibility to do the 'right things' in everyday situations. The local transport system is often perceived as an unavoidable and unchangeable structural necessity; e.g. the private car is needed to manage the day's tasks of driving to school/kindergarten, work, shopping, social activities, since the public transport system does not match the individual needs for 'combined' family travel. The findings here also confirm Holden's results with respect to how the choice of housing (single-family, row or multifamily dwellings) also determine to a large extent the energy use for heating and general electricity use in households. The abilities of 'green' families' to significantly reduce the 'in-house' energy consumption, beyond the average usage per type of housing, is not documented in the existing empirical materials. In other words, to a large degree, when the type of house is chosen, the profile of energy consumption is set.

What does this imply then for the possibility of attitude change as a means to change household consumption? The findings indicate that the role of *specific attitudes* directed towards specific acts warrants further study. This attitude factor is the only variable showing any statistically significant relationship with reduced energy consumption (through everyday travels). Such specific attitudes do not, however, evolve in an 'information vacuum'. Environmental organisations and networks could play an important role as providers of information on specific environmental acts and problems.

This clearly points towards a role for information campaigns also by national and local authorities.

Another point is that urban planning policies, as with other policies and measures for the promotion of sustainable consumption, need to be supported by the majority of people to be politically legitimate. Thus consumers are called upon to not only promote sustainable consumption through their daily behaviour, but also – in their capacity as voters – to actively support necessary changes in national policy (Thøgersen, 1999). Furthermore, even in those cases where regulatory measures in one form or another have been implemented, there are almost always degrees of freedom left to the individual consumer. This means that the final outcome depends on individual consumer choice (Thøgersen, 1999).

The above then leads us to a discussion of the implications of the findings for the broader discourse on ideal types of urban organisation and planning. The dispute within the planning literature as to the "compact city" as a particularly sustainable urban model is linked to the possibility of relating empirical findings to urban planning for sustainable development. Empirical findings of the type presented here, in a given city and at given point in time, are not necessarily possible to achieve through futuristic planning (Handy, 1996). Earlier studies (Holden, 2001; Skjeggedal et al., 2003) emphasize that relations between consumption and land-use characteristics might differ considerably from place to place.

Having said this, the question of what constitutes a sustainable urban form is placed in a new light from our findings. While the analysis of energy use for housing and everyday travel supports the idea of the compact city, there are several other issues that have to be confronted. The most important of these is related to travel by plane. The housing density of an area – which strongly correlates with its proximity to the city centre – seems to have opposite effects on energy use for everyday travel and leisure-time travel. While high-density living reduces energy use for everyday travel, the opposite applies to energy use for leisure-time travel. High-density living correlates with increased energy use for travel by plane.

This is clearly illustrated here by the results for Grünerløkka and Vålerenga in Oslo. Living close to the city centre, residents from these neighbourhoods use far less energy for everyday travel than people living in more remote areas like Rykkinn and Bjørndal. But they use much more energy for travel by plane. This is not to say that high density *causes* travel by plane. We do not suggest that living in a densely developed residential area triggers an immediate need to buy a plane ticket. Rather, the relationship seems to be that high energy use for travel by plane by residents of these areas is a *possible long-term* indirect effect of high-density living.

The findings could also be interpreted as a reminder of key characteristics of the *sustainable* compact city, beyond increased urban density. Access to a variety of public and private services in connection to residential areas have impact on the extent of everyday travels. This requires an active public planning practice. Also, better public regulation of energy use in new multifamily buildings could contribute to a reduction in energy use for housing even further.

Additionally, the expectations of a reduction in everyday travels in the compact city rely on a parallel development of public-transport services. Experiences from the Environmental City Programme in Norway[xviii] show that cities easily integrate perspectives on high density in their land-use planning, but that they nonetheless fail to develop a more environmentally friendly transport system (MoE, 2000). Thus most of the potential for reducing everyday travel is lost.

All in all, the results seem to indicate a certain *limit for densification*. Total energy use decreases as density approaches a certain point, but beyond that point the total energy use appears to increase. This is similar to a pattern in the relationship between energy use and *city size* found by a number of empirical studies of cities in Norway, Sweden and England (Næss, 1997; Holden, 2004). In this light, it is relevant to discuss the general role and impact of outdoor recreation areas in central urban areas, as well as the specific types of housing in relation to such areas that might contribute to more sustainable urban consumption patterns. The posited advantages of 'mega-cities' or 'extreme-density areas' with respect to sustainable energy consumption through travel seem to be outweighed by the advantages offered by more modest forms of urban compactness.

References

Aall, C., Holden, E. and Høyer , K.G. (2003) *Bustad, forbruk og økologiske fotavtrykk (Housing, consumption and ecological footprints)*, Report 16/2003, Sogndal: Western Norway Research Institute.

Aall. C. and Norland, I. T. (2002) *Det økologiske fotavtrykket for Oslo kommune (The ecological footprint of Oslo municipality)*, Report 1/02, Oslo: ProSus/University of Oslo.

Boarnet, M. G. and Crane, R. (2001) *Travel by design. The influence of urban form on travel*, New York: Oxford University Press.

Breheny, M. (1996) Centrists, Decentrists and Compromisers: Views on the Future of Urban Form, in Jenks, M., Burton, E. and Williams, K. (Eds.) *The Compact City. A Sustainable Urban Form?*, London: E & FN Spon.

CEC (1990) *Green Paper on the Urban Environment*, Commission of the European Communities, Brussels: European Commission.

Djupskås, O. T. and Nesbakken, R. (1995) *Energibruk i husholdningene 1993 (Energy Use in Households 1993)*, SSB Report 95/10, Oslo: Statistics Norway.

Handy, S. (1996) Methodologies for exploring the link between urban form and travel behaviour, *Transpn Res. – D* 1(2), s. 151-165.

Elkin, T., McLaren, D. and Hillman, M. (1991) *Reviving the City: Towards Sustainable Urban Development*, London: Friends of the Earth.

Enwicht, D. (1992) *Towards an Eco-City: Calming the Traffic*, Sydney: Envirobook.

Fazio, R. H. ans Zanna, M. P. (1981) Direct experience and attitude-behaviour consistency, in Berkowitz, L. (Ed.) *Advances in Experimental Social Psychology*, Vol. 14, New York: Academic Press.

Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention, and Behaviour*. Reading, MA: Addison-Wesley.

Hellevik, O. (1991) *Forskningsmetode i sosiologi og statsvitenskap* (Reserch Method in Sosiology and Political Science), Oslo: Scandinavian University Press.

Hille, J. (1995) *Sustainable Norway*, Oslo: The Project for an Alternative Future.

Holden, E. (In Prep.): *When and how can green attitudes direct sustainable household consumption?*, In Preparation.

Holden, E. (2004) Ecological Footprints and Sustainable Urban Form, *Journal of Housing and the Built Environment*, 19 (1), pp. 91-109.

Holden, E. (2001) *Boligen som grunnlag for bærekraftig forbruk (Housing as basis for a sustainable consumption)*, Dr.ing. thesis 2001:115, Trondheim: Norwegian University of Science and Technology.

Holden, E. og Norland, I. T. (submitted) Three Challenges for the Compakt City as a Sustainable Urban Form – Household consumption of energy and transport in eight residential areasin the Greater Oslo Region. Submitted to *Urban Studies*.

Holden, E. og Norland, I. T. (2004) *SusHomes – En undersøkelse av husholdningers forbruk av energi til bolig og tranprort i Stor-Oslo. Dokumentasjonsrapport*. ProSus-report no.3/04, Oslo: ProSus/University of Oslo.

Jacobs, J. (1961) *The Death and Life of Great American Cities. The Failure of Town Planning*, New York: Random House.

Lorek, S and Spangenberg, J. H. (2001) Indicators for environmentally sustainable household consumption, *Int. J. Sustainable Development*, 1 (4), pp. 101-120.

McLaren, D. (1992) Compact or dispersed? Dilution is no solution, *Built Environment*, 18 (4), pp. 268-84.

MoE (2002) *Bedre miljø i byer og tettsteder (A better environment in cities and towns)*, Parliamentary White Paper no. 23 (2001-2002), Oslo: Ministry of Environment.

MoE (2000) *Utvikling av miljøbyer. Erfaringer og anbefalinger fra Miljøbyprogrammet. (The Development of Green Cities. Experiences and recommendations from the Green City Programme).* Main report. T-1320, Oslo: Ministry of Environment.

Moisander, J. and Uusitalo, L. (1994) Attitude-behaviour inconsistency: Limitations of the reasoned action approach in predicting behavior from proenvironmental attitudes, in Antonides, G. & Raaij, W. F. v. (Eds.) *IAREP/SABE Conference*, Rotterdam, July 10-13.

National Consumer Agency of Denmark (1996) *Miljøbelastningen ved familiens aktiviteter (The environmental impact from households)*, Report 1996:1, København: Forbrukerstyrelsen.

NEGH (2001) *Plattform for Grønn Hverdags forbrukerveiledning. (Platform for the Norwegian Environmental Home Guard's consumer guidance.)* Adopted by the NEHG Board, January 2001.

Newman, P. and Kenworthy, J. (2000) Sustainable Urban Form: The Big Picture, in Williams, K., Burton, E. and Jenks, M. (Eds.) *Achieving Sustainable Urban Form*, London: E & FN Spon.

Næss, P. (1996) *Urban Form and Energy Use for Transport. A Nordic Experience*, Dr.ing. thesis 1996:20, Trondheim: The Norwegian Institute of Technology.

Næss, P. (1997) *Fysisk planlegging og energibruk (Physical Planning and Energy Use)*, Oslo: Tano Aschehoug.

Næss, P. (2005) Residential Location Affects Travel Behavior – But How and Why? The case of Copanhagen Metropolitan Area, *Progress in Planning*, 1 (63), (forthcoming).

Owens, S. (1992) Energy, Environmental Sustainability and Land Use Planning, in Breheny, M. J. (Ed.) *Sustainable Development and Urban Form*, London: Pion Limited.

Pieters, R. (1988). Attitude-behavior relationships, in W. F. v. Raaij, G. M. v. Veldhoven, & K.-E. Wärneryd (Eds.) *Handbook of economic psychology*, Dordrecht: Kluwer Academic Publishers.

Scherlock, H. (1991) *Cities are Good for Us*, London: Paladin.

Skjeggedal, T., Nordtug, J., Wollan, G. and Ystad, D. (2003) Fortettingsrealisme (The realism of Densification), *Plan*, 6.

Thøgersen, J. (1999) *Making ends meet. A synthesis of results and implications of a research programme*, Working Paper No. 99-1, Aarhus: Aarhus School of Business.

Titheridge, H., Hall, S. and Banister, D. (2000) Assessing the Sustainablity of Urban Development Policies, in Williams, K., Burton, E. and Jenks, M. (Eds.) *Achieving Sustainable Urban Form*, London: E & FN Spon.

Vallacher, R. R. and Wegner, D. M. (1987) What do people think they're doing? Action identification and human behaviour, *Psychological Review*, 94, pp. 3-15.

Vilhelmson, B (1990) *Vår dagliga rørlighet. Om resandes utveckling, førdelning och gränser (Our daily mobility. On the development, distribution and limits of travelling)*, TFB report 1990:16, Stockholm: The Swedish Transport Board.

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(1) The environmental impact is here measured in terms of the ecological footprint (Aall and Norland, 2002), which is a tool for providing environmental impact assessments, and which collates a broad spectrum of environmental consequences caused by the consumption of three groups of resources: energy, material and land. Lorek and Spangenberg (2001) showed that environmental problems in Europe are all – except for those caused by high toxicity of small volumes of substances – correlated to the consumption of these three groups of resources.
(2) Food is best treated separately, as it requires different methodological approaches and discussions.
(3) The SusHomes project is part of the research programme SusLink at the Programme for Research and Documentation for a Sustainable Society (ProSus) at the Centre for Development and the Environment (SUM), University of Oslo. More detailed information on the programme is available at: http://www.prosus.uio.no.
(4) 'Row housing' includes semi-detached houses. 'Multifamily housing' includes all kinds of blocks of flats.
(5) http://www.gronnhverdag.no/
(6) Energy use correlates with a large number of different environmental issues (e.g. emissions of greenhouse gases, substances that causes health problems and damaging buildings, and emissions that causes acidification), and is therefore a good indicator of environmental demands.

(7) Wood consumption represents a particular problem when calculating energy use in the household. A number of studies have shown that it is difficult to get a precise estimate of the amount of wood that a household actually consume during a year. A qualitative estimate of what consider a “reasonable” figure is therefore used, implying that a small number of households were taken out from the analyses.

(8) Long leisure travels by car is defines as travels longer that 100 km one way. Destination categories for car travels are: Three different parts of Norway, the Nordic countries, Northern Europe, and Southern Europe. Destination categories for plane travels are: Three different parts of Norway, the Nordic countries, Europe and countries outside Europe

(9) Different coefficients are used for travels between Monday to Friday and in the weekend respectively. All coefficients are given in Holden and Norland (2004).

(10) Excluding five weeks for holiday each year.

(11) Coefficients are given in Holden and Norland (2004).

(12) The EHG has taken its name from the existing Home Guard – Heimevernet in Norwegian ("National Guard" in American) – and is, to a certain extent, based on the same principles. Participants are expected to perform their tasks wherever they live, within their family, neighbourhood or local community. Everyone takes responsibility for theirs immediate environment, and everyone is "armed". As consumers, club members and employees we have the "weapons" needed to defend the environment against damage.

(13) In the Likert scale the results are controlled for so-called ‘fixed response sets’: studies have identified that respondents have a tendency to respond solely positive/negative to all questions, regardless of their content (Hellevik, 1991). A weakness of the Likert scale approach, however, is that the statements could be difficult to characterize as solely positive or negative in relation to the overall attitude under consideration (Hellevik, 1991). In our case the given values are based on our own evaluations. Therefore the correlations based on the index have to be interpreted with some caution. Despite this, we find the index useful due to its simple and illustrative presentation of the respondents’ attitudes.

(14) Types of housing include: single-family house, row house and multifamily house.

(15) Statistically significant at the 5% significant level

(16) Further details of the analysis models and the data for single variables can be found in Holden and Norland (2004).

(17) Long leisure-time travel by plane: Logarithmic curve estimation regression model, y=1228 Ln(x)+6190, R2=0,639. Everyday travel: Logarithmic curve estimation regression model, y=-959 Ln(x)+4966, R2=0,412

(18) Miljøbyprogrammet (1993-2000), run by the Ministry of Environment.

The Environmental Benefit of Car-free Housing: A Case in Vienna

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Abstract

A case-control study of the car-free model housing project in Vienna was conducted to evaluate whether people living in this settlement have more sustainable lifestyles than people living in comparable buildings in Vienna. The purpose was further to find out what lifestyle aspects make a difference in the environmental impact of the households and to test the study methods, i.e. the use of Household Environmental Impact (HEI) assessment based on household interviews, and without conducting a full consumer expenditure survey. Car-free households have substantially lower environmental impacts in the categories of ground transportation and energy use; their CO_2 emissions of these two categories are less than 50% of those of the reference settlement. Both samples are close to the Autrian average in air transport. The car-free households have slightligh higer incomes than the reference households and thus higher emissions in the other consumption categories. As a result, the per-capita CO2 emissions are only slightly lower than in the reference settlement, but the per-€ emissions are about 20% less.

1 INTRODUCTION

Consumers can contribute to sustainable development and hence also to the reduction of greenhouse gas emissions on two levels: (1) They can systematically choose the more environmentally friendly of functionally similar products and services, and (2) they can prioritize activities which cause less pollution and hence develop more sustainable consumption patterns. This study investigates differences in the patterns of consumption between two settlements that are hypothesized to have different consumption patterns. One settlement has been advertised as “car-free”; the tenants are contractually bound to not own a car and instead have the option to participate in a car-sharing scheme. The other settlement, in close proximity and of similar age as the first, is also a theme-settlement with the title “women’s workshop”. Car ownership influences the pattern in which people organize their lives, both daily life with routines such as how to do shopping, where and how to bring kids to, and how to get to work; and leisure activities. It was expected that the car-free housing project also attracted more environmentally conscious tenants, since it was advertised as “car-free” and as having green features such as roof-top gardens, ponds (“biotopes”), and solar hot water collectors. The research question is whether these two groups of households have systematically different consumption patterns. Is there a measurable difference in environmental impact? How can this difference be explained? We also compare the households from the case studies to the average Austrian resident (household), based on data from the last consumer expenditure survey (Klotz 2002).

2 RESEARCH DESIGN

The project is designed to capture key socio-economic characteristics of households, environmental motivation, and household environmental impacts (HEI). The research was conducted in the following phases:

1. Analysis of the household environmental impacts of the average Austrian household, based on data available from the 2000 Consumer Expenditure Survey (CES). Selection of activity categories and variables which are important for the overall HEI and hence should be collected from the households.
2. A quantitative survey of households in the two settlements, plus supplementary interviews, e.g. with the building management.
3. Analysis of the data.
4. Qualitative interviews with selected households to investigate motivations for environmentally interesting behaviour.

The challenging part of implementing this research design is to collect data sufficient in quantity and quality to allow a representative analysis of the buildings. Evaluations of HEI are often based on consumer expenditure surveys (CES) collected by statistical offices. These detailed surveys require that respondents record all their expenditures over a 2-4 week period in a dairy and are followed by an extensive interview about larger purchases such as cars and holidays. Such a survey is hence connected with substantial effort and costs. Recordings from a single household are not seen as representative for that household, but only for the period that was recorded, so that artificial households are assembled of different surveys covering an entire year.

We have hence developed an approach for estimating the household environmental impact based on data obtained in a one-hour interview with the household, including getting access to utility bills. This approach and the corresponding survey make systematic use of existing data, such as building characteristics and data about the building, and the Austrian CES for estimating the composition of residual expenditures not covered in the survey.

The survey systematically covers appliance ownership, ownership of cars and real estate, energy use and transportation. In addition, expenditure for food and hotels and restaurants are recorded.

The survey of the car-free housing project was conducted in the summer of 2004. It was substantially more difficult to find individuals who were willing to respond to the survey that we had anticipated. 42 households were surveyed, of 244 in the settlement. The sample was a sample of convenience. Given this experience, the survey was slightly simplified for the use in the reference settlement. This survey was conducted in the “women’s workshop” housing project. The second sample consists of 46 households.

3 TWO SETTLEMENTS IN COMPARISON

Both samples show a very similar socio-economic structure. The households in both groups are of similar size, the available living space is of similar dimension, and the level of education of respondents in both settlements is far above the Viennese average. Due to the fact that both settlements are relatively new and located in the same district of Vienna it is not astonishing that the selected settlements are inhabited by people with similar socio-cultural background. We observe rather homogenous social milieus.

In both settlements – in the car-free and the reference project – the average size of households is above the Viennese average. Although large volume housing projects at the periphery typically attract young families this is only partly true for our cases. In the car-free settlement as well as in the reference project nearly every second household is childless. Every fourth household in the car-free project is a single household. Just as many households are inhabited by only two persons. All in all there are slightly more large families and in total more children in the reference settlement than in the car-free project. Nevertheless, there are fewer singles and more families with children than average in Vienna.

Respondents in both samples are much better educated than the Viennese population. Especially in the car-free settlement with nearly 50 % there is an extremely high percentage of people with a university degree. The concept of the project – to organize mobility without private car – was obviously attractive for persons with high formal qualifications in particular. According to the high level of education people in both settlements are working in well paid white-collar jobs. Males could be often

found in trendsetting industries like IT or in the educational sector, e.g. as scholars at the university. Many of the female occupants are working as school teachers, in the consultation service or in the health care system.
Given the high percentage of well educated persons in both samples it is notable that the average family income in the selected settlements is only a little bit above the Viennese average. In relation to the number of persons per household it is even clearly below this reference. Moreover, both samples contain both high and low-income households. Families with very different financial resources are living next to each other.
The size of the flats ranges between 50 and 130 sqm. The average size in the car-free project is 86 sqm, compared to 82.6 sqm in the reference project. Similar to the financial situation of the households in both projects flats are larger compared to the Viennese-wide average (70 sqm), per capita the living space is below average. In the car-free settlement there are on average 33.5 sqm living space available per person, compared to 30 sqm in the reference settlement. In other words the average "consumption" of living space in the reference project is 10 % below the car-free and even 20 % below the Viennese standard.

	Car-free project	Reference settlement	Vienna
Size of household			
average size of household	2.57	2.76	1.96
average number of children per household	0.67	0.91	0.55
Occupation			
white-collar worker	52.40%	52.20%	
blue-collar worker	8.70%	2.50%	
civil servant	14.30%	6.50%	
self-employed	2.40%	4.30%	
retired	11.90%	6.50%	
in-training	7.10%	8.70%	
unemployed	4.80%	4.30%	
Education			
secondary school	7.20%	8.70%	33.24%
vocational school	4.80%	15.20%	28.60%
technical school	4.80%	10.90%	10.56%
A-levels	38.10%	39.10%	15.76%
university degree	45.20%	23.90%	11.84%
Average annual net income (Euro)	32 282	30 867	28 320
minimum (Euro)	9 100	7 000	
maximum (Euro)	72 800	75 000	
Average annual net income per capita (Euro)	12 560	11 180	19 720
Average size of flat (sqm)	86.00	82.60	70.90
minimum (sqm)	50	47	
maximum (sqm)	130	107	
Average size per person (sqm)	33.50	30.00	36.20

Table 1: Some general information

Equipment ownership is slightly higher in the reference settlement, except for TV-sets. There are only a few cloth-dryers (9.5 % and 6.5 %). Most households own one or more computers, and about 75 % have a connection to the internet. In the car-free settlement, only one of the 42 households owned a car; in the reference settlement, 67 % of the households owned a car, 11 % even more than one. In both settlements almost everybody owns a bike.

As expected the results for mobility show significant differences between the two settlements. Car-free households use public transport, whereas for the reference-households the car is the most important means of transportation. Car-free households have slightly more air trips and larger distances than the reference group. However, the overall mileage of the average car-free household – covered by car, train, and airplane – was clearly below the reference group. While car-free households have covered an average distance of about 9400 km, reference households have spent more than 17000 km.
In the car-free settlement cars are playing indeed a very limited role to meet private transport needs – therefore residents cope well with aim and label of the project. Six of ten car-free households did not use a car in 2003 at all. Only one out of 42 households there is a privately owned car available. This household alone is responsible for more that 60 % of total mileage in the car-free settlement sample. The remaining mileage was covered with car-sharing or rental cars. The most important reason to use a car is to do a bigger purchase, e.g. people use a car to carry furniture. The situation is quite different in the reference project. Most of these households own at least one private car which is the major means of mobility of the family. On average each household in the reference settlement covers a distance of 11000 km per year. The value in the car free settlement is with about 570 km extremely low.

Selected types of transport	Car-free project	Reference settlement
Car		
households with 0 km in 2003	59.5 %	27.3 %
fraction of km with car-sharing	35 %	0.8 %
Average distance per household in 2003 (km)		
by car	566	10 979
by train	1 848	124
by airplane	6 948	6 237
total distance by car, train, airplane per household (km)	9 362	17 340

Table 2: Selected information on transport. This does not include commuting by public transit or walking/biking.

4 HOUSEHOLD ENVIRONMENTAL IMPACT CALCULATIONS

Household environmental impact assessment has been pioneered in the field of energy analysis with the calculation of embodied and direct energy use by different household groups. The first analyses of this type by Herendeen and colleagues (Bullard III and Herendeen 1975; Herendeen 1978; Herendeen and Tanaka 1976) already combined energy input-output analysis to estimate the energy use for the products and services consumed by a household with data on the consumption of different energy carriers by the households themselves. Today, this type of analysis also takes into account emissions and potentially resource use and material flows beyond energy. For a review of the literature, see (Hertwich 2004). The objective of this type of analysis is to quantify the contribution of different household activities or demand classes, such as food, clothing, transportation and dwellings, to the overall household environmental impact (HEI).
In this study, we started by analysing the household environmental impact of the average Austrian, using the input-output tables (Kolleritsch 2004), the environmental accounts (Eurostat 2001), and data from the 1999/2000 consumer expenditure survey (CES) (Klotz 2002). We found that transportation

and energy use in households are the most important contributors to greenhouse gas emissions. Direct energy use and transportation are usually not or only incompletely represented in input-output analyses, so we decided to use life-cycle assessment (LCA) data to model these impacts.

Input-Output Analysis

Emissions intensities of commodities in basic prices were calculated following the standard equation

$$M = F\left(I - A\right)^{-1}$$

Where A is the input-output coefficients in commodity-commodity formulation calculated from make and use tables using the industry-technology assumption. The input-output coefficients include both domestic and imported products $A=A^d+A^i$ (Peters and Hertwich 2004). The coefficients include domestic and imported products, where imports are treated as if they were produced domestically. F is the emissions or resource use per unit commodity produced. Emissions and resource use per industry sector are allocated to commodities using the normalized make table, i.e. reflecting the industry-technology assumption.

The emissions intensities of different commodities in purchaser prices were calculated from those in basic prices using tables on the trade and transport margins, taxes and subsidies for the different products. The tables include information on which sectors produce the different margins, so that the emissions connected to trade and transport are included in the emissions intensities of the commodities.

Life-Cycle Analysis

We use data from the Eco-Invent database (Ecoinvent 2004) where appropriate data is available, that is for electricity, train, overland bus, and airplane. For green electricity, we use a Swiss wind power plants. For car transport, all data is based on the LCA of a VW Golf A4 (Schweimer and Levin 1999). Data relating to producing and maintaining the car was captured in a per-km component. This assumes that all cars cause about as much pollution to produce and maintain as the Golf A4. The fuel-related and direct emissions were captured in a per-liter component. Emissions for district heating were obtained from the utility (Wallisch 2004) and include only direct emissions; not emissions connected to building the infrastructure. Emissions from using the cities public transport system was calculated from the energy use of the transport system (Wiener Linien 2004), passenger number, and appropriate emissions coefficients for the natural gas driven buses (Beer et al. 2000).

5 COMPARISON OF IMPACTS

Table 3 presents the average per capita direct and indirect emissions in Austria as obtained from the input-output calculations. It was later found that this assessment did not include direct emissions from transport, which are on the order of 0.6 t CO_2/person. In addition, emissions of “bunker fuels” in air traffic equivalent to 1.2 t CO_2/person are also omitted in Table 3.

Emissions	Indirect								Direct	Total
Areas of consumption	Energy	Shelter	Food	Cloth-ing	Care	Mobil-ity	Recre-ation	Other		
CO_2 [t]	0.84	0.57	0.45	0.21	0.10	0.90	0.51	0.42	1.29	5.30
NO_x [kg]	1.23	1.56	2.41	0.64	0.37	4.36	1.79	1.23	1.70	15.27
COD [kg]	0.19	0.75	1.26	0.67	0.34	0.60	1.65	1.90	7.33	14.70
AOX [g]	0.47	1.90	2.09	1.41	2.28	1.59	2.94	3.98	2.93	19.60
Toxic waste[kg]	16.15	9.23	7.10	4.55	1.46	10.07	8.99	11.42	12.64	81.60

Energy [GJ]	3.35	7.04	8.14	4.41	1.57	7.61	7.16	7.13	51.25	97.66

Table 3: Distribution of HEI according to the input-output calculation

The evaluation of emissions of the two settlements in Table 4 indicates that in some categories, the car-free settlement has lower per capita environmental impacts, while in other categories the reference settlement is better. The difference is never more than 20 %. For all indicators, the average Austrian household has higher impacts, and it also has higher expenditures. Please note that the numbers for toxic waste generation and energy use are somewhat more uncertain than the other numbers. The data for primary energy use for the energy and transport categories was estimated. The assessment of toxic waste was based only on the IO table. Because of uncertainties in the emissions factors used in connection with the IOA and the data in the underlying LCA, the emissions estimates for halogenated organic compounds (AOX), chemical oxygen demand (COD), and NOx are more uncertain than those for CO_2, which can be calculated quite accurately from a carbon balance.

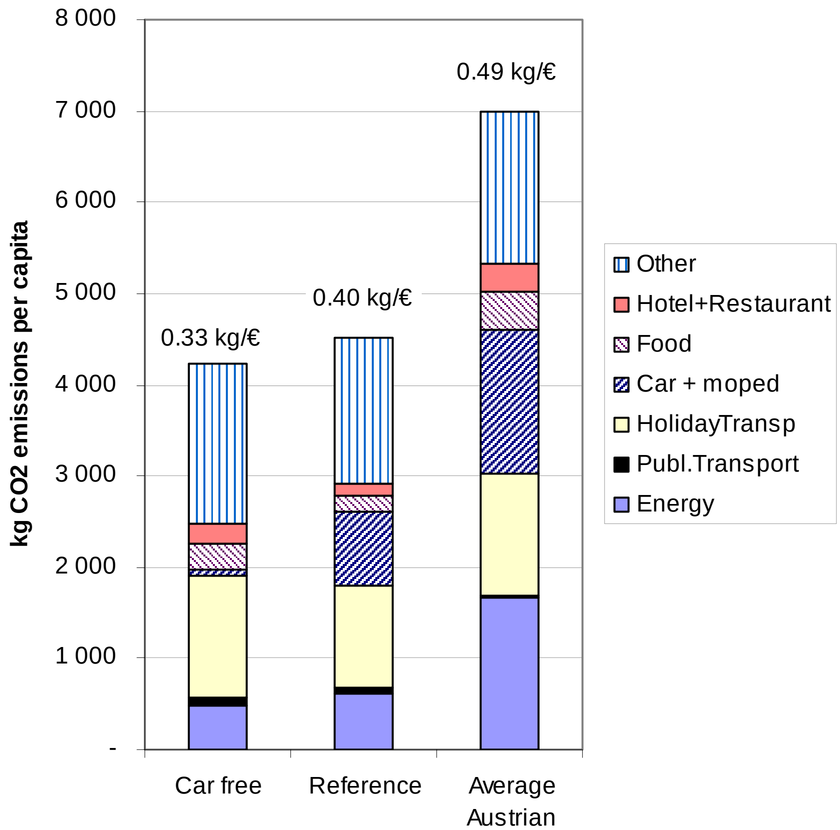

Fig. 1: Per capita CO2 emissions of the two settlements in comparison with the average Austrian.

	CO_2 [t]	NO_x [kg]	COD [kg]	AOX [g]	Toxic waste[kg]	Energy [GJ]	Expenditure [k€]
Car-free	4.2	14	10	15	61	75	12.7
Reference	4.5	13	9	13	54	80	11.2
Average	7.0	16	11	16	72	101	14.3

Table 4: Comparison of per capita household environmental impact and expenditure between the two settlements and the average Austrian.

We put most effort into understanding the CO_2 emissions, because global warming is probably the most important impact connected to household consumption. Fig. 1 shows a comparison of the two settlements and the Austrian average using the categories we have distinguished in our calculations. The households in the car-free settlement have lower CO_2 emissions. The difference is even larger when one looks at CO_2 emissions per Euro spent. Households in the car-free settlement have a somewhat lower share of transportation (35 %, versus 44 % for the reference settlement and 42 % for the average Austrian household). In the car-free housing project, the emissions associated with energy are 25 % lower than in the reference settlement, because there households use 30 % less electricity and have more subscribers of green electricity, which causes only 10 % of the emissions of the grid-average. The emissions related to energy are much lower in the two Viennese settlements than in Austria on average. This is related to the use of district heating for heating and hot water. Since waste incineration, an important heat source in Vienna, is treated as "carbon neutral," the CO_2 emissions are much lower than those from oil and natural gas combustion, the most important heating fuels in suburban and rural areas.

6 DISCUSSION

The study shows that the two reference settlements are indeed fairly similar. This was of course part of the study design. The aspect in which they differ is the car-free feature. It was our hypothesis that this would extend to other areas of behaviour as well. Although tenants in the car-free settlement show environmental awareness on a much higher level, ecological sound behaviour is more or less restricted to every day transport (extensive use of bicycles and public transport for daily needs), and does not apply, e.g. for air trips. Since we did not find a difference in the consumption of organic food, which was high in both settlements, we did not further investigate behaviour not related to energy use and transportation. The overall differences between the settlements in CO_2 emissions and energy use are small, and much lower than the variations inside the settlements. This may come as a surprise, but this result is not that difficult to explain.

- For the car-free settlement, 53 % of the emissions are estimated from the IOA, i.e. it belongs to the categories food, hotels and restaurants, and 'other.' To estimate the 'other' emissions, we just used a typical expenditure pattern as derived from the consumer expenditure survey. Any systematic variation in these expenditures is not covered by our assessment. In the categories assessed by LCA, the reference settlement had 33 % higher CO_2 emissions per capita than the car-free settlement.
- The rebound effect is important (Hertwich 2005). It is assumed here that everybody spends their income; any money saved by not owning a car goes to some other purpose. The "other" category has only 14 % of the emissions intensity of cars (Table 5), but this is more than 0. If the money saved is spent on air transport, much higher emissions can result. As far as we could determine, these households eat out more and have a higher consumption in the 'other' category.
- For the car-free settlement, air transport accounts for 64 % of the CO_2 emissions associated with energy and transport. For the reference settlement, this number is only 43 %. The per capita CO_2 emissions of energy and transport not considering air transport are 720 kg in the car-free settlement and 1500 kg in the reference settlement. The car-free settlement has a lower emissions intensity in holiday transport, because of the use of trains and buses. This is not because the households do not use airplanes; in fact they travel slightly more by airplane than the reference settlement.

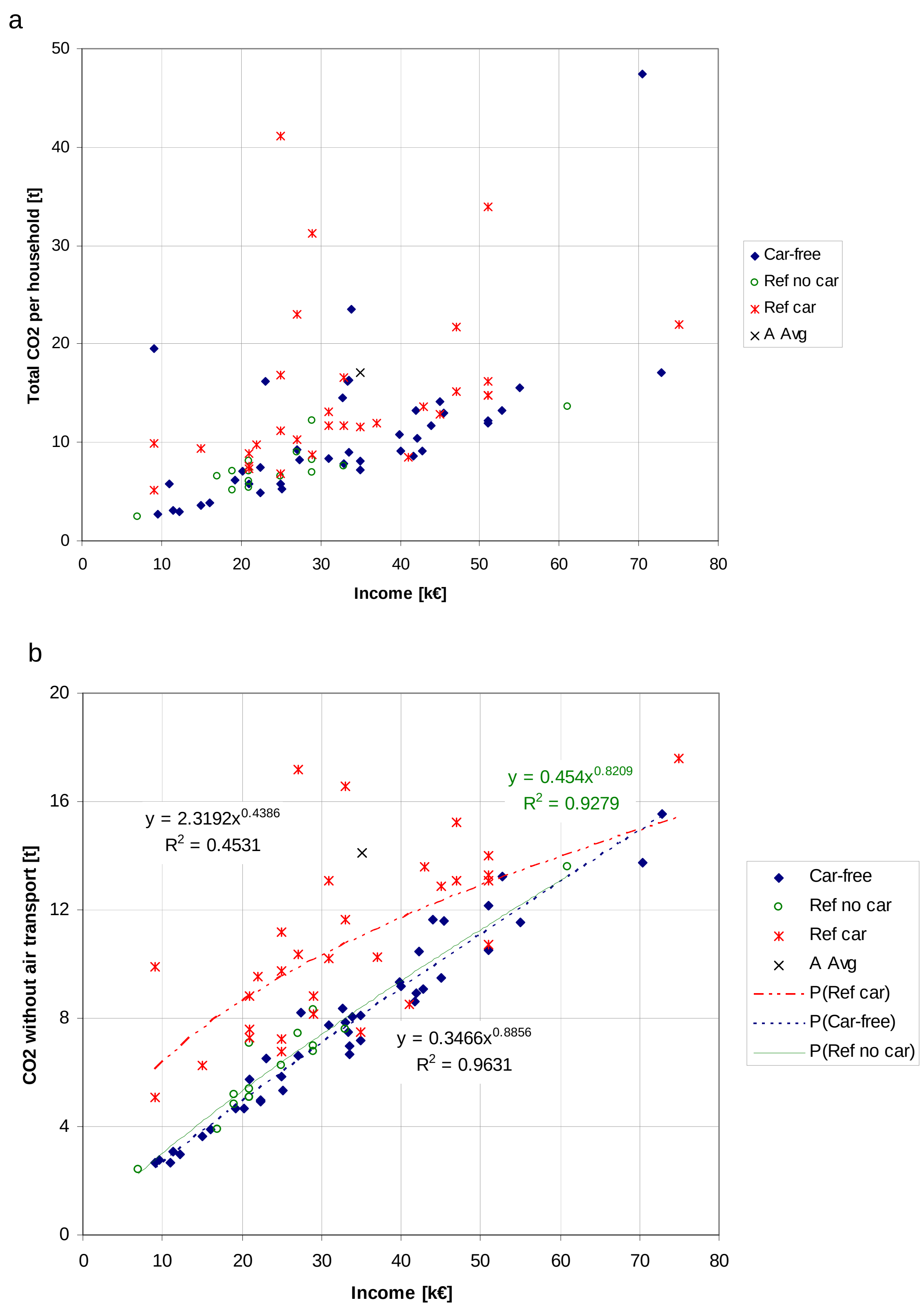

Fig. 2: Total CO2 emissions per household, (a) with and (b) without air transport, as a function of household income. For the reference settlement, we distinguish between households with and without cars.

	Energy	Public Transport	Holiday Transport	Car moped	Food	Hotel Restaurant	Other	Total Average
Car-free	0.96	0.35	4.50	0.54	0.24	0.18	0.19	0.33
Reference	1.50	0.47	7.37	1.45	0.24	0.18	0.19	0.40
Average	3.08	0.40	6.52	1.49	0.24	0.18	0.19	0.49

Table 5: CO_2 emissions intensity in kg CO_2/€.

Past investigations of energy use and of CO2 emission of household based on CES have shown that both variables are a strong function of income (Herendeen 1978; Herendeen and Tanaka 1976; Wier et al. 2001). Income elasticities of energy use are commonly between 0.6 and 0.9 (Hertwich 2004). This result may to a certain degree be a modelling artefact, because indirect energy use and emissions were mostly determined with IOA and are hence naturally correlated with the expenditure level. Environmental differences between e.g. buying on luxury car or two inexpensive family cars at the same cost cannot be distinguished. Similarly, spending more money on buying organic food results in higher impacts compared to buying the same products from conventional consumption. This problem of course also affects our study. The relationship between CO2 emissions and household environmental impacts still provides some interesting insights.
Figure 2a indicates that in our two samples, there is a fairly wide scatter of CO2 emissions especially for higher income. The situation changes when we subtract out air transport, as Figure 2 b shows. There is a high correlation between income and CO2 emissions for the two groups that do not own a car. The income elasticities are similar, 0.89 and 0.82, as the power-law fit in Figure 2b shows. For the car-owning tenants of the reference settlement, however, the correlation is much lower and the elasticity is only 0.44. Table 5 indicates the CO2 intensity of the different categories investigated. It shows that many categories have a similar CO2 intensity. Only those with intensities significantly different from the average can cause substantial deviations from a linear relationship between expenditure and CO2 emissions. These are for our two samples the air flights, the energy, and the car use. The physical infrastructure of the buildings conditions the energy use, so that only car use and air planes contribute to a substantial difference among the samples. There seems to be no correlation between car use and income in the reference settlement.

Looking at our whole sample, there is little correlation between income and air transport (r^2=0.03) and absolutely no correlation between the CO2 emissions of ground transport and air travel. In our sample, there is hence no indication the money saved from not owning a car is systematically diverted to air travel.

What we can learn from this investigation for the development and promotion of more sustainable consumption patterns is that there is an urgent need to limit air travel. In addition, households not owning a car have lower CO2 emissions and energy use. The promotion of such a life style will help to promote sustainable consumption patterns. The emissions saved from not using a car are higher than those from buying green electricity.

7 CONCLUSIONS

Our study indicates that the car-free housing project has indeed lower CO_2 emissions, measured per household, per capita, or per € spent, than the reference settlement. Both settlements have lower emissions than the Austrian average, which can be explained by the lower expenditure and factors connected to larger family size, the use of district heating, and lower mobility needs. Both avoiding car use and purchasing green electricity are effective in reducing the respective CO_2 emissions in the car-free settlement. Due to the importance of air transport and of the residual expenditure categories estimated by IOA, the difference between the two settlements is small. More detailed data on nutrition and other expenditure would be needed to confirm that there is indeed no systematic difference in the remaining expenditure categories.

We demonstrated that the sustainability of consumption patterns of specific populations can be studied without administering a full-scale consumer expenditure survey, and that interesting results can be obtained. A combination of LCA and IOA is required to study the emissions, and the approach should be informed by using available statistical information on household consumption patterns. Improving the sustainability of consumption patterns requires looking at the entire set of patterns and limiting air transport, which is growing at a high rate.

Acknowledgements

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8 REFERENCES

Beer, T., T. Grant, R. Brown, J. Edward, P. Nelson, H. Watson, and D. Williams. 2000. *Life-cycle emissions analysis of alternative fuels for heavy vehicles*. CSIRO Atmospheric Research Report C/0411/1.1/F2. Aspendale, Australia: CSIRO.

Bullard III, C. W., and R. A. Herendeen. 1975. Energy impact of consumption decisions. *Proceedings of the IEEE* 63:484-493.

Eurostat. 2001. *Nameas for air emissions - results of pilot studies*. Luxembourg: Office for Official Publications of the European Communities.

Ecoinvent, v.1.1. Eco-Invent Centre, Zürich.

Herendeen, R. A. 1978. Total energy cost of household consumption in Norway, 1973. *Energy* 3:615-630.

Herendeen, R. A., and J. Tanaka. 1976. Energy cost of living. *Energy* 1:165-178.

Hertwich, E. G. 2004. Lifecycle approaches to sustainable consumption: A critical review. *Environmental Science & Technology*:submitted.

———. 2005. Consumption & the rebound effect: An industrial ecology perspective. *Journal of Industrial Ecology* 9 (1-2).

Klotz, J. 2002. *Verbrauchsausgaben - Sozialstatistische Ergebnisse der Konsumerhebung + cd rom*. Vienna: Statistics Austria.

Kolleritsch, E. 2004. *Input-output tables 2000*. Vienna: Statistics Austria.

Peters, G., and E. G. Hertwich. 2004. *Production factors and pollution embodied in trade: Theoretical development*. Working Paper 2004/5. Trondheim: Norwegian University of Science and Technology, Industrial Ecology Program.

Schweimer, G. W., and M. Levin. 1999. *Sachbilanz des Golf a4. Mit Bilanzplänen und Ergebnistabellen*. Z 99.519.501.00. Wolfsburg: Volkswagen.

Wallisch, A. 2004. Personal Communication. 2004.12.15 Emissionsdaten an oenb studie.Xls, Vienna.

Wiener Linien. 2004. *Alles über uns - Betriebsangaben 2003* Wiener Linien.

Wier, M., M. Lenzen, J. Munksgaard, and S. Smed. 2001. Effects of household consumption patterns on co2 requirements. *Economic Systems Research* 13 (3):259-274.

Singing for our Supper – who calls the tune in shaping demand for food in the UK?

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Abstract

The scale and nature of consumer demand are clearly important factors in shaping sustainable societies. In the case of food provided to Western Europeans, consumer demand has long passed beyond the expression of a basic need for nourishment and encompasses many other factors such as aesthetic perceptions, and personal values. Studies of innovation more generally show us that this complex phenomenon described as "consumer demand" is not shaped in a vacuum: it takes form as a result of the continuous 'dialectic' between consumers and others in the value chain.

In the food system that terminates at UK consumers we can also see that producer, processor and retailer organisations are each seeking to increase their profitability. While efficiency improvements, corporate growth by takeover and hard negotiation are all deployed to this end, "adding value" for consumers has become a key means of achieving this objective. Branding and the development of new products that are more "sophisticated" than basic foods constitute two important aspects of adding value.

At each point in the system that links food producers to consumers, it is possible to identify value-adding strategies that favour organisations situated at that point. For example, if producers can develop and market successfully brands of basic foods (such as new named varieties, like the potato "Maris Piper") they may be able to charge a premium price and limit the scope for retailers to drive prices down by changing source. In a different example, we find a primary processor of chicken seeking to add value by developing a brand linked to the segregation of meat from sources with improved animal welfare standards. Secondary processors such as yoghurt manufacturers can create new products by incorporating into their offerings a variety of ingredients, many themselves derived from foods or food by-products.

In this paper we discuss, through a series of examples, the implications of such strategies for patterns of consumption and for the sustainability of the food system in terms of issues like energy use, waste generation, employment levels and location. In conclusion we discuss how these commercially-driven strategies can feed off and in turn feed into, advocates' (and consumers') notions of sustainable food that are defined in somewhat different ways: "organic", "local", "ethical", and so on.

1. Introduction

The spotlight of political and public concern about the depletion of environmental resources has over time shifted from an almost exclusive concern with the ways in which goods and services are produced to the emergence of a second, though rather dimmer, spotlight that examines the consumption practices of consumers. Much of the academic debate on consumers and the environment has followed the early stages of that for business and the environment: a concern to raise awareness of a problem and then sets of prescriptive measures of how behaviour should be improved. Whilst businesses may be regulated and required to improve their environmental performance many of the messages that they receive are about how they will be better businesses if they can better manage their environmental impacts. Remarkably similar messages are often targeted at consumers, if they could change their shopping habits they will be better, more environmentally responsible, people. The environment (or sustainability) is something to be 'bought into', or consumed as part of our lifestyle.

There are at least two problems with putting the onus of protecting the environment on the decisions of consumers (see Southerton et al). First, the focus is on the consequences of individual decisions and how those may affect the environment and not on how decisions on consumption are constructed and sustained or contested and revised. Second, choices about what to consume "are mediated through social institutions and technical infrastructures through which [goods and] services are provided" (Southerton et al, p1). In other words analysis of consumption cannot be examined separately from an understanding of production (Harvey, p188). But what sort of relationship between the two is being posited? According to Southerton and his colleagues (p7) whether the language of path dependency, lock-in or scripts is used "all point to the way that processes of consuming are configured by many aspects of production which have a structuring effect on what goods and services are provisioned, how the goods and services shape the consumption of related products, and how objects are used." In the remainder of this paper we critically explore how production and consumption are linked together. Our analysis is based upon an analysis of food chains and we draw upon examples from the chicken and potato industries in the UK. A brief description of the role of the supermarkets and how they seek to create choices overlies the supply chain analysis. We point to the critical role that supermarkets play in managing food supply chains but also that they have their own hierarchy. There is a source of variability also in the ways in which food supply chains will operate. Finally, we assess the potential for alternative, more sustainable food supply chains based around organic production and consumption. For it is here in the evaluation of alternative food systems that we can gain the clearest sense of the dominance of conventional food chains and of the challenges faced in reorganising production manufacturing and consumption.

Throughout the paper we are keen to point out that an important contextual factor governing the food supply chain is the policy and regulatory context in which it operates. This will influence what foods are delivered and how they are delivered. Whilst regulations on food quality and safety will, of course, be paramount there are also other regulatory influences that will enable and constrain the food chain. Given the significance of retailers in the UK context it is worth noting that its particular model of development with large out of town distribution centres and retail outlets has been enabled by the operation of the planning system that has permitted such large scale and dispersed developments. These major capital investments means that retailers, along with producers, manufacturers and processors and distributors must continually innovate and create food choices for their consumers.

This paper is based on ongoing research at two different levels. First, there has been the study of publicly available data sources (e.g. market reports, web sites) of key private and public sector organisations. Second, there has been a series of key person interviews and we have guaranteed anonymity to our informants because of the potential sensitivity of the issues that we are addressing.

2. Restructuring the supply chain: policy and economic implications

The protracted relative economic and political decline of farming has been accentuated by the dramatic rise to prominence of first food manufacturers (Flynn, Marsden and Ward 1991) and more recently retailers (Wrigley 1991, 1992, 1994). These have proved to be the two most buoyant sectors within the food system, and are dominated by a small number of large firms. Key food manufacturers include AB Foods, Booker, Allied Lyons, Grand Metropolitan and Unigate, whilst the most important food retailers are Tesco, Asda and Sainsbury. Over the past two decades the major retailers have undergone considerable expansion such that today they have captured about two thirds of food retail sales. In contrast the smaller independent retailers account for an ever declining proportion of sales. (For chickens the major supermarkets currently account for about three-quarters of retail sales, see below). It is the major multiples that increasingly determine the shape of the British food sector and are able to influence the food choices on offer. Together retailers and manufacturers have been sources of considerable innovation across a range of areas from new products, to the distribution and storage of those products.

Within government deliberations at the Food Standards Agency (FSA) and at a European level of food related committees and their recommendations are significant for food choice because they are able to propose modifications to the boundaries of existing regulations. As the food companies and retailers search for new products and processes there is frequently a need for new regulations or the amendment of existing regulations. A good example of the types of changes that have been made are reflected in government's attitude to food regulations which have "tended to move away from imposing compositional standards on food ... to provide more effective ingredient and nutritional labelling" (Foreman 1989, p118). The extra flexibility this modified stance has given food manufacturers is reflected, for example, in low fat products which were previously outlawed by specifications on minimum fat content.

As we have briefly argued above, the food regulatory framework is a dynamic one and plays a key part in structuring the choices that are open to consumers to make. The key constituent elements within the framework are economic interests, although government remains the ultimate arbiter of rules. Government's role is not static, and, increasingly in conjunction with private interests, is modifying consumer rights, particularly around contestations concerning quality parameters.

Ministerial thinking on the market and regulation has resulted in a reconstruction of government's traditional public interest form of regulation that prevailed until at least the late 1970s, and is deepening its relationship with the multiple food retailers. As one official remarked in the mid 1990s:
"the government's position is that the market is, broadly speaking, the best determinant of what happens in industry and business. Ministers see us at MAFF [now DEFRA] as a group of people who are able, through releasing powers of regulation, as being able to facilitate the success of business. The attempt has been made to reduce all regulations to an absolute minimum ... The point is that present ministers neither believe in regulation nor in spending money. [But] they [do] believe in encouragement, facilitation, knowing a lot about business ... that's the sponsorship role, in a sense."
These are sentiments that would strike a resonant chord in government circles today.

Releasing powers of regulation has not meant that the traditional public sector role of protecting the consumer from health risks associated with food have been subverted. Rather what has happened is that different sets of rights, intimately linked to private sector provision, have been fostered. Within the ideology of the market, consumers are empowered, are free to make the choices as they see fit. What we are witnessing is the government essentially trying to act as backstop, to ensure basic standards of food safety. Over and above this the multiple retail outlets are creating additional rights based on their different guarantees of food quality and choice, which are available to their customers.

Now it is the corporate retailers who play a central role in promoting to their individualised consumers their vision of quality and diversity of consumption. For retailers choice is based around variety and a hierarchy of standards. Different retailers seek to imbue their products with notions of quality and to do this they must be able to exercise considerable influence over the supply of products. For retailers and shoppers there will be different notions of quality depending on where purchases are made. So, for example, there will be different expectations when entering the door of a Waitrose store or a local Co-op. In a similar way Mark Harvey (p203-4) has argued that "supermarkets distinctively aggregate consumers in a new way and present a distinctively organised and differentiated new array of products to them."

3. Retailers and consumption: the supply chains for chicken and potatoes

So, where government largely regulates for food safety and choice at the point of sale, retailers also operate their own private systems of regulation along the supply chain. Below we briefly describe how the chicken and potato supply chains are constructed in Britain. Chicken and potatoes are both important foods in the British diet and for British agriculture. Chicken is the most valuable meat (in terms of retail sales) and potatoes the most valuable fruit or vegetable. Over the last decade the production of potatoes has remained largely stable but the consumption of fresh potatoes has decreased and that of processed potatoes increased. Poultry production shows a steady increase in output and an increasing part of consumption of chicken is in a processed form. Some idea of the growth in processed foods can be gained from the figures below (see Table 1).

Table 1. Household consumption of potatoes and poultry in Great Britain, grams per person per week

	Fresh potatoes	Processed potatoes	Uncooked poultry	Cooked poultry
1985	1162	117	-	-
1990	996	135	221	15
1995	803	188	215	22
2000	707	202	214	39

Source: MAFF, 1991-1997, 1998, 1999, 2000

The reason for the increase in the consumption of processed foods in these two products is due to the rise of frozen and especially chilled foods. Convenience foods are obviously attractive to consumers but also represent a significant form of added value for food manufacturers and retailers. Many of the convenience foods are marketed under the supermarkets own labels. An indication of the value of frozen food retail sales in the Britain is provided in the table below (see Table 2).

Table 2. Retail sales of frozen potatoes and poultry 1995-1999

	1995	1996	1997	1998	1999
Potatoes - Value of sales, million pounds	343	337	311	350	385
Potatoes - Volume of sales, thousand tonnes	406	421	450	472	492
Poultry - Value of sales, million pounds	729	817	773	828	878
Poultry - Volume of sales, thousand tonnes	248	280	264	266	270
Total value of frozen food retail sales in million pounds	4,538	4,854	4,776	4,898	5,051

Source: Euromonitor, 2000a, 2000b.

Investigation of the way in which the two food supply chains operate is revealing. The chicken supply chain is remarkably short because of the high level of integration between actors. The chicken supply chain is also very concentrated; there are several large chicken producers who incorporate in their activities several stages in the supply chain from breeding to final further processing. Most of the chicken farms are owed by integrated companies or contracted to them. There are no large independent producers of broiler chickens. The contrast with the potato supply chain is marked. Independent producers dominate potato production. Some potato producers when they begin growing will not know whom they will sell their produce to, while chicken producers are always produced for an identified customer. There are also many more potato producers than there are chicken producers.

Supply chain maps of the chicken and potatoes can be found on the following pages (see Figure 1 and Figure 2). The different stages that make up the supply chains are described in Annex 1.

Figure 1. Chicken supply chain map

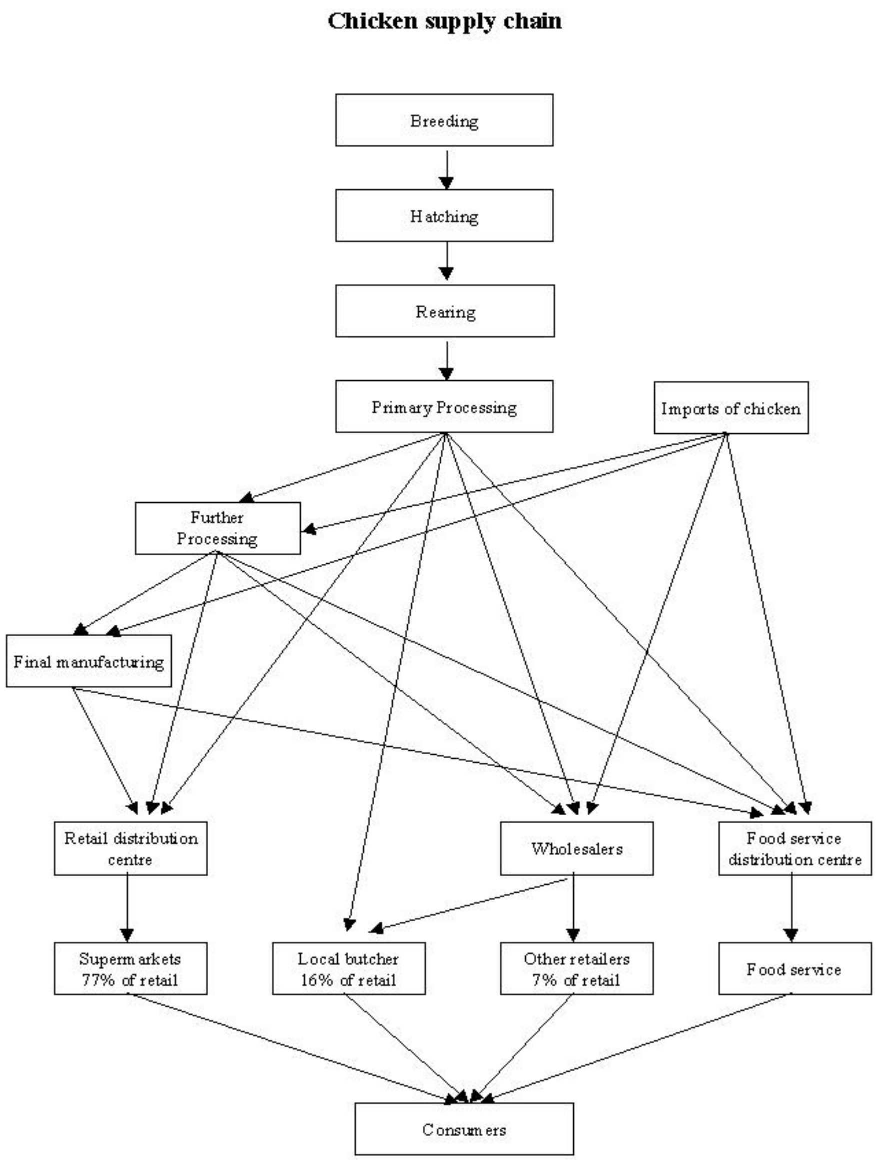
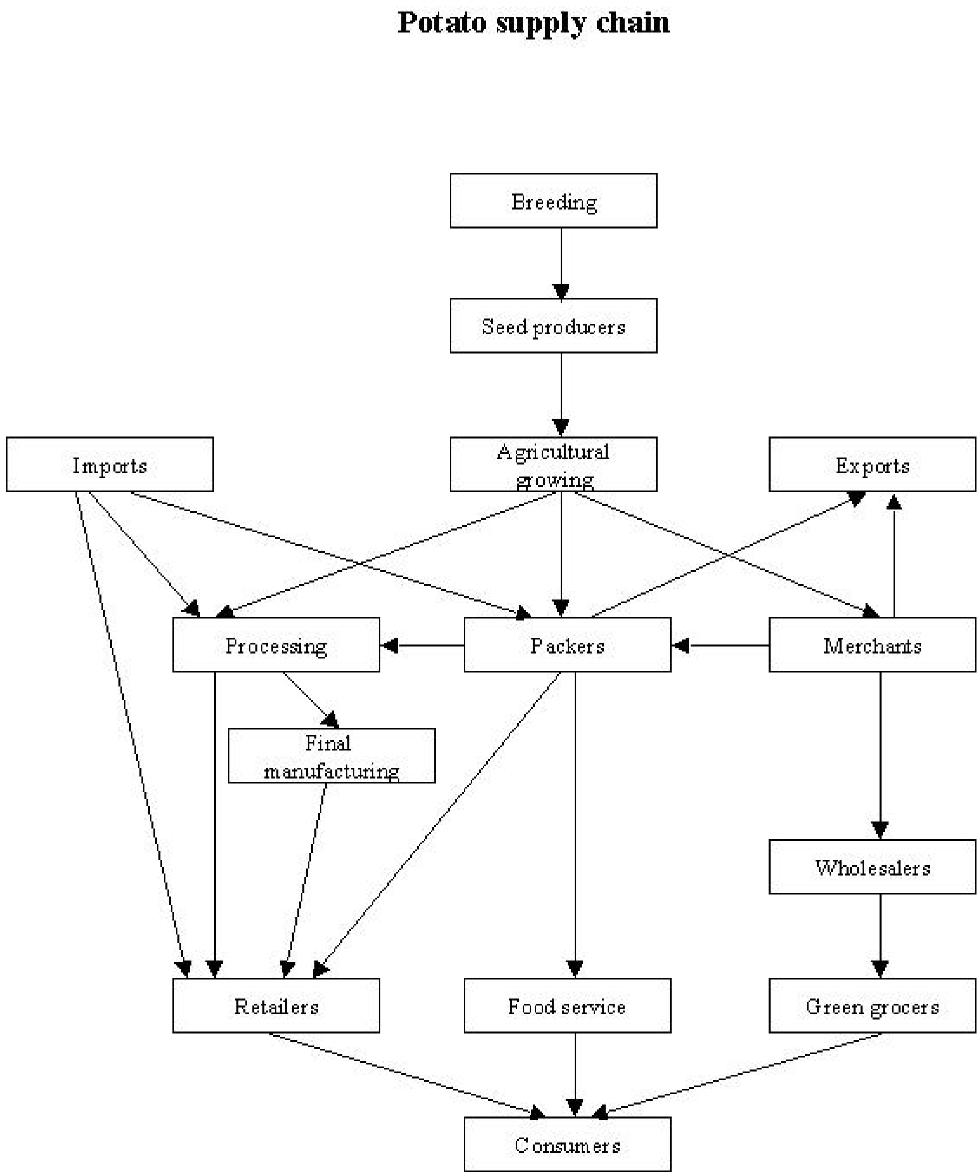


Figure 2. Potato supply chain map



What do the maps show about food choices, consumption and policy? Traditionally many chicken breeds have been used for both the production of meat and eggs. However, the large scale demands for both products has led to the breeding of specialist chickens that are used for either meat production or egg laying. So, the current industrial broiler production is dominated by a very limited number of breeds, one of the most popular of which is the Cobb 500. Factors that need to be borne in mind in accounting for the decline in the number of chicken breeds used in mass meat production are related to the development of a standard product. These include:

- Batch production
- Increasing mechanisation of chicken processing
- A concentrated and integrated production and processing sector that was keen to promote consistency rather than variability
- Meeting the requirements of food retailers and manufacturers for product consistency and quality. (This is a very important factor and is explored further in the next section).
- Standardisation of packaging and display in retail outlets.

Currently, British potato growers favour several varieties. The most important are Maris Piper (the main crop variety is the preferred choice for chip frying, and it accounts for 25% of the entire potato planted area in Britain), Estima (an early crop variety that accounts for 8.8% of the total planted area), Lady Rosetta (4.8%) and Maris Peer (4.7%). Although not as marked as for chicken production, there is once again a noticeable reduction in the variety of potatoes that are grown in Britain for the mass market, and the emergence of one dominant variety. Again, like the chicken supply chain, a similar set of factors will be promoting homogeneity.

The choice of chicken breeds and potato varieties that come into the food system are managed by the growers. The growers, especially those producing chickens, which are highly market oriented, are responding to messages from further up the supply chain. The irony is that as variety in Britain decreases consumers have increasing opportunities to purchase an ever greater number of chicken and potato related products in the major supermarkets. For example, Sainsbury offers more than 50 fresh varieties of potatoes products for online shoppers, 25 frozen potato products, 16 ready meals mainly produced from potatoes and 8 canned potato products. Tesco meanwhile offers online to its customers: 20 raw potato products and 6 organic raw potato products, 16 value added potato products, 31 varieties of frozen chips, and 21 other frozen value added potato products.

4. Managing the food supply chain

For the major food retailers the choices that they are able to offer their customers are inextricably linked to the quality of the products. Quality is linked to competition amongst the retailers. As a leading figure in one of the major food retailers put it: ‘For our customers, we’re in the business of offering quality’. He continued:

> “Well, we’re all competing for the same share of the purse. There is only a finite number of calories that people can eat in a day. Our job is to make sure that it is

our calorie that they are buying and not someone else's. So, we only make our profits by satisfying our customers, and we have to discover what it is that satisfies them. ... They're saying that there is a particular level of quality that they want, and we have researched this exhaustively, and every product that we produce goes through customer research to find out whether it is of the right quality."

To be sure of the quality of a product means that the company has confidence in the ability of food manufacturers to deliver appropriate standards. The interviewee went on to outline the procedures involved:

"The work that we do with the manufacturers - we do not make any products ourselves, but prior to anybody making any food for us, they have to satisfy one of our food technologists that they have complied with the criteria that they have set out in their quality management system manual which involves an audit. ... We devise this, in consultation with the suppliers who are involved. Sometimes suppliers say, well that is very interesting but we can't do this and we can't do that, so this consultation process is important. There is a lot of prior consultation. At the end of the day, there is a set of criteria, a set of standards, that we have set out for any manufacturer, and if they can't adhere to those standards in the audit, then they are not in the frame. This has to be sorted out before we start on the negotiations involved in buying stuff. Any buyer in this building knows that he/she does not go to any factory unless they have been formally approved. We will definitely not accept any food from unapproved sources anywhere by anybody.

So once the supplier is approved we start to talk about the product that is to be developed. In that development process, there will be customer research ... through our stores. We have market research agents in our stores asking customers to taste food in kitchens blind, to satisfy quality criteria, so that when we have a satisfactory customer report then we can market the product. So the technologists are really the key people who work in partnership with the producers to design, develop and procure the products. So the quality management process is governed by technologists effectively. They are backed up by laboratories here. We have got consumer kitchens here. We have got sensory panels, fragrance panels, wearer trials of clothing, packaging laboratories - and the whole thing that backs it up by saying there is a need for subjective information to meet our objectives. But what the analysts do is to check the competence of our suppliers."

The results of the supermarkets' strategies are significant for the choices that consumers make. As a retailing interviewee put it:

"We don't have any control over brands. What Mr Mars does, or what Mr Kellogg does, is up to them. But 50% of food in Britain is bought under own label, and we have total control over our own label - in terms of source manufacture, specification, composition, nutrition, packaging right through to the whole thing. It's totally under our control."

5. A more sustainable system?

A concern about the environmental sustainability of the food production and consumption system, which is highlighted by harmful agricultural techniques, has led to the creation of alternative strategies for food production, particularly in the area of agriculture. These alternative strategies relate to concepts of ecological food production (Begon, 1990), alternative agriculture (Wolf and Allen, 1995), local supply chains (Bellows and Hamm, 2001), low input sustainable agriculture (Wagner, 1999) and organic agriculture (Bell and Morse, 1999). In relation to chicken production, the most notable alternative strategy for chicken production is organic chicken. Organic produce accounts only for 1% of the entire UK food market (Taylor, 2002), but the organic chicken supply chain is growing in its importance (see Table 5).

In theory it would be possible to construct an alternative, organic, food system to challenge the current conventional system. Agricultural production is, perhaps, the easiest stage to conceptualize the system differences since organic agriculture has to be certified to show that there is an absence of defined substances in the production process. Organic production, since it promotes itself as a healthier and more environmentally friendly alternative, is likely to seek to reduce the amount of energy used in the manufacturing, retailing and consumption of food. These demands may make themselves felt in a reluctance to engage with conventional manufacturing and retailing companies and to promote the virtues of seasonality and product variability since they arise from a ‘natural’ production process. In practice, however, the organic chicken supply chain largely mimics its conventional counterpart. We illustrate why this may be the case through the case of Capeston Farm, one of the largest producers of organic chickens in the UK.

As a number of commentators, such as Hughes (1989), Freeman and Soete (1997) and Utterback (1996) have recognized outstanding individuals are regarded as important for the creation of novelty. This holds true for radical innovation in particular. The potential for organic production as an alternative system certainly makes it a radical one. Capeston Farm moved into organic chicken production in 1998, at a time when organic chicken production was highly fragmented and marginal, and it illustrates clearly the role of individuals in the innovation process. For some years prior to the late 1990s the farm had reared conventional poultry on a small scale, but in 1997 the farm experienced a severe financial crisis due to the loss of key customers. This was a defining moment for the farm as they could have either continued on the conventional route or move into a new niche. They chose the latter as they recognized they could not compete with the large poultry producers and, on a positive note, believed that some British consumers were seeking to change their shopping habits and become ‘careful’ consumers. In the beginning, the farm encountered the problem of procuring chicks suitable for organic production. Hatcheries in the UK were unable to supply the slow growing breeds that were required, so the farm eventually started sourcing from France and later bringing the production till 4,000-5,000 broilers a week.

What is notable about the shift in production system is that for the owners of the farm it was made for commercial reasons. Despite the strong normative element within the organic movement such values played no part in the decision making of Capeston Farm. Moreover, the owners of the Farm did not notice a lot of change in moving from conventional to organic production. As one member of the family commented:

> "...the only changes are in the use of the food for indoor brooding Indoor rearing is almost the same, apart from the feed. For outdoor rearing [a requirement of organic poultry production] it is just having the courage to open the doors. And we cannot rely on antibiotics [another condition of organic production]."

In practice, it is only at the stage of agricultural production that the organic supply chain differs from conventional supply chain, and even here the differences, at least for one set of producers are not perceived to be radical. At the stage of rearing there are distinct differences in breed, feed, period of growing and manner of keeping chickens. However, at the stages of food processing and distribution the two food systems are almost identical. In the stage of processing although slaughter houses should be certified as organic, the equipment is identical to that in conventional primary processing. Indeed, Capeston Farms have recently purchased slaughtering equipment from a conventional grower and, once again, like their conventional counterparts, have a highly integrated production system, so that they can retain as much value added as possible. The use of chilling and freezing is at a similar level in both supply chains. Innovations present in conventional food supply chains such as refrigeration, packaging and cooking also apply to organic foods. Perhaps one of the best indications of the similarities between the conventional and organic chains is that conventional producers will now often have organic sidelines. In terms of structure of the supply chain, the analysis shows that from being marginal supply chains, organic food production and distribution has now been adopted by large mainstream producers, processors and retailers as part of their diversification strategy. Large supermarket chains now sell organic foods alongside their conventional products. Currently, around 80% of total UK organic market is dominated by the supermarkets and ironically this is a higher figure than for conventional chicken because the latter are also widely distributed in the burgeoning food service industry (e.g. takeaways, restaurants and snack bars).

Thus, the sustainability implications of present organic food supply chains may not differ substantially from those of conventional food supply chains. Although the current organic supply chain does not appear to be more sustainable, the general perception of organic production would seem to argue for greater sustainability benefits. Whilst organic farming will use different inputs, the case of chickens shows that any sustainability benefits are far from straightforward. For instance, organic chickens need to be fed for longer and require more land. There are, moreover, several barriers that prevent the further development of strategies for organic production and consumption and fuller integration of an organic approach to other stages of the food supply chain. Firstly, the organic chicken supply chain is considerably dependent upon operators in the mainstream conventional food supply chains, such as large food producers, processors and retailers. Secondly, large food processors and supermarket chains support conventional food production and consumption. Thirdly, consumption patterns remain oriented towards conventional food production and consumer demands for organic foods remain low.

Fourthly, government policies do not sufficiently encourage organic food production. Fifthly, organic supply chain involves imports of old day chicks, frozen cut meet and other chicken products, which mimics the supply chain of the conventional system.

6. Conclusions

Within government and the food consumer lobby, the idea of choice is important. Once safety criteria have been satisfied there is a strong belief that consumers should have the freedom to make decisions about what they want to buy. It is an approach to consumption that fits well with the strategies of the major retailers. For the retailer choice is a complex matter that has different implications for their supply chains. At one level supermarkets are largely indifferent to variety. Once a product has met the supermarkets quality criteria they do not mind much whether it comes from one, two or ten different varieties. What the supermarkets will be interested in however, along with the food manufacturers, is how they can introduce variations on that material (e.g. the number of different types of frozen chips). At another level, though, supermarkets like to be able to provide their customers with a number of choices (e.g. varieties of new potatoes) and this depends upon their buyers having access to diverse markets to satisfy niche consumer demands. Here variety may be a virtue though the supply chains may only operate for a temporary period.

The nature of the regulatory framework has an important consequence for food choices. The much greater diversity of consumption opportunities, certainly compared to the late 1940s and 1950s, allied to changing patterns of regulation, means that notions of quality are increasingly embedded in where consumers purchase products. And this in turn depends on the ability of retailers and manufacturers to engage in supply chain management, which will vary enormously. There is, therefore, the potential for already significant gradations of food quality between different retail outlets to be further accentuated.

Annex 1

Stages in the chicken supply chain (see Figure 1):

- Breeding – representing parent flock, where selective breeding is taking place for developing breeds for broiler production and production of eggs. In 2003, some 6.85 million female broiler parent chicks were placed in UK (DEFRA, 2003).
- Hatching – the stage where eggs are hatched in special incubators, this process takes 21 days. After that one-day old chicks are transported to chicken farms. In 2002, there were 810 million chicks were placed from hatcheries in UK (DEFRA, 2003).
- Rearing – the stage of chicken growing on a farm, involves feeding the birds and taking care of them till they reach appropriate age and weight. They are placed on litter and grown out to 2.2 kg in 39 to 42 days. From the farm fully grown chickens are transported to the processing plants. Poultry industry is fairly a concentrated sector, for example, according to the Business Monitor PA1003, in 2002 there were 725

VAT-based enterprises in farming of poultry and 95 VAT-enterprises engaged in processing and preserving poultry meat, which have some 145 local units (Fenn, 2000).

- Primary processing – this stage involves slaughtering of chicken, de-feathering, invisceration, chilling, maturation, cutting, packaging and pricing. In 2002, some 832 million chickens were slaughtered. The average liveweight of broiler at the point of slaughter was 2.25 kg. That year 1,202 thousand tonnes of broiler carcass weight was produced of which 213.5 thousand tonnes was exported as whole and cut, meanwhile some 362.87 thousand tonnes of broiler meat was imported mostly in cuts (DEFRA, 2003) (See Table).
- Further processing – the stage where value added to the chicken, such as pre-cooking, adding spices, etc.
- Final manufacturing – is the stage when chicken is mostly used as an ingredient for the preparation of chilled food, such as ready meals, sandwiches and soups.
- Wholesale
- Retail – include retailers and food service. The retail dominates the sales of chicken. However, large volumes are channelled through the food service.
- Consumption

Stages in the potato supply chain (see Figure 2):

- Breeding – process of developing new varieties of potatoes.
- Seed selection – the stage where seeds are selected and improved for better potato production. Seeds are later supplied to the farms.
- Agricultural growing/farming – the stage where potatoes grow from the seed to the stage of their ripe. Potatoes gathered and then transported to primary processing stage. The potato industry is shrinking in terms of its players. The number of potato growers decreases every year: there were 5,262 potato growers in 2002, 5,606 growers in 2001 and 6,143 growers in 2000 (British Potato Council, online). In 2002, potato was planted on the area of 159,000 hectares, while 146,000 hectares were occupied by main crop and only 13,000 by early crop. That year 6,375,000 tonnes of potatoes were harvested in UK which was worth £463 million (MAFF, 2003a).
- Merchants – which are engaged in exports, supply for processing, packing and wholesale. There were 1,030 potato purchases in 2000 and 864 in 2001 (Fenn, 2000).
- Packing - the stage when potatoes are cleaned, graded, weighed, packed and priced.
- Processing – the stage of value adding, such as peeling, pre-cooking, cooking, seasoning, preparation of various products. On the stage of potato processing the sector looks more concentrated, there are 55 VAT based enterprises engaged in processing and preserving of potatoes in 2002, which have some 85 local units (Fenn, 2000).
- Final manufacturing – the stage for value adding leading to the chilled production, where potatoes are used as ingredients for the preparation of soups, ready meals, salads, etc.
- Wholesale
- Green grocery sale – the stage of retail through the green grocers, who are supplied by the wholesalers
- Retail – includes supermarkets and other outlets, except for green grocers.

- Food service – include fast food service, restaurants, takeaways, work canteens, etc.
- Consumption. UK is by far is the largest consumer of potato and its products in per capita terms. In 1999, UK per capita consumption of potato and its products was 111 kg, while in Finland 70 kg, Sweden 53 kg, Germany 78 kg, France 67 kg, Holland 84 kg, USA 62 kg.

References

Euromonitor. (2000a) Frozen foods: the international markets. [electronic database] Euromonitor: Global Market Information Database. URL: http://www.euromonitor.com/gmid/

Euromonitor. (2000b) Frozen food in Europe. [electronic database] Euromonitor: Global Market Information Database. URL: http://www.euromonitor.com/gmid/

Flynn, A., Marsden, T. and Ward, N. (1991) 'Managing food? A critical perspective on the British experience', Changement technique et restructuration de l'industrie agro-alimentaire en Europe, INRA Actes et Communications, no. 7; 159-81.

Foreman, S. (1989) Loaves and Fishes, London: HMSO.

Ministry of Agriculture, Fisheries and Food. (1991) Household food consumption and expenditure 1990: annual report of the National Food Survey Committee. HMSO.

Ministry of Agriculture, Fisheries and Food. (1992) Household food consumption and expenditure 1991: annual report of the National Food Survey Committee. HMSO.

Ministry of Agriculture, Fisheries and Food. (1993) National food survey 1992: annual report on household food consumption and expenditure. HMSO.

Ministry of Agriculture, Fisheries and Food. (1994) National food survey 1993 annual report on household food consumption and expenditure. HMSO.

Ministry of Agriculture, Fisheries and Food. (1995) National food survey 1994 annual report on household food consumption and expenditure. HMSO.

Ministry of Agriculture, Fisheries and Food. (1996) National food survey 1995: annual report on food expenditure, consumption and nutrient intakes. Stationery Office.

Ministry of Agriculture, Fisheries and Food. (1997) National food survey 1996: annual report on food expenditure, consumption and nutrient intakes. Stationery Office.

Ministry of Agriculture, Fisheries and Food. (1998) National food survey 1997: annual report on food expenditure, consumption and nutrient intakes. Stationery Office. URL: http://www.defra.gov.uk (accessed 1/09/03).

Ministry of Agriculture, Fisheries and Food. (1999) National food survey 1998: annual report on food expenditure, consumption and nutrient intakes. Stationery Office. URL: http://www.defra.gov.uk (accessed 1/09/03).

Ministry of Agriculture, Fisheries and Food. (2000) National food survey 1999: annual report on food expenditure, consumption and nutrient intakes. Stationery Office. URL: http://www.defra.gov.uk (accessed 1/09/03).

Ministry of Agriculture, Fisheries and Food. (2001) National food survey 2000: annual report on food expenditure, consumption and nutrient intakes. Stationery Office. URL: http://www.defra.gov.uk (accessed 1/09/03).

Harrison, M., Flynn, A., and Marsden, T. (1997) 'Contested regulatory practice and the implementation of food policy: exploring the local and national interface', Transactions of the Institute of British Geographers (forthcoming).

Wrigley, N. (1991) 'Is the 'Golden Age' of British retailing a t a watershed?', Environment and Planning A, 23; 1537-44.

Wrigley, N. (1992) 'Antitrust regulation and the restructuring of grocery retailing in Britain and the USA' Environment and Planning A, 24.

Wrigley, N. (1994) 'After the Store Wars? Towards a New Era of Retail Competition?', Journal of Retail and Consumer Services, 1; 5-20.

Scenarios for the Environmental Assessment of Consumption and Production

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In the last National Environmental Policy Plan, the Dutch government noticed that dealing with the major environmental problems demands for a long-term transformation process comprising technological, economic, social-cultural and institutional changes (VROM, 2002). To give the government adequate advice on this transformation process, the Netherlands Environmental Assessment Agency decided, to develop long-term scenarios, which describe the impact of Dutch production and consumption on the environment in the Netherlands and outside the Netherlands. For that purpose, we developed four scenarios for consumption and production in the Netherlands. The storylines of these scenarios are based on the storylines of the IPCC-scenarios (IPCC, 2000). The two main uncertain trends that frame these storylines are the trend towards a more *global* or a more *regional* (divided) world and the trend towards a society where *material* or *immaterial* values become increasingly important. These storylines were further elaborated for the Netherlands. From these storylines we built scenarios from a consumer perspective. That is, we first described the development of the demographic, socio-cultural and economic aspects that affect consumer decisions, such as population growth, age structure, household size, changes in lifestyle, trends in consumption and income growth. Then we calculated the consumption pattern of a household in 2040 for the four scenarios with our Consumption Model (cf. Rood et al., 2003; see also Vringer et al., 2001), while using the Dutch Budget Survey for 2000[1] as a starting point. The consumption pattern of an average household was transferred in total consumption for the Netherlands by using the population growth in the scenarios.
Production for the four scenarios is demand driven. Total demand consists not only of private consumption, but also of public consumption and exports. From the storylines we obtained notions with respect to international competitiveness and openness that affect exports and imports. For the export of consumption goods, we also took the foreign consumption demand into account. This was derived from the growth in the Dutch consumption demand. The development of public consumption is assumed to be related to the measure of importance of immaterial values, but also to population growth and

[1] For the Budget Survey, approximately 2000 households are interviewed about their expenditures. During a year they keep a housekeeping book for the larger expenditures and for a few weeks they keep up with the daily-life expenditures. The Budget Survey distinguishes approximately 350 types of products. The Survey is performed by the Dutch Statistical Agency (CBS).

economic growth (education, public health). From total demand, production in 112 sectors is calculated with a dynamic input-output model (cf. Idenburg and Wilting, 2005; for the way we dealt with technological change and investments, see also Wilting et al., 2004). With this model we can also easily derive value added, imports and employment from the production in the 112 sectors for the four scenarios.

The environmental performance of production and consumption in the Netherlands is in Nijdam and Wilting (2005) determined for 2000, by using an input-output method. For the 112 production sectors the contribution to the main chemical stressors (greenhouse gasses, acidification, eutrophication, photo-oxidant formation, traffic noise, human toxicity) and physical stressors (land use, wood use, fish use, fresh water use) were determined. These results were used to calculate the indirect environmental load[2] of the 350 product-groups that are distinguished in the Budget Survey. The direct environmental load was added to obtain the total environmental load of the aforementioned product-groups. An interesting feature of the method is that account was taken of the regional origin of the different production steps, where we distinguished the regions the Netherlands, OECD Europe, the rest of OECD and the rest of the world. Therefore, the regional origin of the environmental load of consumption is known, which allows us to determine the (foreign) ecological footprint of the Dutch consumption (where we did not add up the results for the different stressors mentioned before).

To determine the environmental performance of production and consumption in the scenarios, we took the results from Nijdam and Wilting (2005) as a starting point. Technological changes that affect the environmental performance are incorporated in the dynamic input-output model. For the four scenarios, the environmental performance of the production in the 112 sectors that follows from the dynamic input-output model, is translated to the environmental performance of the consumption of 350 product-groups. For the *direct* environmental load of energy-related consumption, we made separate calculations. Finally, we calculated the (foreign) ecological footprint of the Dutch consumption for the four scenarios.

Literature

- Idenburg Annemarth and Harry Wilting, DIMITRI: A Model to Study Policy Issues in relation to Economy, Technology and Environment, in: J van den Bergh and M. Janssen, *Economics of Industrial Ecology; Materials, Structural Change, and Spatial Scales*, MIT Press, Cambridge, Massachusetts (2005, forthcoming).
- IPCC, *Special report on emission scenarios; A special report of Working Group III.* Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge (2000).
- Nijdam Durk and Harry Wilting, Environmental Load from Dutch Private Consumption: How Much Pollution is Exported?, *Journal of Industrial Ecology 9, 1-2* (2005, forthcoming).
- Rood Trudy, Jan Ros, Eric Drissen and Kees Vringer, A Structure of Models for Future Projections of Environmental Pressure Due to Consumption, *Journal of Cleaner Production 11*, pp 491-498 (2003).
- Vringer Kees, Theo Aalbers, Eric Drissen, Ruud Hoevenagel, Coen Bertens, Trudy Rood, Jan Ros and Jan-Anne Annema, *Nederlandse Consumptie en Energiegebruik in 2030 (Dutch Consumption and Energy Use in 2030)*, RIVM report 408129015, Bilthoven (2001), In Dutch.
- VROM (Netherlands Ministry of Housing, Spatial Planning and the Environment), Where There's a Will, there's a World; Fourth National Environmental Policy Plan, English summary: http://www2.vrom.nl/Docs/internationaal/NMP4wwwengels.pdf (2002).
- Wilting Harry, Albert Faber and Annemarth Idenburg, *Exploring Technology Scenarios with an Input-Output Model*, Paper presented at the International Conference on Input-Output and General Equilibrium: Data, Modelling and Policy Analysis, September 2-4, 2004, Brussels, Belgium (2004).

[2] The indirect environmental load concerns the load that follows from the production, transport and trade of a product, while the direct environmental load refers to the load that follows from the consumers' use of the products.

Dimensions in consumers' visions of future sustainable societies

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Abstract

The point of departure for this paper is the unsustainable development in modern societies, and the political goals set by individuals, NGOs and political authorities to stop this process and move our production and consumption in a radical more sustainable direction. This means that potential and possibilities for change are one of the crucial objectives in modern political and scientific discourse.

The potential for change can be discussed within two different frameworks. First of all we can use status quo as our starting point, and discuss what can be done on local, national and global level to move production and collective and individual consumption in a more sustainable direction. The alternative approach is to set a sustainable goal in the far future. "In 30 – 40 years our society will be a susatinable society, what must be done – on various levels – to reach this goal?" This is the back-casting approach, and the advantage of this approach is that there are rooms for visions, we are not tied up in the traditional way of dealing with social, economic and political matters.

Consumers are not only important actors when politicians and NGOs try to reach their political goals, but also actors in the process to formulate the goals. This is special important within the back-casting approach. *But what is the consumers' vision about the future sustainable society*? This is the main objective discussed in part of the European **ToolSust project**: *The involvement of stakeholders to develop tools for sustainable development. (www.toolsust.org).* This paper reports from the stakeholder workshop in Fredriksstad, the Norwegian part of the project. In a sort of focus group stakeholders were invited to share their vision about the future in the city. We are able to identity two dimensions in these sustaiable visions. The first is the relationship between traditional values and technological solution one the one hand and modernistic values and technical innovation on the other. The other dimension is the relationship between local democracy and decentralised solutions on the one hand and more centralised democracy on the other, linked to the development of the city centre.

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1. Introduction and aim of the paper

The aim of this paper is two-dimensional. First of all we want to describe and discuss the back casting method as an instrument for scenario building. Secondly we will present visions of future sustainable societies from the European ToolSust project. This paper presents visions from the stakeholder meeting in Fredrikstad, Norway.
The main objective of the ToolSust research project is to develop, test, improve and implement environmental tools for various groups of stakeholders concerned with a sustainable development in the city of tomorrow. ToolSust is a part of Key Action 4 “City of Tomorrow and Cultural Heritage” from the programme “Energy, Environment and Sustainable Development” within the Fifth Framework Programme of the EU. In the project, a look is taken at the environmental situation in five European cities, and an assessment is made of how households can contribute towards improving the present situation. The cities are Fredrikstad in Norway, Groningen in the Netherlands, Guildford in United Kingdom, Padua in Italy and Stockholm in Sweden. The potential for change is analysed in both a short- and long-term perspective. The main innovative aspects of the project are the development of tools for a sustainable development of consumption and the involvement of stakeholders in this process: identifying goals, developing and testing various tools for sustainable consumption and the implementation of these tools in everyday life. More information about the project can be found at www.toolsust.org.

This paper presents methods and data within the long-term perspective. We are concerned about potentials for long-term changes using a back-casting approach in close collaboration with stakeholders. Stakeholders of interest in the ToolSust project are local political authorities, consumer organisations, environmental organisations, retail businesses, households and individuals. We will test a method for involving local stakeholders in discussions about long-term changes and part of this work is to produce several images of future systems for shopping and household practices based on suggestions from the stakeholders themselves.

The aim of this paper is to present and discuss the methods, approaches and results drawing from the experiences that the Norwegian ToolSust team collected while using the back-casting approach in collaboration with stakeholders during two workshops in Fredrikstad during February and March 2003.

The paper starts with a background section where the theoretical foundations and current practice of scenario formulation including back casting are explored. In the same section we also present the workshop methodology. We continue with an account of the back casting exercise carried out with a group of stakeholders in Fredrikstad. We will focus on four visions of the future, developed along two dimensions. At last we will discuss the environmental impact of these visions, are they radical enough to meet the challenges of a reduction of energy use by factor four or factor ten?

2. Methodological Background: Scenarios and the back-casting approach

One aim of the ToolSust project was to test, develop and propose a method that can help local stakeholders envision substantially more environmentally friendly solutions for everyday urban life. This may be achieved by using scenario generation with a back-casting approach in combination with the workshop methodology. The following text gives a short theoretical background to scenario generation and the back-casting approach, as well as the workshop methodology. We also review current practice. For those wanting more information we recommend reading the literature referred to.

A general definition of a scenario is that it is a description of possible future developments that seem plausible under different sets of assumptions and provide a background against which policy assessments can be made. Scenario analysis is one in a family of several methods for future-orientated studies where forecasting and projections are also included. Scenario analysis is increasingly used in long-range policy research, since it provides a way of identifying future issues and problems for policy-making in an environment of uncertainty (Banister et al., 2000). The scenario approach was developed as an alternative way of studying the future compared to the forecasting approach. The fruitfulness of the latter for providing solutions to highly complex long-term sustainability problems has been doubted. This is because forecasting is based on the dominant trends that have already contributed to current environmental problems (Dreborg, 1996). The advantage of scenarios is that they may widen the perception of researchers and policymakers regarding future opportunities and policy options. Scenarios are often created by applying brainstorming techniques, and the process is as important as its results.

There are different scenario traditions and here we are mainly concerned with the back-casting approach. Backcasting is orientated towards finding solutions to major societal problems and identifying innovative policy options. It is applied to long-term complex issues, involving many aspects of society as well as technological innovations and change. Typically, the aim is to provide policymakers and the interested general public with images of the future as a background for opinion forming and decisions. Backcasting as a term was introduced by Robinsson (1990) who defined it as:

> The major distinguishing characteristic of backcasting analysis is a concern, not with what futures are likely to happen, but with how desirable futures can be attained. It is thus explicitly normative, involving working backwards from a particular desirable future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point.

Dreborg (1996) sums up the following characteristics that favour back-casting:

- When the problem to be studied is *complex*, affecting many sectors and levels of society;
- When there is a need for *major change*, i.e. when marginal changes within the prevailing order will not be sufficient;
- When *dominant trends are part of the problem* - these trends are often the cornerstone of forecast;

- When the problem to a great extent is a matter of *externalities*, which the market cannot treat satisfactorily;
- When the time horizon is long enough to allow considerable scope for deliberate choice.

He concludes that the problem of how society could attain sustainability fits into this pattern.

In practice, the back casting approach has so far mainly been used in studies of alternative energy futures or in studies where future greenhouse gas emissions are less than now. Commonly, a certain sector, such as transportation, has been selected for an analysis (Steen et al., 1997, Banister et al., 2000). The backcasting exercise is usually carried out by a team of researchers and/or experts and involves series of meetings. The approach usually starts with the team formulating an image or several images of the future that satisfy some defined requirement of sustainability. This requirement can, for example, be a quantitative goal for energy use in the transportation sector. Steen et al. (1997) defined one goal based on the future global potential for renewable energy generation and an equal partitioning of it between the world's population. The time horizon was 2040. In the Dutch COOL project, the goal was a reduction of greenhouse gas emissions by 50-80 % by 2050 as compared to the levels of 1990 (Hisschemöller and Mol, 2002).

The image formulation usually requires several meetings during which technical and societal solutions for achieving the set goal are discussed. It has been carried out in-house by a team of researchers (Steen et al., 1997, Banister et al., 2000) or by involving stakeholders (COOL, 2000). Commonly, a team of researchers support the image formulation process by calculating or otherwise analysing the environmental consequences of proposed solutions in between the meetings. Finally, one or several images are proposed that fulfil the identified goal. In Steen et al. (1997) two images of a future sustainable transportation system were formulated and the description of the images included aspects related to spatial planning, infrastructure, and behaviour and vehicle efficiency.

The second step in the back casting process is to analyse the path towards the proposed image/images. This step is less developed than the first one. In Åkerman et al. (2000), which was a follow-up of the images proposed in Steen et al. (1997), strategies related to a more sustainable transportation system were explored. They included policy packages addressing technological development, urban structure and travel behaviour. The policy packages entailed measures to promote cleaner transport modes as well as measures aimed at hampering modes with larger emissions etc. Other back casting studies of sustainable transport also conclude that technological improvements alone will not be enough (COOL, 1999; COOL, 2000; OECD, 1999). It will also be necessary to break the trend of increasing transport volumes. This will require structural changes (spatial structure) of society in order to reduce the need for travel.

The review of current practice with back casting shows that local stakeholders have not been included so far. Lessons from the COOL project, where stakeholders relevant for the national, European and global levels were included, are that preparation pays off, that it pays to invest in participant involvement, that scientific information has to be well presented and that there has to be ample time for discussion during the different phases of the back-casting exercise (Hisschemöller and Mol, 2002). Furthermore, the review shows that earlier studies have focused on sectors, such as transportation, energy or agriculture. We found no example of a back-casting exercise with such a broad scope of activities as we have in the ToolSust project.

3. Experiences of back-casting with local stakeholders from Fredrikstad

In this section we describe how we planned and carried out two workshops with local stakeholders in Fredrikstad in February and March 2003. We present some of the material we used and the results in terms of scenarios.

3.1 Assembling a team of researchers

The project leader assembled a team of three persons, including himself. The team members had different roles in the course of the project:

- The team leader acted as the co-ordinator and the facilitator at the workshops. He also wrote out the scenarios.
- The second team member took care of the recruiting, and the practical arrangements for the workshops. He also calculated the energy consequences of the scenarios, and have done most of the reporting.
- The third member acted as a support during the whole process, and participated in the second workshop.
- All team members collaborated in working out the 4 scenarios.

3.2 Recruiting stakeholders

To start with, we thought this would be one of the hardest parts of this project. The reason for this, is that a similar workshop on a future Fredrikstad was arranged in 1997. The process and outcome of that workshop received some criticism locally, especially in the local media.

It turned out that the stakeholders were quite enthusiastic about our arrangement. This may have several explanations; some due to our strategy, others are externalities out of our control.

As an experiment with new dissemination techniques, two team members had a stand at a local shopping mall on the 11th of January. We had told the local media about the arrangement in advance, and they showed up. The stand was covered both on a local radio station and on the front page of the largest local newspaper. This turned out to be very valuable: When we started to call up the stakeholders we could refer to that newspaper article, and it seemed everybody had read about the arrangement, and through it recognised our project.

7-10 days after the invitations were sent out, we started to call up the stakeholders. The response was positive, and some stakeholder groups wanted to send more than 1 participant. We sat up the following criteria:

1. It is not desirable with many representatives from one organisastion, as the total number of participants should be 15-20.
2. The participants should have a local connection. Regional or national representatives are not beneficial.
3. Participants who just want to come to observe, like journalists, can disrupt the creative process.

All the invited stakeholders were reminded of the meeting in a second letter. Here we stressed that we expected the participants to act as if substantial reductions of environmental impacts would be needed in the future. Even if they did not agree to this, we asked them to accept this as a point of departue for the day. The reason was to prevent a timeconsuming debate on the meeting on wheter or not the current environmental situation is serious. We also underlined that it was not necessary to know a lot about environmental questions, it was more important to have a heart for Fredrikstad.

The stakeholders that finally showed up at the workshop represented environmental NGOs (3), local politicians (9), local communities (2), green households (1), administrators (2), the housing association (1), the Fredrikstad Environmental Forum (1) and the local Consumer Council (1). The politicians came from the Conservatives, the Christian Democrats, The Liberals, the Labour Party, the Socialist Left Party and from two local political parties: the "Against the Municipality Merger" list and the "Urban Environment" list.

Unfortunately we failed in getting the retail business presented. We were also in close contact with Fredrikstad Industry and Trade Association, but they were regrettably unable to send someone.

3.3 Carrying out workshop 1 with the stakeholders

The conference room was prepared according to the guidelines listed in Eden and Ackerman (1998).We had brought with us Post-It notes in two colours (one for ideas and the other for cluster headings), pens for us and the participants, paper to be handed out (here the participants could write down their ideas) and green and red dots (for the voting).

We started the meeting with a short presentation of the project and the programme of the day. We continued by putting an overhead sheet on the projector with the instructions for the time travel:

> Imagine that you visited Fredrikstad in the future, 40 years from now, and lived there for one day. You were as old as you are now, and you still needed to eat, drink, travel and rest like you do today.
>
> What are your memories from that day? How did you shop and travel, what did you eat, what was your occupation, what happened with your garbage, was there any garbage? What did the city look like?
>
> Remember, it is your memories that count, and they may encompass substantial changes in city structure, transportation systems and daily routines

The participants were given approximately 10 minutes to do the time travel, and write down their ideas, before we started the collective idea generation.

We started rounds where everybody got the chance to tell us one of their ideas. We had almost five full rounds, and ended up with more than a hundred more or less different ideas. The workshop leaders looked for potential clusters which then were presented to the participants. They came up with some adjustments, and a lively discussion followed on under which heading the different ideas or suggestions should be put.

Then came the voting. Each participant was given 6 green and 3 red dots. Green symbolised "desirable/good idea", while the red dots symbolised "not desirable/bad idea". They were asked to put these on the suggestions of their own choosing.

4. Identifying dimensions and making images of the future

Modern and Traditional was the first dimension we identified: Is one step backwards needed to get to the future (Traditional view), or are new innovations and inventions both socially and technically a feasible way (Modern view)?

The present area of the Fredrikstad municipality, is the result of a merger of 5 municipalities in 1994. There are still tensions connetected with this, and a political party devoted to oppose this is still represented in the local council, *Nei til storkommunen/Against the large municipality* (Methi et al., 2001).

We feel these tensions are present in the suggestions, and suggest that *Urban and Local* is the second dimension. Pairing the two dimensions, we get the following four scenarios for Fredrikstad in 2040:

1. Urban and Modern
2. Local and Modern
3. Urban and traditional
4. Local and Traditional

To get a clearer impression of what the four scenarios would look like we had a brainstorming session. Here we wanted to explore the scenarios to a greater extent, quite disconnected from the suggestions from the local workshop.

4.1 Modern and urban Fredrikstad:

The future sustainable Fredikstad is a modern and urban municipality. This means that the social and technological innovations are made within a degree of urbanisation that is qualitatively different from today. It is distinguished by:

- A concentration of the population in the city
- A multicultural Fredrikstad
- A geographical proximity between work and dwelling
- Service production, concentrated on care and cultural activities
- Shared dwellings
- Cafés and public eating, to a high degree vegetarian
- No cars in the city centre, small transportation demand
- The food is produced locally, but not in the city, direct ditribution
- Separation at source, but small demand because of waste reduction
- Recreation outside of the city

4.2 Modern and local Fredrikstad

The future sustainable Fredrikstad is a modern and decentralised municipality. This means that the social and technological innovations are made within a decentralised structure that is qualitatively different from today. It is distinguished by:

- Sustainable local communities, with a high degree of local supply of services
- Some parts of the service production is nontheless centralised
- There is a proximity between work and dwelling, based on broadband and home offices
- Shared houses, within a local structure
- Cafés and public eating, a high degree of vegetarian food
- There are no cars in the local centres, but there is a certain demand for transportation from the local communities to the centre
- The food is produced locally, with direct distribution
- Local separation at source, but quite small due to waste reduction measures
- Recreation in the local environment

4.3 Traditional and urban Fredrikstad

The future sustainable Fredikstad is an urban municipality, distinguished by traditional technological and political solutions. This means that the social and technological alternatives are improved versions of existing solutions we already know. The needs are more or less the same as today, but they are met in a sustainable way, characterised by:

- A concentration of the population in the city
- Cafés and restaurants, high degree of organic food
- The shops are localised in the city centre, and mostly sell organic food and eco-labelled goods
- No cars are allowed in the city centre, there is a toll ring aorund the city, separate lanes for public transport and shuttle bus free of charge
- Cars that run on hydrogen
- Fredrikstad – the bicycle city
- Effective separation of waste at source
- District heating
- Recreation takes place outside of the city, so transport is needed.

4.4 Traditional and local Fredrikstad

The future sustainable Fredrikstad is a decentralised municipality, distinguished by traditional technological and political solutions. This means that social and technological alternatives are improved versions of versions that already exist. The needs are more or less the same as today, but they are met in a sustainable fashion, characterised by:

- Sustainable local communities with a wide local offering of services
- Parts of the service production nonetheless centralised
- There is a proximity between work and dwellings, but quite a few are dependent on commuting
- The shops are localised in the city centre and they sell mostly organic foodstuffs, and ecolabelled goods
- A city centre without cars surrounded by a toll ring, separate lanes for public transport, and shuttle bus free of charge
- Cars that run on hydrogen
- Cycle pths in the local communities and to the city
- Effective and local separation of waste
- A certain degree of private food prodution
- Recreation out of town, with associated transport needs

5. Calculating energy efficiency gains

In this step we also used the results from an earlier workpackage in the ToolSust-project, to calculate energy efficiency gains in the four images of the future. An explanation on how this was carried out, is included in the Appendix. The results were reductions between 19 and 41 % compared to the total energy use of the average Fredrikstad household in 1997.

After deciding what daily life would look like in the four different scenarios of the future Fredrikstad, we also had to find ways to calculate the differences in energy use between them. Some features we assume to happen in all scenarios, other are more specific.

All scenarios:

Organic and local production of food
No packing
30% more energy effective production of goods (Except travel and direct energy)

Modern and urban:

Less meat, no snacks, chocolates or lemonades
Shared houses
Autofuel use reduced with 75%
Shared eating

Modern and local:

Same as Modern and urban – but money from reduced autofuels are use for train-travel (to city centre)

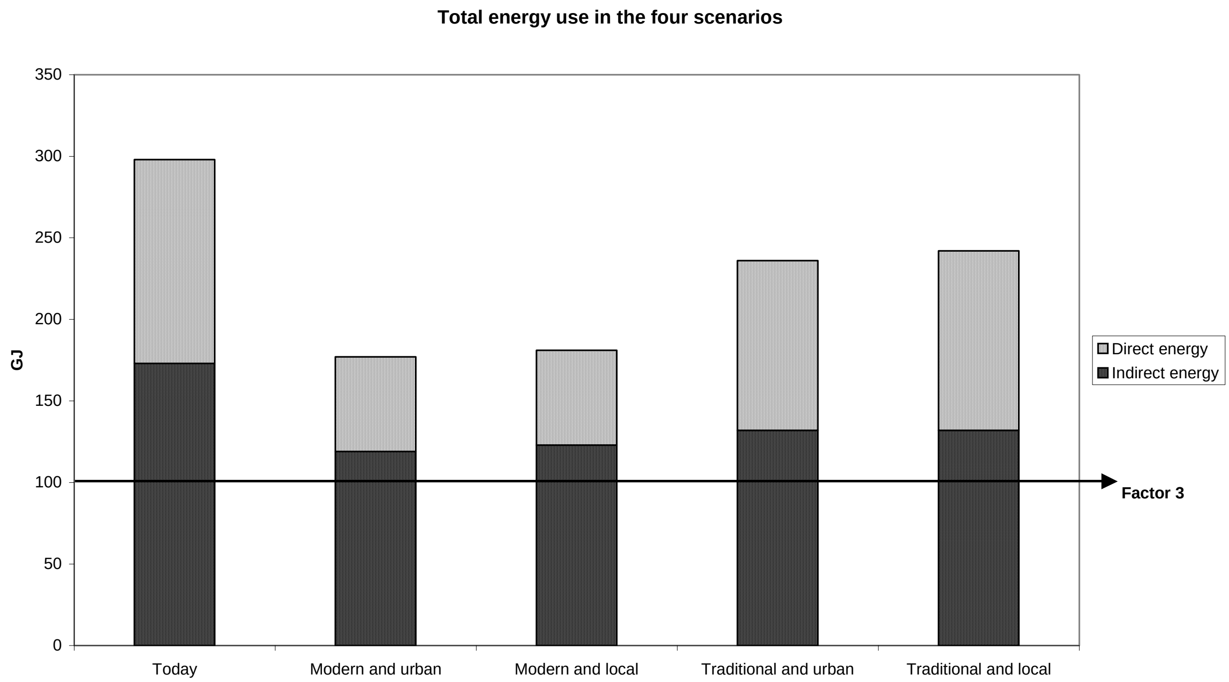
Traditional and urban:

Autofuel use reduced with 50%
Money saved on reduced autofuel used on bus.
Detached houses with same energy demand as today – but with renewable energy

Traditional and local:

Autofuel use reduced with 35%
Money saved on reduced autofuel use used on bus

These results can also be presented graphically:



The goal of Factor 3 (a reduction of energy use by 2/3) is by many regarded as necessary to reach the goal of sustainability.

Discussion

Here we have reported from two workshops held in Fredrikstad, where local stakeholders came up with suggestions for long-term visions of sustainable every-day life in the future in cooperation with researchers from SIFO. For this purpose we employed a back-casting approach developed especially for the ToolSust project by fms in Stockholm. We have made some useful experiences that we think can be valuable inputs to a further development of the back-casting approach as a tool.

Our main conclusion is that the back-casting approach and methodology is a suitable way to include and to a certain extent commit local stakeholders in imaging a future society on a local scale. A challenge will be the communication of the results to the rest of the community, so that they feel committed to it too.

One of the main improvements we suggest on the method applied, is to allocate more time and resources to help the participants "reach" the future in their time travel. As we have seen, many of the suggestions put forward by the stakeholders, were to a great extent based on possibilities already present. Audiovisual facilities like music, drawings or movies to set the participants in a creative mood, are some suggestions to ease the time travel.

On the recruitment we felt we were quite successful, at least on the first workshop. Reminding the stakeholders about the project by figuring in the local press in advance seems to have been helpful. We were also quite insistent in the recruitment process with letters, emails and phones. We are of the opinion that the composition of the group was quite good, reflecting the conflicts and consensus in the Fredrikstad municipality. But it would be advantageous if we had managed to get one or more representatives from the retail business.

By using a tool developed earlier in the project, the Norwegian EAP-programme (Throne-Holst et al., 2003), we were able to give a rough indication of the energy consequences for the stakeholders' proposals. Even though it is only a rough indication, it is a much better and realistic feedback than most policy makers are able to give. These indications were The EAP-programme has its limitations for what we have applied it to here, it is not a very dynamic database, in the sense that the number of parameters that can be manipulated, is quite restricted.

The last workshop was also a nice experience, both according to the stakeholders and ourselves. We should have put more emphasis on getting stakeholders to turn up in the numbers they did on the first workshop. We also believe that the discussion on how to get there, i.e. the most desirable scenario, have room for improvements. The stakeholders should have been asked to be more spesific on the necessary steps on the path towards a sustainable and enjoyable future.

Literature

Banister, D., Stead, D., Steen, P., Dreborg, K-H., Åkerman J., Nijkamp P.,

Schleicher-Tappeser R., 2000. European Transport Policy and Sustainable Mobility. London:Spoon Press.

Carlsson-Kanyama, A., Dreborg, K-H., Engström, R., Henriksson, G. 2003. Possibilities for long-term changes of city life: Experiences of back-casting with stakeholders. Deliverable No. 18 in the ToolSust-project. FMS-Report 178. Environmental Strategies Research Group, Stockholm.

COOL 1999. Climate Options for the Long Term including the Work Plan for Phase 2. Wageningen: Wageningen University.

COOL 2000. Climate Options for the Long Term: Path Analysis. Wageningen: Wageningen University.

Dreborg, K-H. 1996. Essence of backcasting. Futures 28 (9), 813-828.

Eden, C., Ackerman F., 1998. Making strategy. The journey of Strategic Management. Sage Publications.

Hisschemöller, M., Mol, A-P-J. (Eds)., 2002. Climate OptiOns for the Long-Term (COOL) Evaluating Dialogues. Report no: 410 200 119, Dutch National Research Programme on Global Air Pollution and Climate Change.

Methi, N., Stø, E., Throne-Holst, H., Vittersø, G., 2001. Consumption and Environment in Fredrikstad. ToolSust Deliverable No.6: Norwegian National Report. Project Report No.17-2001. SIFO, Lysaker.

Robinson, J.B. 1990. A recipe for people who hate to predict. Futures 22 (8), 820-842.

SSB 2000. Energistatistikk 1998/Energy Statistics 1998. Official Statistics of Norway. Statics Norway: Oslo-Kongsvinger.

Steen, P., Dreborg, K-H., Henriksson, G., Hunhammar, S., Höjer, M., Rignér, J., Åkerman, J., 1997. Färder i framtiden. Transporter i ett bärkraftigt samhälle. KFB rapport 1997:7.

Throne-Holst, H., Stø, E., Kok, R., Moll, H., 2002. Household Metabolism in Fredrikstad. ToolSust Deliverable No. 8.: Norwegian National Report. Project Report 9-2002. SIFO, Lysaker.

Åkerman, J., Dreborg, K-H., Henriksson, G., Hunhammar, S., Höjer, M., Jonsson, D., Moberg, Å., Steen, P., 2000. Destination framtiden. Vägar mot ett bärkraftigt transportsystem. KFB rapport 2000:66.

Appendix

Assumptions and calculations

“Reductions in autofuel use”

Regarding the possibilities for better energy intensities for transport, Steen et al (1997) have made estimations of this potential up to the year 2040. The potential they see for reducing energy use, are given in table A1.

Table A1. Potentials for reducing energy use for passenger traffic until the year 2040, related to year 1995. Unchanged speed and occupation

Transport mode	**Reduction potential**
Car, internal-combustion engine (short distance)	-75%
Car, internal-combustion engine (long distance)	-65%
Bus (short distance)	-60%
Bus (long distance)	-40%
Ferry (about 20 knots)	-30%
High-speed ferry (about 40 knots)	-30%
Rail (long and short distance)	-50%
Air	-50%

Table A2 How energy for transportion were specified in Work Package 2:

Description	**Energy intensity (MJ/NOK)**
organized holiday trips domestic	1,20
organized holiday trips abroad	2,08
train	1,55
taxi	0,67
other public transport	0,29

If we use the potentials for reduction given in Table A1, we get the following energy intensities for different travel modes in 2040. For Other public transport, we use the numbers for buses (short distance), as there are no subways or trams in Fredrikstad. For the category Organized holiday trips abroad, we consider it to be dominantly air travel. It is considered synonymous to the category *Package tours, abroad* in the Norwegian Consumption study.

Concerning the organized holiday trips doemstic, this will probably be a mixture of train, long-distance buses and air travel, and the subsequent reduction in energy need should be around 50%.

In line with the Swedish assumption (Carlsson-Kanyama et al., 2003), we consider that production processes are 30% more effective in 2040, so the new energy intensity of the car itself, is reduced from 1,25 MJ/NOK to 0,88 MJ/NOK.

Table A3 Energy intensities for different travel modes, today and in 2040.

Transport modes	**Today**		**2040**	
	MJ/pkm	**MJ/NOK**	**MJ/pkm**	**MJ/NOK**
Rail/Train	1,07	1,55	0,54	0,78
Taxi	5,74	0,67	1,44	0,09
Other public transport	1,87	0,31	0,75	0,12
Organized holiday trips abroad		2,08		1,04
Organized holiday trips domestic		1,20		0,60

"30% more energy effective production of goods"

It is assumed that 40 years from now 30% less energy will be needed during the whole production chain off all goods and services. This includes more energy efficient transport of goods. Accordingly we multiplied the energy intensity per unit result from EAP, by 0,7. Travel and direct energy are not included in this exercise.

"Organic food"

For all scenarios we assumed organic food products, as this was suggested in the workshop, and seemed to fit into the description of all scenarios. To calculate the energy consequences of this, we assumed that the energy requirement to produce organic food is 20% less than what is needed for conventional products. The energy per kilo for all food stuffs in the EAP-datafile "Basic goods" were consequently reduced with 20%.

"Local food"

To see the effect of locally produced food stuffs, we set the transport distance in the EAP-model for all *relevant* products to 100km. By relevant we understand foods that we consider can be produced locally (not bananas, pineapples, oranges etc.).

"Less meat, no chocolates, snacks or soft drinks"

Here we used numbers supplied by the Swedish team. Reducing consumption of meat, greenhouse vegetables, soft drinks and junk food, and increasing the consumption of legumes and root vegetables. These measures result in a 20% reduction in the indirect energy use on foods.

"No packaging"

Another of the suggestions from our workshop that we considered relevant for all scenarios, is that we in the future would have no packaging at all. To calculate the consequences of this, we sat the energy per kilo of packing material to zero in the EAP-datafile "Packaging".

"Shared housing"

In our Modern-scenarios we envision shared housing. This will also have consequences for direct energy use. We assume that this form of living result in a 40% reduction in energy demand for heating. This is equal to the difference between detached houses and flats in Norway in 1990.

"Public eating"

In 1990, 4% of direct energy use in Norway were used for cooking (SSB, 2000). In the scenarios were public eating is relevant, we imagine this to be redused to 1%.

The Contribution of Research *in Dialogue with Reflective Practice* for Sustainable Consumption

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ABSTRACT
Life cycle assessment is a top-down, rationalist, positivist, analytical method, and so are the life cycle-based methods, studies, and models being developed by the international community working on life cycle-based sustainable consumption and production (SCP). Meanwhile, fields of practice of development, education, research, evaluation and corporate governance, all relevant to and connected to sustainable consumption and production, are each in the process of being transformed from the bottom up, by "cells" of localized reflective practice. When we consider these processes all at once, as in the present paper, what emerges is the possibility for what might be called a "participation revolution." However, what each of these participatory practice domains lack, as does SCP itself, is institutions enabling global dialogue between over-arching research and bottom-up, reflective practice. Also missing are institutions that enable the cells of reflective practice to dialogue with each other. This paper briefly surveys participatory methods in each of the fields of practice. The paper the describes and promotes a holistic approach based on emerging Internet technologies to engage top-down, positivist research in evolutionary dialogues with bottom-up participatory methods. The paper outlines a way to use the semantic web and grounded metadata to create a true dialogue between SCP practice and SCP research, methods, tools, and predictive models. As we advance our own goal of enabling SCP to become a coherent body of research integrated with practice, we can simultaneously pilot and refine infrastructures that will empower the participation revolution to come to life.

Introduction: Positioning Life Cycle-Based Methods for Sustainable Consumption: On Top

"LCA is a technique for assessing the environmental aspects and potential impacts associated with a product… throughout a product's life (i.e., cradle to grave) from raw material equisition through production, use, and disposal."[4]

"The impact categories, category indicators, and characterization models should be internationally accepted, i.e., based on an international agreement or approved by a competent international body;…value choices and assumptions made during the selection of impact categories, category indicators, and characterization models should be minimized; …the characterization model for each category indicator should be scientifically and technically valid, and based upon a distinct identifiable environmental mechanism and/or reproducible empirical observation."[5]

Life cycle assessment is a top-down, rationalist, positivist, analytical method, and so are the life cycle-based methods, studies, and models being developed by the international community working on life cycle-based sustainable consumption. By these terms, we mean:[6]

Reductionism: (1) the attempt to explain processes by the same explanations (as by physical laws) that chemists and physicists use to interpret inanimate matter; (2) a procedure or theory that reduces complex data or phenomena to simple terms

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[4] ISO 14040, *Life cycle assessment: Principles and framework*, Geneva: International Standards Organization, 1997, p. iii.
[5] ISO 14042, *Life cycle assessment: life cycle impact assessment*, Geneva: International Standards Organization, 1999. Section 5.3.
[6] http://www.m-w.com/cgi-bin/dictionary

Analysis: separating something into component parts or constituent elements.

Positivism: a theory that theology and metaphysics are earlier imperfect modes of knowledge and that knowledge is based on natural phenomena and their properties and relations as verified by the empirical sciences.

Logical positivism, also called logical empiricism, is a 20th century philosophical movement that holds characteristically that all meaningful statements are either analytic or conclusively verifiable or at least confirmable by observation and experiment.

The ISO standards and LCA guidebooks characterize LCA as a method for describing a product system and its impacts on the environment objectively, analytically, and quantitatively. The purpose is to provide *objective* information to support design of policies by policy makers, design of products by manufacturers, and selection of products by buyers. *Objective* information describes a reality that is independent of any observer, "perceived without distortion by personal feelings, prejudices, or interpretations." Contrast this with *subjective*, "characteristic of or belonging to reality as perceived rather than as independent of mind; relating to or being experience or knowledge as conditioned by personal mental characteristics or states; peculiar to a particular individual; modified or affected by personal views, experience, or background."[7]

The current analytical, positivist approach to sustainable consumption via extensions of LCA is well-expressed by the announcement for the workshop to which this paper is submitted:[8]

"The implementation of sustainable consumption requires research to assess the environmental impacts of different lifestyles, to develop proposals for changes in consumption patterns, to deliver insights into the factors that shape consumption, to develop and evaluate scenarios, and to study and evaluate efforts of implementation. It requires research to deliver tools and information to policy makers, industry and the interested public."

As Reed et al. (2005) note: "Like most positivist science, reductionist frameworks tend towards the top-down development of indicators that is led by experts."[9] This effectively characterizes current practice in LCA-based SC as well. Using positivist methods of experiment and analysis and expert-based indicators, we experts strive to identify and design options that are objectively best for the environment, for human health, and even (most recently) for human happiness. Then we use more expert analysis to characterize drivers of consumer behavior and to build models predictive of consumer responses to product and policy design; and finally we use a combination of product engineering, marketing/communication and advertising to steer consumers towards more sustainable behavior. Note the one-way flow of information from policy makers and manufacturers to drive consumer behavior, as expressed in slides from a recent meeting in our workshop series.[10]

The point being stressed here is *not* that the current approach is objectively wrong. Rather this paper suggests that the top-down, positivist approach is incomplete. Reed et al. (2005) have demonstrated in several case studies how top-down and bottom-up processes for developing impact measurement systems and sustainability indicators are complimentary and both needed. Top-down approaches bring knowledge from outside the application cases; bottom-up methods were shown to provide indicators that are more easily measured, understood and communicated,

[7] http://www.m-w.com/cgi-bin/dictionary
[8] http://www.indecol.ntnu.no/events.php
[9] Reed, Mark, Evan Fraser and Andrew Dougill, 2005. "An integrated methodological framework for developing and applying sustainability indicators with local communities", draft manuscript provided by author.
[10] Slides kindly provided by Dr. Atsushi Inaba during the 2004 meeting in Leeds, for a presentation titled "Life Cycle Approaches to Sustainable Consumption."

and the bulk of which (e.g., 90%) were consistent with scientific understandings of the cause-effect chains. Thus, this paper describes and promotes a holistic approach based on emerging Internet technologies to engage top-down, positivist research in evolutionary dialogues with bottom-up participatory reflective practice methods for SCP. To summarize ahead of time: Researchers in SCP need, at this moment, to do more than develop among ourselves a common research agenda and system for inter-comparison of results; further, our linkage to practice needs to be much deeper than case study comparisons. In addition we need to hear from and learn from the actors in practical, critically self-reflective projects at each step in their implementation. From these actors we need to be able to learn which indicators they seek, which indicators they find useful and why; what kinds of predictive analyses with what results are needed; how well the presently available tools are serving their needs; what external resources (including but not limited to analysis, prediction, and impact estimation) to they seek from external experts and from each other in order to better progress on SCP. Before describing the proposed integration, the paper next introduces participatory methods.

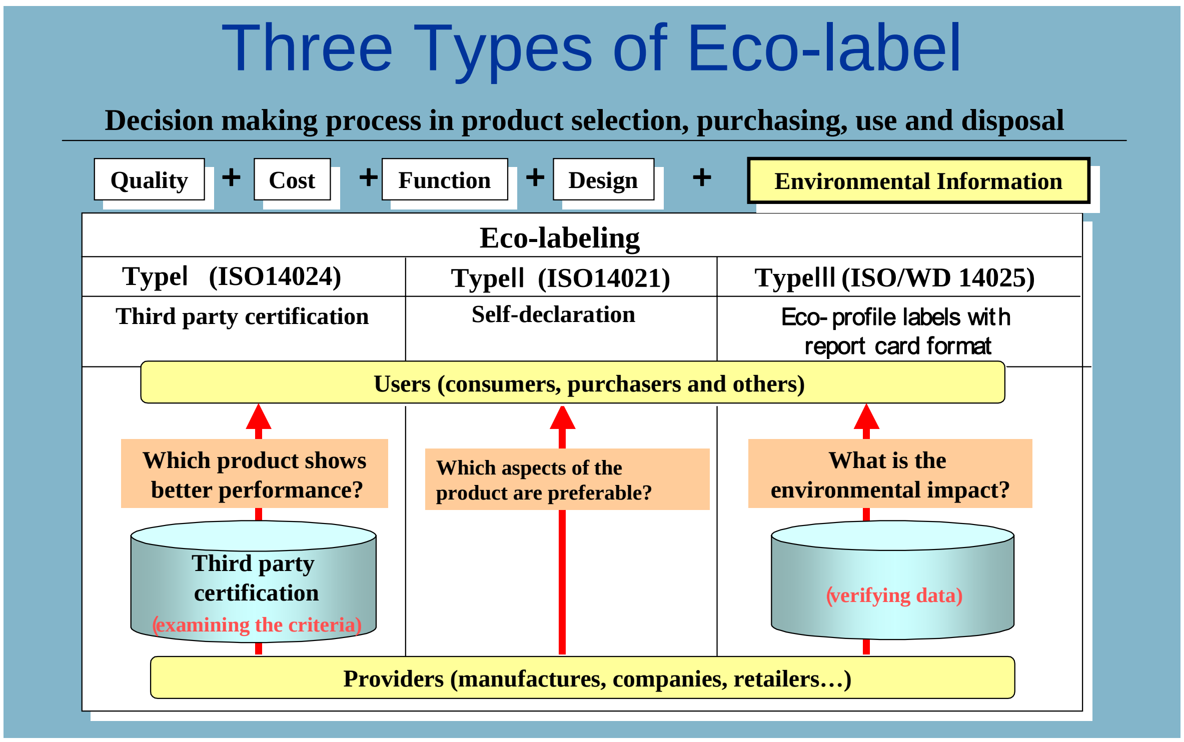

Figure 1: Note the one-way flow of influence from providers to consumers/purchasers

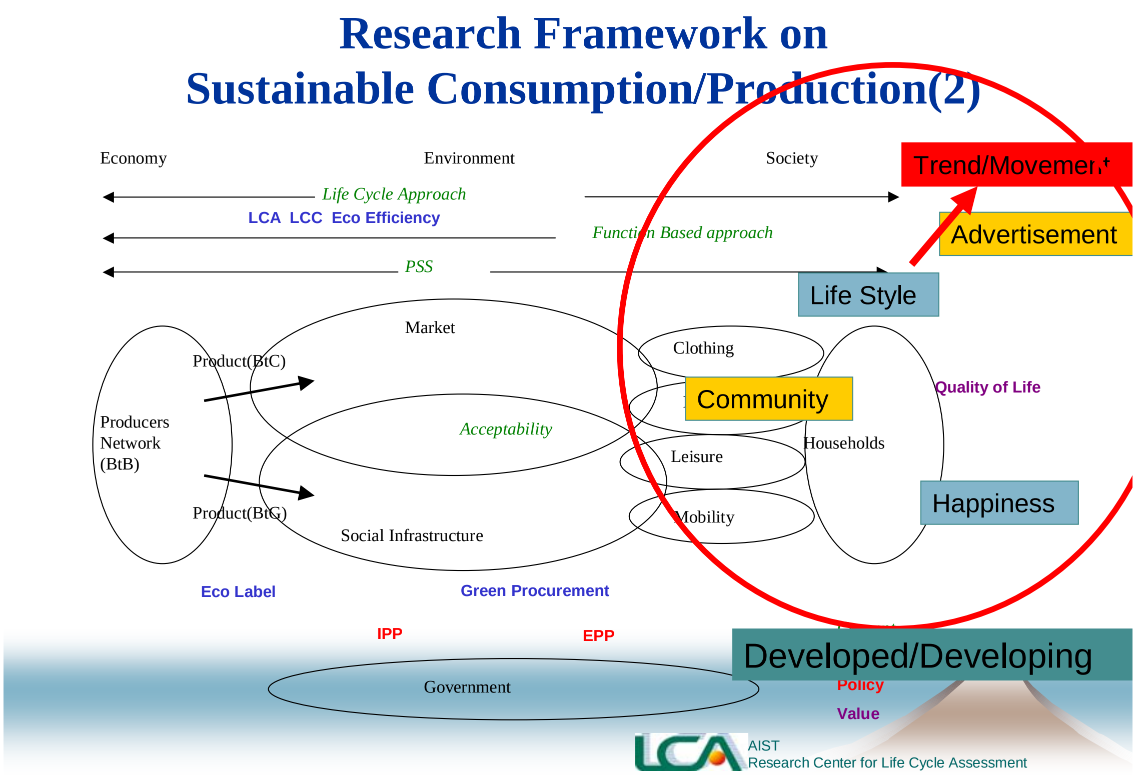

Figure 2: Note the flow of influence on consumers from government and the market

An Introduction to Participatory Methods for Life Cycle SC Modelers

There is a vast breadth of methods and applications of participatory methods that are relevant for application to one or more aspects of life cycle-based sustainable consumption. This is because of the broad spectrum of planning, action, and evaluation encompassed by the topic of sustainable consumption, and because of the wide scope and variety of participatory methods in use and ongoing development. Drawing on a review of participatory methods relevant to sustainable consumption and development, this section attempts to summarize and position the available methods and fields of expertise.

We begin by considering a general linear process of planning/action/evaluation which is characteristic of LCA, product policy development, eco-labeling, and cleaner production. This linear process is intentionally described in general enough terms to also relate to natural resource management, development projects, the definition and use of sustainability indicators, and local Agenda 21 activities. In Figure 3a, the process is not only linear, but also drawn to depict the currently mainstream approach within the LCA-based SC fields: top-down, expert-driven and expert-centered planning, implementation management, and evaluation.

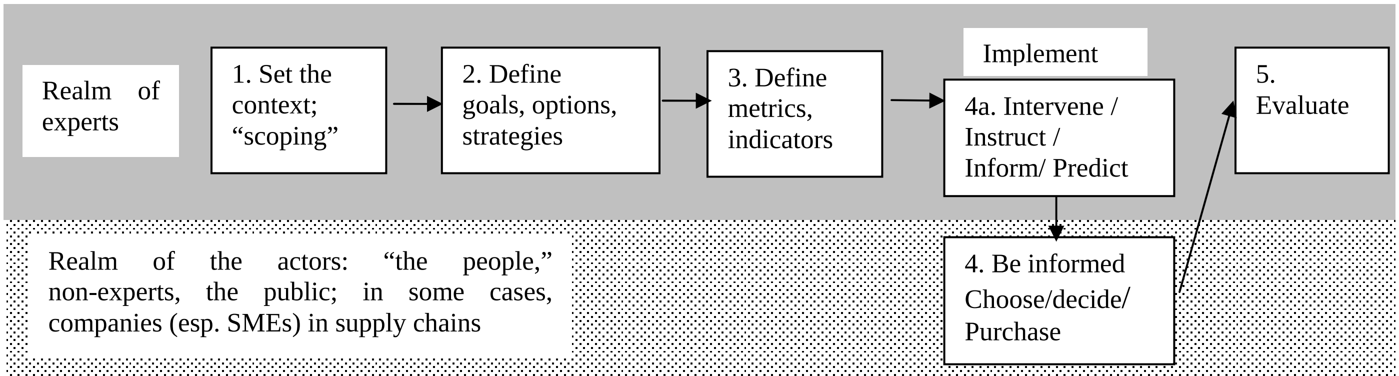

Figure 3a: Mainstream Top-Down Linear Framework for Planning/Implementation/Evaluation

Participatory methods, as a broad group, entail one or more of the following changes to the mainstream framework:

1. *Participatory evaluation* methods share some control over the evaluation step with the actors. The degree of control sharing, the way control is shared, and the rationale for sharing control varies significantly among methods of participatory evaluation, as will be briefly summarized below. In many cases, sharing control over evaluation also entails sharing control over definition of the metrics and indicators. The mainstream framework, modified to incorporate participatory evaluation, is depicted in Figure 3b.
2. *Participatory development* methods bring the actors more degrees of control over the planning and implementation phases. As with participatory evaluation, the degree, the way, and the rationale for control sharing varies among the methods. The mainstream framework, modified to incorporate participatory development without participatory evaluation, is depicted in Figure 3c.
3. Participatory methods, because they tend to share some planning and/or evaluation tasks with the actors, often lead to a closer *connection between action and learning*. There are two ways this gets reflected in the methods.
   - First, there may be explicit attention to, and design for, the learning that takes place during the acting ("learning by doing").
   - Second, especially if the implementation is done by a permanent organization rather than a temporary project or analysis team, there may be a shift from the linear model of plan/act/evaluate to a cyclical or spiral model where the lessons from each iteration "feed back" into the planning for the next iteration. A cyclical model of highly participatory planning and evaluation is presented in Figure 3d.

The emphasis on the actors as learners and evaluators, on the knowledge of the actors before and after the intervention/implementation, helps re-cast the "experts" more precisely as "external experts" and the actors as "internal experts."

Of course "learning" is surely present in the mainstream, linear, rationalist/positivist, top-down model as well: it is what we call "research." In this model, the learning is done by experts in the research community, which itself is often outside the realm of the practitioner experts and policy makers who plan, implement and evaluate. This is "objective research", collecting and analyzing case studies; making cross-sectional comparisons; performing statistical analysis; looking for trends, patterns, and factors that can help explain outcomes; and building, testing, and refining predictive models. As will be emphasized later, external observer-based learning is neither better nor worse than, neither a replacement nor replaced by, the internal, participant-based learning of participatory methods. Both kinds of learning are essential; *what we need to implement is a process for dialogue among them.*

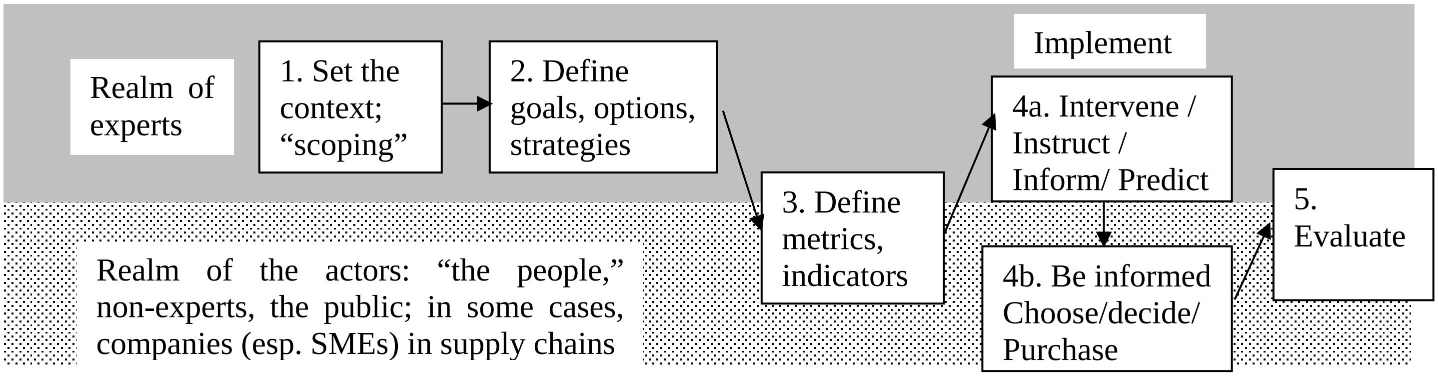

Figure 3b: Participatory Evaluation, sharing control of metric development and evaluation

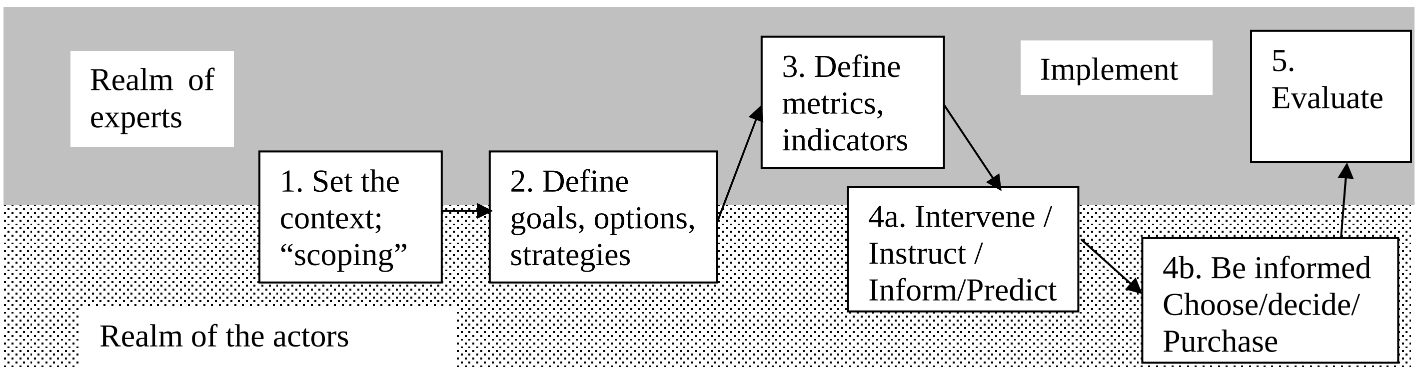

Figure 3c: Participatory Development, sharing control of planning and implementation

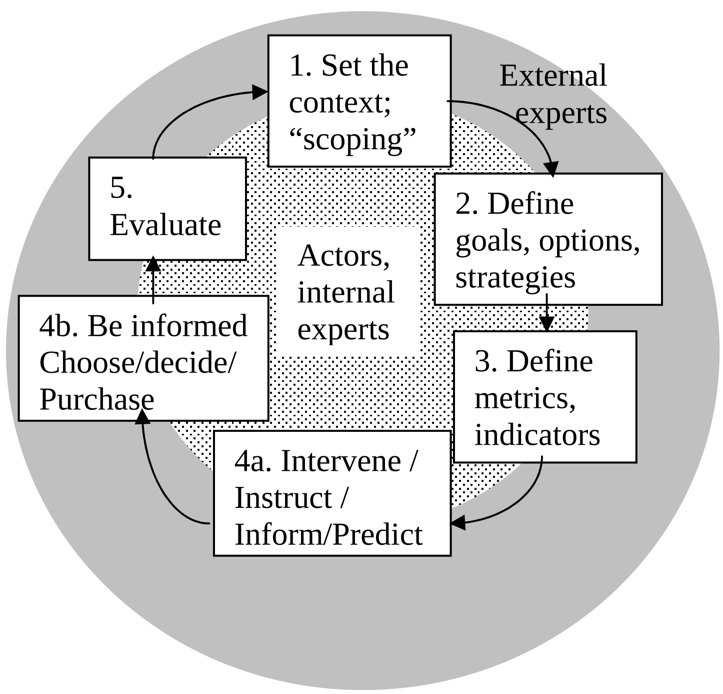

Figure 3d: Participatory development and evaluation in a learning loop

Very Brief Survey of Participatory Methods

As described in the previous section, participatory methods may be grouped under two major headings: one related to evaluation, research, or "inquiry", and the other related to development, action, implementation. As also described above, these methods work towards a linkage of reflection and action, evaluation and implementation. Thus, while coming from different fields and domains of practice, they progress towards culmination in a holistic action/reflection loop as was illustrated in Figure 3d.

In addition to evaluation and development/implementation, a third domain of practice, education (especially adult education) has had its own movement for increased participation. Particularly in the developing world, this "popular education" movement has strongly influenced participatory evaluation, and has increasingly merged with participatory development. Finally, we also note that in the private sector, an "unfolding stakeholder engagement" model is taking shape and bringing businesses great value as they cede increased co-control and responsibility to stakeholders.

The four fields of practice -- Development, Evaluation, Education, and Corporate Governance – and the movements for increased popular control/empowerment plus the increased integration of learning and action, are depicted as parts of a "meta-movement" in Figure 4.

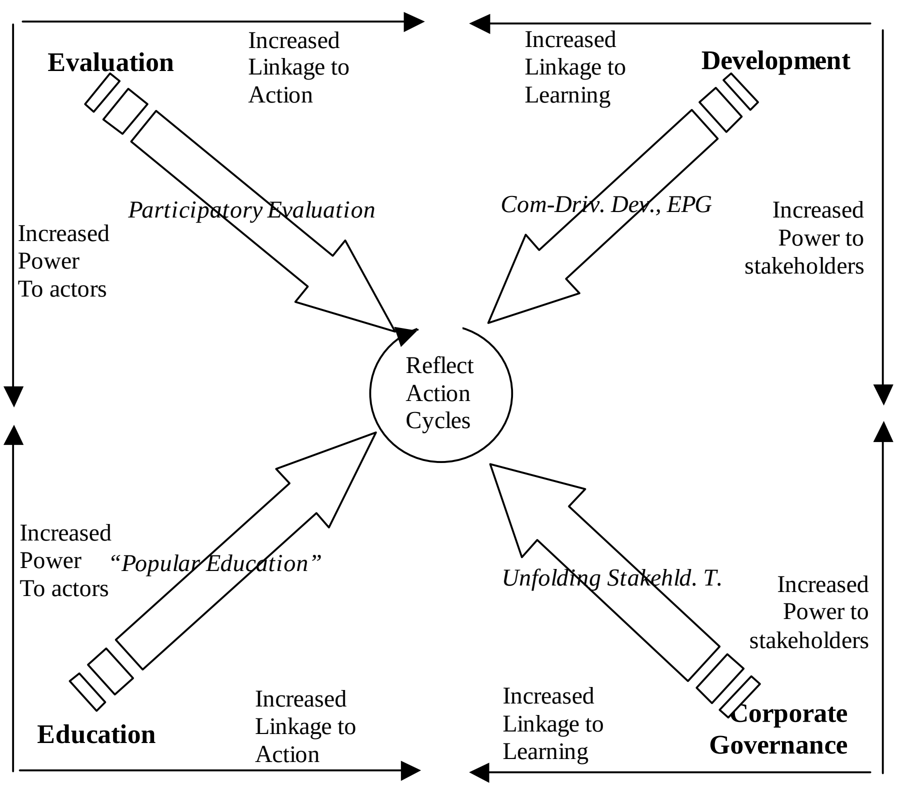

Figure 4: The "Participation Revolution": Towards empowered, context-specific reflect/action cycles

Participatory Evaluation: "Collaborative Inquiry"

Evaluation "involves the production of knowledge about the effectiveness and efficiency of development interventions."[11] Participatory evaluation (PE) can be defined as "a process of self-assessment, collective knowledge production, and cooperative action in which the stakeholders in a development intervention participate substantively in the identification of the evaluation issues, the design of the evaluation, the collection and analysis of data, and the action taken as a result of the evaluation findings." (Jackson and Kassam, 1998. p. 3)

In a review of the broad field of methods grouped under a heading of "collaborative inquiry", Cousins and Witmore (1998) differentiate and position the many PE approaches in terms of their "how" (using three dimensions of process) and their "why" (their function, based on a underlying philosophical or political intent). As dimensions of process they use:

- Control of the evaluation process (Ranging on a spectrum from research-controlled to practitioner-controlled)
- Depth of participation (ranging from consultation to deep participation); and
- Scope of stakeholder participation (ranging from primary users to "all legitimate groups")

They then situate each of the following methods for collaborative inquiry within this 3-dimensional grid, citing its originating authors and practitioners: Stakeholder-based evaluation, school-based evaluation, democratic evaluation, developmental evaluation, empowerment evaluation, participatory action research, emancipatory action research, and cooperative inquiry.

The underlying *intent* of a PE method (and its practitioners) is, for Cousins and Whitmore,[12] ultimately even more important than the mechanics of the process. Building on similar observations by Garaway (1995) and Pursley (1996), they differentiate two streams of participatory evaluation, which they label as *practical* PE and *transformative* PE. A very brief condensation of their review follows.

Practical PE has arisen primarily in the US and Canada. Its primary function is to foster the *use* of evaluation. It adopts participation for practical reasons. Its core premise is that stakeholder participation in evaluation will enhance evaluation relevance, ownership, and thus utilization.

In contrast, transformative PE methods invoke participatory principles and actions in order to democratize social change. The transformative methods have quite different ideological and historical roots from practical participatory methods. Transformative PE emerged in the early 1970s, primarily but not exclusively in the developing world – notably Latin America, India, and Africa. This emergence was in part as a reaction to positivist models of research and evaluation that were seen as exploitive and detached from urgent social and economic problems. The transformative methods are deeply rooted in, and primarily practiced by, members of movements for community and international development, adult education, and the women's movement. The work of Brazilian adult educator Paulo Freire has been central in providing the philosophical base for transformative PE.

Three key characteristics of transformative PE are:

- A central aim is to empower people through participation in the process of constructing and respecting their own knowledge;
- The distance between researcher and researched is broken down; all participants are contributors working collaboratively;
- Critical reflection calls for participants to question, to doubt, and to consider a broad range of social factors, including their own biases and assumptions.

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[11] Jackson, Edward and Yusuf Kassam, eds., 1998: *Knowledge Shared: Participatory Evaluation in Development Cooperation.* West Hartford, CT, USA: Kumarian Press.

[12] Whitmore, Elizabeth, 1998: *Understanding and Practicing Participatory Evaluation.* San Francisco: Jossey-Bass.

In summary, transformative PE conceives of evaluation as a *developmental* process which, by involving less powerful stakeholders in investigation, reflection, negotiation, decision making, and knowledge creation, changes or transforms individual participants and power dynamics in the social and cultural contexts. (Pursley, 1996).

Participatory Development

We suggest the consideration of two broad fields of practice under the heading of Participatory Development. These are Community-Driven Development within the development field, and the broader set of experiments that Fung and Wright (2003)[13] label "Empowered Participatory Governance."

Community-Driven Development is a field of practice and theory that increasingly overlaps with the field of participatory evaluation described earlier. It has arisen through increased use of participatory methods in designing and carrying out development projects. An excellent review of the theory, methods, track-record and challenges within the international field of Community-Driven Development is provided in (Narayan 2002).[14] Therein, Community-Driven Development is defined as "The process of giving control of development decisions and resources to community groups. Communities can be geographic entities, such as urban neighborhoods or rural villages, or groups with common interests, such as water user associations, parent-teacher associations, herders, members of a micro-credit society, or women's groups. Once formed, these groups typically work in partnership with support organizations and service providers – local governments, the private sector, or NGOs – to develop and implement projects that meet their immediate priorities in education, health, sanitation, transportation, resources management, economic activities and other livelihood issues." (Dongier et al., 2002, p. 209.)[15]

It has become widely appreciated that the effectiveness of development assistance hinges critically on the degree of ownership and control experienced by the communities who are developing. This finding has been consistently documented at levels from villages to continents.[16], [17], [18], [19], [20]

The advantages of community-driven development stem from such factors as:

- The value of local expertise and information, providing a better appreciation of the problems and insights concerning the most effective solutions
- The increased level of motivation that comes from being able to exercise control over the decisions that affect one's life and development.
- The accountability for positive results that goes hand-in-hand with sharing control.
- The lasting benefits of capacity development that results from the participatory involvement.

As a result of the proven effectiveness, lasting benefits, and well-established track record of participatory and empowerment approaches to development, the approaches have gone from being a "fringe" or cutting edge concept and method during the 1980s to a more mainstream

[13] Fung, Archon and Erik Olin Wright, 2003: *Deepening Democracy: Institutional innovations in empowered participatory governance.* London: Verso.

[14] Narayan, Deepa, ed., *Empowerment and Poverty Reduction: A Sourcebook.* Washington, D.C.: World Bank.

[15] Dongier, Philippe, D. Owen, A. Ryan, T. Shah, I. Pswarayi-Riddihough, and D. Narayan, 2002: "Community-Driven Development", in Deepa Narayan, ed., 2002.

[16] Naryan 2002.

[17] Kanbur, Ravi and Todd Sandler, 1999: *The Future of Development Assistance.* Washington, DC: Overseas Development Bank.

[18] Murphy and Cunningham 2003.

[19] Richardson, Jean, 2000: *Partnerships in Communities.* Washington, DC: Island Press.

[20] Fung, Archon and Erik Olin Wright, 2003: *Deepening Democracy.* New York: Verso.

characteristic of development projects at the local level as funded by institutions including the World Bank and the Asian Development Bank.[21]

Fung and Wright (2003) assert that a wide variety and increasing number of experiments in local governance, in both developing and industrialized contexts alike, share surprising similarities in motivating principles and institutional design features, having “enough in common to warrant describing them as instances of a novel, but broadly applicable, model of deliberative democratic practice that can be expanded both horizontally – into other policy areas and other regions – and vertically – into higher and lower levels of institutional life” (p. 15). They name this model Empowered Participatory Governance (EPG).

EPG attempts to advance three currents in social science and democratic theory. First, it applies deliberative processes to concrete maters such as street paving, school improvement and habitat management. Second, it builds on the recent body of work that shows the importance of civic life and non-governmental organizations to vigorous democracy. Finally, EPG is “part of a broader collaboration to discover and imagine democratic institutions that are at once more participatory and effective than the familiar configuration of political representation and bureaucratic administration.”

Fung and Wright suggest that three general principles are fundamental to all EPG experiments:

1) A focus on specific, tangible problems;
2) Involvement of “ordinary people” affected by these problems as well as officials close to them; and
3) The deliberative development of solutions to these problems.

They then suggest that three institutional design features enable effective implementation of these principles:

A) The devolution of public decision authority to empowered local units;
B) The creation of formal linkages of responsibility, resource distribution, and communication that connect these units to each other and to centralized authorities; and
C) The use and generation of new state institutions to support and guide these decentralized problem-solving efforts.

Building on Fung and Wright’s claim that the practice of EPG can be expanded into other policy areas, this paper argues for its application in sustainable consumption-related development experiments occurring in communities within the global consumer class. These experiments will learn from and compliment the advanced state of participatory democratic practice among development projects in the “developing world.” Such experiments within the consumer class include initiatives and even small movements related to assessment and greening of household consumption at the neighborhood level; lifestyle design, and the broader movement of sustainable community planning under, for example, Local Agenda 21. The design challenge is to make these experiments more participatory, deliberative, integrated within learning frameworks, using knowledge and techniques from the broader “participation revolution.”

Popular Education and Participatory Research

The work of Paulo Freire, cited earlier for its influence on participatory evaluation, lies at the heart of “Popular Education” movements in Latin America. An excellent historical and contemporary review of these movements is provided in (Kane 2001).[22] The translation from Spanish or Portuguese into “popular” is imperfect; the word in Spanish and Portuguese invokes poor, working-class, peasant class, and less empowered segments of society. Popular education

[21] Sweetser, Anne, 2002: “Participation and social capital: The ABD experience.” Presented at the conference on “Participation for Global Action and Change”, University of Guelph, Ontario, Canada.

[22] Kane, Liam, 2001: *Popular Education and Social Change in Latin America.* London: Latin America Bureau.

is a body of educational methods, theory and practice aimed at helping people in these societies to overcome oppression and injustice.

Another distinguishing feature of the Popular Education movements in Latin America is their integration of education and organized social action. As Kane writes: "Action or 'social practice' is the primary concern of popular education; people are encouraged to step back, metaphorically, from their practice, examine it objectively and then, strengthened by this reflective process, re-engage in action. In its turn, the new form of action is subject to the same critical appraisal, in a constant spiral of action-reflection-action, which Freire, borrowing from Marx, referred to as 'praxis'." In light of Kane's review, the boundaries between "Popular Education" and both participatory evaluation and community-driven development appear to be semantic than substantive. The writings and practice of Ira Shor (1992)[23] and the half-century legacy of the Highlander Center in the Appalachian US[24] are two North American cousins of Popular Education.

Closely related to empowerment development, participatory evaluation, and popular education are the bodies of *research* that seek directly to empower local communities. These include participatory rural appraisal (PRA) and Participatory Action Research (PAR). They both represent well-tested instruments for engaging beneficiaries in collective research exercises.[25]

PRA is a contemporary variant of Rapid Rural Appraisal and Agroecosystem Analysis, both of which appeared in the late 1970s.[26] All are intended to help link the scale of individual farms and villages with the regional scale of development, but the more recent PRA especially emphasizes a grass roots approach that is focused on empowering decision making and application at the local level.[27] Likewise, PAR, or simply participatory research, is a method of research that attempts to enable marginalized groups to increase their power by acquiring serious and reliable knowledge.[28] Emerging from the fields of sociology and anthropology, it pays special attention to methods that value indigenous culture and history while producing and diffusing new knowledge.

Another closely related and promising body of participatory research practice has been referred to as "citizen science,"[29] of which perhaps the most shining example is the decades-long evolution of village-level resource mapping and management methods in India. During the 1990s this "people's science movement" led to the People's Biodiversity Registers program, involving hundreds of rural and forest-dwelling communities. Reviews of Indigenous American perspectives on ecological/sustainability science are provided by [Cajete, 1999 and 2000].[30],[31] The focus of these approaches is to capture these communities' understandings of their natural

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[23] Shor, Ira, 1996: *Empowering Education: Critical teaching for social change.* Chicago: Univ. Chicago Press.

[24] Adams, Frank, 1975: Unearthing Seeds of Fire: The Idea of Highlander. Winston-Salem: Blair.

[25] Freedman, Jim, 1998: "Simplicities and complexities of participatory evaluation. In Jackson, Edward and Yusuf Kassam, op cit.

[26] Chambers, Robert, 1994. "The origins and practice of participatory rural appraisal. *World Development 22:* 953-969.

[27] Berkes, Fikret, 2002: "Cross-scale institutional linkages: Perspectives from the bottom up". In *The Drama of the Commons,* Washington, DC: National Academy Press.

[28] Jackson, Edward and Yusuf Kassam, 1998: *Knowledge Shared: Participatory Evaluation in Development Cooperation.* West Hartford: Kumarian Press, p. 10.

[29] Berkes, 2002. p. 307.

[30] Cajete, Gregory A. 1999: *Ignite the Sparkle: A Native Amerian Science Education Curriculum Model.* Skyland, North Carolina: Kivaki Press.

[31] Cajete, Gregory A. 2000: *Native Science: Natural Laws of Interdependence.* Santa Fe: Clear Light Publishers.

environment and resources, of ongoing ecological change, of their development goals and how they wish to manage their resources.[32]

Corporate Governance and “Unfolding Stakeholder Thinking”

A fourth quadrant to Figure 4 is added by considering the evolution of increasingly participatory approaches to corporate governance. This is clearly relevant to the “cleaner production” and product life cycle design side of sustainable consumption and production.

The term “stakeholder perspective” was first used in the early 1960s, amid a growing realization that there are people and organizations other than the stockholders who are affected by the operations of a firm.[33] The concept of “stakeholder management” by companies was introduced and popularized in 1984 by a book which introduced a definition for stakeholder that is still widely used today: “A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization’s objective.”[34]

The basic mindset within this field from 1984 through the late 1990s (and indeed, still among perhaps the large majority of participants) is one that frames the corporation as the primary agent, and examines the ways in which corporations can improve their long-term business prospects by “managing” stakeholder perceptions and actions. Corporate units dealing explicitly with issues management emerged during the 1980s, along with other functions designed to deal proactively with external stakeholders: community relations, media relations, customer relations, investor relations.[35] Of course, corporations may survey and listen to stakeholders as part of this “management” model, but there is no ceding of even partial control to the stakeholders. Industries cling to the one-way, management approach to stakeholder engagement out of a perceived need for control of the process. Ironically, companies less-effectively achieve their larger business goals with such an approach, for two reasons: lack of stakeholder buy-in, and stone-walling.

As Epstein and Roy show,[36] the business case for sustainable development hinges on stakeholder responses. “Sustainability performance and actions are drivers of stakeholder reactions. It is through stakeholder reactions that managers can accurately translate actions and performance into the resultant costs and benefits.” It has been extensively documented that stakeholder responsiveness is greatly enhanced by (and perhaps increasingly, *requires*) *ownership* of the process results by the stakeholders.[37] Ownership is enhanced when stakeholder share in all phases of the engagement from problem framing, options generation, evaluation and selection.

One reason that businesses cling to control is that some have experienced unreasonable demands from stakeholders who were unwilling to depart from their *a priori* stance, to “give and take”, to honor the real trade-offs inherent in the situation. Adopting an immovable stance in a dispute is referred to as “stonewalling.” Again ironically, it is by fully engaging and at least partially empowering stakeholders that companies can move beyond stakeholder stonewalling. This involves invoking the emerging concept of *Stakeholder Responsibility.*

Fuelled by processes of dialogue and stakeholder engagement strategies, we can see the beginning of important shifts in understanding the role(s) of companies with respect to other actors in society. Stakeholder responsibilities create a situation of mutual engagement and responsibility. Stakeholders who place demands on firms or other organizations have some

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[32] Gadgil, et al., 2000: “New meanings for old knowledge: The People’s Biodiversity Registers programme. *Ecological Applications 10:* 1251-1262, cited in Berkes, 2002.

[33] J. Andriof, S. Waddock, B. Husted and S. Rahman (2002) *Unfolding Stakeholder Thinking: Theory, Responsibility and Engagement.* London: Greenleaf.

[34] R.E. Freeman (1984) *Strategic Management: A Stakeholder Approach.* Boston: Pittman.

[35] Andriof, Waddock, Husted, Rahman (2002) p. 12.

[36] M. Epstein and M-J Roy (2003) “Making the business case for sustainability: Linking social and environmental actions to financial performance”, *Journal of Corporate Citizenship* 9:79-96.

[37] Kanbur, Sandler, and Morrison (1999).

responsibility for assuring that their demands do not have significant unintended negative consequences. Consequences of stakeholder demands can apply to the firms themselves or other stakeholders whose interests and needs have not been fully understood or taken into account. Stakeholder responsibilities suggest the need for an active process of mutual engagement and in giving 'voice' and even a degree of influence to activists and other outside stakeholders who may be critical of the firm.[38]

A recent interpretation of the World Summit on Sustainable Development made a similar point about NGO responsibility. "NGOs … need to improve their efforts at practicing what they preach in terms of accountability, stakeholder dialogue and legitimacy. They should also develop a more differentiated view of business that goes beyond black-and-white caricature."[39]

<u>Final Considerations about Participatory Methods</u>

Building on the emphasis of Cousins and Whitmore (1998) on identifying the underlying intent of the participatory methods, I would expand from their list of two threads (pragmatic versus emancipatory) to suggest four primary rewards that stem from participatory methods.

1. Pragmatic 1: Greater impact through buy-in and ownership.
2. Pragmatic 2: Increased quality of information and relevance of solutions (local actors have good ideas for context-relevant solutions)
3. Emancipation, empowerment (human development and greater equity in power relations)
4. Pluralism, dialogue: information output from the local to the whole: local actors have wisdom that is sealed within these communities until the rest of find a way to listen.)

Power-sharing and empowerment are achieving outcomes 1-3. In the final section we turn to how to better reap the 4th reward. First, we need to consider a process called dialogue.

On Dialogue

The central proposal of this paper is to create structures of *dialogue* between reflective practice and research for sustainable consumption (and production) (and development). But what is meant by "dialogue"? This is a critical concept, at the heart of the whole proposal. Key resources on this concept include the work of David Bohm[40], Scot Peck,[41] and William Isaacs.[42]

One way of understanding dialogue is by contrasting it with our more conventional forms of communication. Isaacs refers to dialogue as "thinking together" rather than "thinking alone" albeit in each others' presence. Bohm contrasts dialogue with discussion. Discussion comes from the same route word as percussion and concussion. In a discussion, opposing or conflicting views contend for supremacy; the goal in a discussion is to convince ("win over") at least the majority of thinkers present about the veracity of one's views. Participants come to a discussion with a fixed view, and through rhetoric, persuasion, argument, (or what they see as the power of their truth and the evidence supporting it) attempt to change the minds of others. A discussion is a contest with winners and losers. Not only do some ideas or viewpoints win while others lose, but since we tend to *identify* with our views, we are caught up emotionally in defending those views to defend ourselves.

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[38] Andriof et al., 2002, p. 15.

[39] R. Hamann, N. Acutt, P. Kapelus (2003) "Responsibility versus accountability", *Journal of Corporate Citizenship*, 9:32-48.

[40] Bohm, David, 1996: *On Dialogue.* Routledge.

[41] Peck, M. Scot, 1987: *The Different Drum: Community-making and Peace.* New York: Simon and Schuster.

[42] Isaacs, William, 1999: *Dialogue and the Art of Thinking Together.* New York: Doubleday.

The differences between a discussion and a dialogue are profound. The first shift is that participants cease to identify with the views and information and knowledge that they bring to the dialogue at the outset. Participants attempt to communicate their understandings to the group while consciously striving to avoid a sense of *identity* with these understandings. Bohm calls this "suspending", using the image that one is offering one's understandings as if they were suspended in the air within a dialogue circle, for all participants to try to consider, to understand and to empathize with, without "embracing" them or taking them on with attachment.

Another critical factor stressed by Bohm, Isaacs and Peck is that self-awareness is essential. At the same time, they each emphasize that while *increased* self awareness is essential, *pure* self-awareness is unattainable – at least without the help of the group, the collective process! Bohm stresses that *thought itself,* presently, is insufficiently self-aware.

What about science? Bohm, p. 38: "If scientists could engage in a dialogue, that would be a radical revolution in science – in the very nature of science. Few scientists question the assumption that thought is capable of coming to know 'everything.' But that may notbe a valid assumption, because thought is abstraction, which inherently implies limitation."

Reflective action cycles are ideal venues for developing and practicing dialogue skills. Indeed, their chance for project success hinges on it, as does their hope of achieving lasting, sustainable change. Bohm's work is foundation concerning the theory and potential for dialogue. Peck addressed the emergence of dialogic processes that he called simply "community" within groups. Isaacs and colleagues are most recently building a body of practical guidance on both process design and participant psychology for achieving dialogue in an increasing variety of settings.

On the Contribution of Research

Our workshop invitation concluded as follows: "These ambitious goals can only be achieved through an international, collaborative research effort… The second part of the workshop discusses the development of a *common, interdisciplinary research approach and a common research agenda*. This effort may include the development of *common data bases, data formats, models, protocols, indicators and assessment methods so that research becomes more cumulative and results can be more easily compared*. It also requires that researchers from different disciplines develop a *common platform*, which includes a set of *core research questions and common publication channels*. This workshop is a first step towards developing the proposal for such a research infrastructure, as well as charting out a plan of action to put it in place." (emphasis added)

The call to action quoted above responds to an implicit question that might be framed: how can we researchers better learn from, and contribute to, each other's work so that the field as a whole better learns and evolves? I share with our workshop's framers their tacit assessment of our current situation: we are a "rag tag fleet" of mostly un-coordinated researchers, working (with few resources) on the same broad topic but from many different angles. Increased *coherence*, shared ways of understanding and expressing, are necessary to help our individual contributions "become more cumulative" and to enable comparisons. How do we become a more effective learning system?

In light of the forgoing sections of this paper, however, the challenge/opportunity/imperative of becoming a learning system extends way beyond the boarders of the small band of SCP researchers. We must similarly (if separately for now) ask, with Jackson and Kassam, on behalf of the tens of thousands of localized, isolated circles of reflective action within participatory evaluation, participatory development, popular education and/or unfolding stakeholder practice:

"How can new paradigms for community, sustainability, deepened democratic life, or human rights be shared if and when they arise from work of this nature?"[43]

The proposed path to solution articulated by our workshop framers is familiar within top-down, positivist research: centralized coordination. A subset of researchers (or, one or more powerful funders, which would bring higher probability of researcher compliance) develops a *metadata system* which researchers are then encouraged to use to structure, report, and share their information resources (research results).

What is a metadata system? Knapp et al. (2004)[44] explain that "the science and art of metadata" address the following challenge: "How to name, organize, assess and use information resources." The explosion of information available via the Internet has spawned the emergence of a whole "sub-industry" addressing metadata. It works at the interface of library science, computer science / informatics, and knowledge engineering. To date, the development of metadata is almost exclusively a centralized, expert-driven, top-down enterprise. How else can standards be developed?

Bottom-up metadata development is addressed in the next section. But for the moment let's continue on the top-down road. After developing our metadata system must come the tasks familiar to researchers: information gathering, pattern identification, and communication. Again, the top-down (and dominant) way this is done follows what might be called a "harvesting" model: results are gathered up from across individual researchers or projects, and are sifted, compared, subject to pattern-finding efforts; resulting findings and lessons learned are documented and disseminated. This harvesting process is what individual researchers are doing all the time as they read each other's work and try to take stock of their fields; it is what researchers are doing when they perform case study surveys and cross-sectional analyses. When the scope of the harvesting exercise is larger than a single research can manage, teams of researchers from one or multiple institutions collaboratively collect, sift, sort, compare, identify patterns, distill and summarize lessons learned. Meetings are invariably a part of this process.

When they seek to learn from practice, members of the non-academic, participatory empowerment/ development/learning/stakeholder management communities follow this same centralized harvesting approach. There seems to be no other way to learn from a population of researchers or practitioners.

However, from the perspectives of participatory methods and dialogue that we have reviewed in this paper, at least we can identify what is *missing* when the harvesting model is applied to populations of hundreds or thousands of localized reflective action circles. First, the circles (the individual communities or ongoing projects) are not in dialogue with the research community. Rather they are observed from above, from outside. They may report to a centralized data collector, or they may respond one-at-a-time to visiting researchers. Second, they are not posing questions, either to each other or to the whole. They are at best responders, but not questioners. Third, the learning and pattern-finding is done by external experts (joined, in special cases, by a small sample of practitioners chosen to participate in a review). The lessons emerge from an *external* reflective process. Then in all-too-few cases, the expert findings are made somehow accessible for dissemination back to the practitioners.

In summary:

[43] Jackson and Kassam, 1998, p. ix.
[44] Knapp, Michael, Brandt Kurowski, Sara Dexter, David Gibson and Robert McLaughlin, 2004: "Metadata Co-Development: A Process Resulting in Metadata About Technical Assistance to Educators." *Proceedings of WWW2004*, May 17-22, New York.

1. Communities of top-down research practice, such as ourselves, need metadata systems and learning process activities in order to become a learning community:
    - We need metadata systems for effective information exchange;
    - Researches need resources to fund individual and group “harvesting” processes: collection, review, synthesis, and dissemination of patterns and lessons learned.
    - A bottom-up, emergent process that facilitates researcher co-harvesting is the institution of open publishing. Peer-review journals are an important subset of this process. The peer review process serves as a quality filter and makes the task of harvesting more manageable; it is also one of the important ways that dominant paradigms defend their positions of dominance.[45],[46]
2. The domains of localized reflective action cycles have the same needs as a group of researchers seeking to become a learning community:
    a. Metadata systems
    b. Resources to support harvesting activities by participants
    c. Mechanisms for efficient bottom-up “publishing” of their findings for free exchange with their peers. Some of these “publication channels” might incorporate forms of peer review, filtering, scoring, or other ways to flag quality/importance/relevance and make collection efficient.

Next, in the context of these observations, we pose 2 questions:

1) Who now drives the learning/evolution of the field of sustainable consumption?
   Are the top-down research and bottom-up practice communities equally empowered in the task of defining the metadata systems and the research frames, learning about sustainable consumption, developing the indicators and metrics and predictive models and setting the direction of the field’s evolution? If not, which groups or interests hold most of this power currently?
2) Could we create other processes, other institutions of engagement and co-learning and even *dialogue* between experts and practitioners, in addition to the present process of one-way harvesting by separate/expert researchers?

Addressing question 1: The conference invitation squarely and completely locates the power to define the metadata and research frame, to review case studies and synthesize learnings, to develop indicators and metrics and models, all in the control of the research community. That is, the research community is attempting to organize itself into a learning community. It would presumably (continue to) observe, and attempt to steer/direct/inform, localized practice.

Within our field of research, who directs the evolution? The direction is loosely shared among those who call for and fund projects, and those who propose and conduct the research.

In the realm of practice in SCP, there is not yet a coherent, interconnected body of localized reflective practice cycles. There are regional networks such as NASCA which provide a way for organizations to self-register descriptions of themselves, but these are not (yet) operating as a set of communication/ coordination channels. Thus, the existing implementation examples mirror the researchers in their fragmentation, isolation, and modest resources. The remainder of the paper addresses question 2, concerning dialogues that link research and practice: for SCP and for its cousin fields of development, evaluation, education/research and unfolding stakeholder thinking.

[45] Kuhn, Thomas, 1996: *The Structure of Scientific Revolutions*, 3rd ed. Chicago: University of Chicago Press.
[46] Buchanan, Mark, 2000: *Emergence*. New York: Three Rivers Press.

Creating an Evolutionary "Metalogue" Linking Reflective Practice and Research

A dialogue among dialogues (thus, a "metalogue") on sustainable consumption is portrayed in this section. Each participating group is a community of individuals, engaged in a reflection/action cycle. Thus, a group might be a localized community of practice, or a set of dialoguing members in a geographically dispersed research community. Adapting general terminology suggested by Czikszentmihalyi (1993)[47], we refer to these communities-in-dialogue as "evolutionary cells" or simply "cells." As in Figure 3d, the reflection/action cycle has five stages. These five stages have been modified and re-expressed slightly to represent the author's current suggestion of five generic stages (which could of course be broken into sub-stages) of such cycles.

At each stage of the cycle, the cell is in self-directed, voluntary, two-way communication with "the environment" – meaning, with other cells and with any other individuals or organizations that are observing one or more cells from outside.

At each stage of the cycle, the content of this communication is as follows:

Outgoing communication from the cells includes one or more of the following:

- Here is how we currently understand our history, status, intent and questions (HSIQ) at this point in our cycle.
- How do you, the environment (or a targeted subset of the environment) understand our HSIQ?
- The following resources (information, analysis, funding, expertise, assistance, materials, equipment, other) would help us achieve our current intent.

Incoming communication to the cells includes one or more of the following:

- Here is how we currently understand your HSIQ.
- Here is what we'd like to ask you to additionally report, concerning your HSIQ.
- Here are resources (directly, or links to resources available elsewhere) in response to your resource request.

That's it! If we could all efficiently find and respond to relevant reports, resource and information requests within a global network of millions of such cells, our small research field will have become a transformative metalogue between research and practice. The technology to enable this process is the Semantic Web, powered by grounded (bottom-up) metadata; both will be discussed in the next section. First we mention a few illustrations of the infinite, evolutionary potential inherent in this metalogue.

A community could state to the "environment" (the world) an infinite number of variations on:

- Our membership includes a household looking to purchase an environmentally responsible car. What should they buy and why?
- We are concerned about global warming and acid rain. What are the highest-priority actions we can take in modifying our consumption? Our lifestyles?
- Our rural community lacks public transportation. We are considering creating a bus system. How has this been tried? When has it succeeded, and what factors lead to success?
- We are interested in preserving open space for non-motorized recreation; how can we prioritize available land parcels for preservation?
- We wish to donate $1000 to fight AIDS in Africa. Where would this contribution be expected to have the greatest positive impact?

[47] Csikszentmihalyi, Mihaly, 1993: *The Evolving Self.* New York: HarperCollins

- I am a single female in my 30s in an urban neighborhood and here is how I currently spend my time. What shifts in lifestyle or activities are likely to increase my well-being without changing income requirements?
- I am considering the following career options; what are the pros and cons of each for social and environmental impacts over my life?
- Five computer programmers would like to donate 2 weeks per year to promote sustainable development in a French-speaking, developing country. What options are there?
- We are designing a micro-credit system for environmentally beneficial investments; what criteria are recommended for use in proposal evaluations?
- We wish to undertake the attached project to promote adult literacy in our community; we seek used computers and $1200 in funding for the first year.

In this system, any organization throughout the world can offer an answer.

- Consulting firms can offer to sell impact evaluations, perhaps with permission to publish the inputs and outputs on the web, which would contribute to a "virtual database" of impact assessment results, and also allow other models' results to be compared; both contributions build global public goods.
- Academics and public research agencies might contribute analysis results for free, as part of the evolutionary dialogue among models.
- Organizations which have developed methods, toolboxes, guidebooks, ratings and evaluations (including ecolabels) would be able to automatically locate and inform any potential user around the world at the key moment of their decision, targeting the objectives and metrics of interest to them. Organizations would have the ability to validate or evaluate the effectiveness and impacts of their decision-support resources, through follow-up with a subset of users based on demographic characteristics, obtaining usage feedback, suggested refinements, etc.

Note that the metalogue enables *bottom-up governance of the evolution of resources* designed to support practice in an infinite variety of application contexts. It creates an open, transparent ecosystem in which there is continuous evaluation and selection on successful systems of metrics and indicators, predictive models, participatory evaluation methods, and all other resources that might support any of the steps 1 through 5 of the reflective action cycle. The global community of users becomes empowered to directly drive the evolution of all the tools and resources that are intended to support their efforts, rather than having this function be provided by bureaucrats hired by agencies that are ostensibly publicly accountable.

At the same time, this global community of users also becomes a transparent, multi-faceted test-bed of tools. Any organization is free to post a solicitation to targeted users of any method, offering resources (e.g., small amounts of funding?) in return for their willingness to participate in research – e.g., evaluate the resource they have used, or to report outcomes over a specified time frame, etc. Predictive models, group process guides, decision-making frameworks, etc., can be evaluated not only on user satisfaction, but based on outcomes over the years following use. For example, all communities over a 3-year period who self-identified as being on the threshold of a particular decision ("we are considering a rural bus system") would be identifiable, and researchers might advertise for participating communities to report descriptive characteristics and outcomes over a subsequent period. The results could be used to test and refine predictive models and decision support tools. In addition to the two-way dialogue between research and practice, the system also enables dialogue within and across practice communities. And note that practice communities will include an unlimited variety of organizations within civil society. Practice communities will include private companies seeking resources to support advances in cleaner production, stakeholder processes, etc. They will also include NGOs, academics, philanthropic foundations, and government agencies.

Making it Work: Semantic Web and Grounded Metadata

The central principle of the Semantic Web[48],[49] is simple: with metadata, the web is transformed, from being essentially a large hypertext document searchable strictly based on text strings (free of any context); with metadata, it becomes "machine-searchable", queryable and analyzable by algorithms that take advantage of the structuring and labeling of information. Recall that metadata is "data about data." Think of metadata as a series of nametags, and bits of descriptive information, flagging and describing web content. However, critically, realize that the metadata is not for people to read (although we can when we want to). Rather, metadata is written for the benefit of algorithms like web crawlers, programs that automatically search the web at lightning speed.

Currently, in the pre-semantic web, crawlers like Google's can find all web pages that contain the word "apple". The results of such a search simply look for the characters a, p, p, l and e in succession without spaces. Period! Some pages will refer to the fruit, others will refer to the company, and still more will contain references to New York ("the Big Apple"). In the semantic web, there might be a set of metadata that identified a text string as reporting a person's favorite fruit. Then, you could use an algorithm to query the web and report back the names and addresses of all persons on earth who had used the web to express that apples were their favorite fruit. With metadata, the entire web is transformed from one long text document (with some media files hanging off of it) into a queryable, participant-created distributed database (or you might more accurately think of it as an ever-expandable realm of ever-more-numerous databases).

As a simple example of what becomes possible, imagine that all documented posted on the web have metatags including *title*, *author*, *keywords*, *date*, and *abstract* or *summary*. This means that some pieces of text would then be identified as the title of a document, other pieces of text would be identified as the document's author(s), and so-on. Once this is true, simple software algorithms can be easily programmed to do a search on what has become the single, global library of the web. Imagine that "cells" of reflective practice around the world can post an information request on the web with parameters such as *purchasing decision*, *product* = 'refrigerator', *objectives* = 'environment', 'social impacts', *environmental objectives* = 'global warming', 'acid rain'. Imagine also that each such information request automatically self-generates a unique "request identification number" when it is first created (e.g., *RequestNumber* = '123xyz'). Once this is true, then any organization on earth interested to offer information to refrigerator buyers who are concerned about the environmental impacts of their purchases would be able to be employing crawler software to continuously find pages of people who are shopping for a refrigerator and self-identify as interested about the environmental impacts of their choice. The information providers can post their information on the web, using metatags, and referencing that "Relevant RequestNumbers include '123xyz'. The third step is that the question originators would then be able to use simple crawler software of their own to search the world for answers to their specific question, perhaps screening out certain types of response, certain types of respondents, etc. The semantic web enables an infinite variety of questions (or, more generally, resource needs) to be found by an infinite variety of would-be responders (resource providers), whose responses can then be found by anyone including the asker.

This would be nice, wouldn't it? All it requires is (1) that everyone be empowered and motivated to create and refine metadata ontologies that are richly descriptive of the users and their

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[48] Berners-Lee, T, Hendler, J., Lassila, O. 2001: "The Semantic Web", *Scientific American*, May 17, 2001
[49] Berners-Lee, T. and Eric Miller, 2002: "The semantic web lifts off." *ERCIM News*, October.

information/resource requests, and (2) that everyone be empowered and motivated to share/post and catalogue resources (labeling them using metadata) being offered. How do we get there? We – that is, literally, *all of us* who chose to participate –solve the metadata challenge in an ongoing way, via joint creation of what Knapp et al. (2004) call "grounded metadata." In their paper, Knapp et al. describe a pilot study in which researchers worked "with numerous individuals and organizations with expertise in technical assistance education topics such as professional development, urban teacher preparation, equity, and school improvement to develop and refine an ontology [a metadata system]. The resulting metadata was used to tag resources in a Semantic Web application in order to disseminate articles, reports, conferences and other resources…We use the term "grounded" because we started with the knowledge of these communities of practice and let the metadata vocabulary arise from it, so that it could best convey their meanings. Our strategy was to let the organizations rely upon their own community's vocabulary for organizing resources and modify it over time as they saw fit. We wanted vocabularies to also aid the search of the resources by their eventual users, and so it was critical that the ontology created across the communities allow each one to use descriptors relevant for its group of users. As subject headings slowly evolved, they were combined into a meaningful hierarchy."

The second challenge is empowering us all to share/post/catalogue resources. Knapp et al. found, and addressed, two bottlenecks in their pilot study. They overcame a "cataloging bottleneck" by minimizing their dependency on professional cataloging, and engineering a self-steering cataloging process, that focused on labeling those terms that end-users showed evidence of valuing, based on server-log analyses. Thus, over time, users were able to focus on using an increasingly limited subset of the metadata. A second bottleneck related to resource posting. At first they had relied on users to nominate resources that editors would find and upload (for pay). The resulting bottleneck prompted them to pilot "an alternative approach in which the members of a community each have log-in access and authority to publish new resources directly to the web, reducing the time and expense involved in screening nominated materials. This also enhances the sustainability of the work, as it is a vehicle by which networks of experts share the modest cost of cataloging and publishing content."

Regarding motivation, it might be clear that once the system was rich with content, this would motivate users, many of whom would also publish/contribute for the same pro-social reasons that millions of people contribute to the open source software movement. But how do we "prime the pump" or "get the ball rolling" in the present example? Norris and Ciroth (2004)[50] describe an emergent network of cells using freely available, multi-lingual, open source, wiki-style content management software. This network creates a global project fund, one quarter of which is annually devoted to projects by literally *every* participating cell. Another quarter of the annual funding is earmarked for projects that extend access for participation to *all* people, not just those why are currently literate and with Internet access. These resources are available and in use.

So, finally, how can the global SCP community employ these free resources to pioneer in the creation of a global metalogue that powers the participation revolution? By doing it.

[50] Norris, Gregory and Andreas Ciroth, 2004: "An emergent open network and global fund for community-driven sustainable development", *Enviro-Info 2004, Proceedings,* Geneva, October.

Demand and Supply

Eco-Efficiency that Reflects the Decline of Product Value: A Case Study on Personal Computers

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1. Abstract

We made an attempt to evaluate the eco-efficiency of reusing personal computers (PCs). Our concept is in line with the conventional eco-efficiency: obtaining the ratio of the provided product value (or function) to its environmental impact. The product value was defined as the value that a consumer receives from a product for a certain period of time, and used three different scales to evaluate it, such as subjective value, the money-based objective value and market price. We demonstrated that eco-efficiency considering the economic and social aspects is a useful indicator to evaluate the product quantitatively focusing on the consumers' use stage, rather than evaluating the environmental aspects alone. In addition, we found a gap between the subjective value and market price, suggesting that filling the gap may help turning this un-sustainable society into a more sustainable mode.

2. Objective

The increasing amount of wasted electric appliances from households draws attention as one of the biggest environmental concerns in Japan. "Law for Promotion of Effective Utilization of Resources" [1] is one way of governmental policies implemented in hope of reducing such problem. This law applies not only to large electronic appliances, such as refrigerator and washing machines, but also computers. At the beginning, the target was used PCs from business offices, but used PCs from household have also become the target since October, 2003. This law was expected to promote reusing PCs; however, it has not actualized in the real society so far [2]. To promote reusing used PCs, it is necessary to discuss not only on environmental but also social and economic aspects. Therefore, we made an attempt to evaluate the eco-efficiency of reusing PCs by evaluating the environmental burden and value and benefits of a product at the same time. Furthermore, we tried to establish a method to evaluate a product value for that purpose.

3. Method

3.1. Our Definition of Eco-Efficiency

"Eco-Efficiency," first suggested by World Business Council for Sustainable Development (WBCSD) [3], is an indicator that evaluates a product, service or production system by comparing a service value with its environmental loads, as shown in Equation (1).

$$\text{Eco-Efficiency} = \frac{\text{Value of products and service}}{\text{Environmental burden}} \quad \text{Eqn (1)}$$

The definition of the value of products or service is still under discussion among the experts and entrepreneurs due to various boundaries and concepts. There have been some cases of using physical mass, such as service unit of MIPS (Material Input per Service Unit), and economic values, such as cost and profit, due to the readiness of quantification [4]. However, it is not certain if these numeric values adequately express the values that are in agreement with consumers' subjectivity. Therefore, we conducted a questionnaire survey to obtain the value which represents the consumers' evaluation closely. The value that the consumers give to a product accounts for physical aspects, such as functions and depreciation by aging, and subjective aspects, such as affection and loyalty. The data points that we obtained from the survey represent how much the value decline after purchasing it, supposing that the value of a brand new product is 100. The concept of the quantification of a product value is shown in Figure 1.

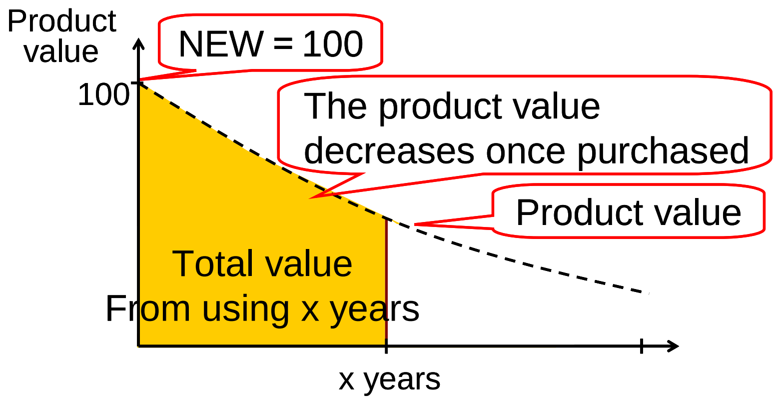

Figure 1. The concept of quantifying product value

To quantify a product value, we set up the following assumptions:

- Product value declines as soon as a consumer purchases the product,
- The value of a brand new PC is 100,
- Sense of worth, demand, and preference to products are uniform, and

- The total value that a computer user receives from using a product is calculated by integration of the obtained depreciation-equation for x years.

We also compared the results with the market price of brand new computers and used computers and trade-in price for the effective evaluation for the validity of our methodology.

3.2. Scenario

In order to compare the eco-efficiencies, we set up four scenarios of how consumers handle used PCs (Figure 2). We assumed that consumers use PCs for 72 months in total and they make an action on the PCs after 36 months of use. We decided that the transition period appears right after 36 months from the purchase of the PC, according to survey results [5]. The assumption was that consumers choose either continuing to use the PC for 36 more months or purchasing a new one. In the case of former, they choose between continuing to use the PC as it is and upgrading some parts, such as mother board, hard disc and RAM memory. In the case of purchasing a new PC, they choose either reusing it or disposing of it. The functional unit is for one consumer to use one PC and they use the same PC for 36 months after purchasing it.

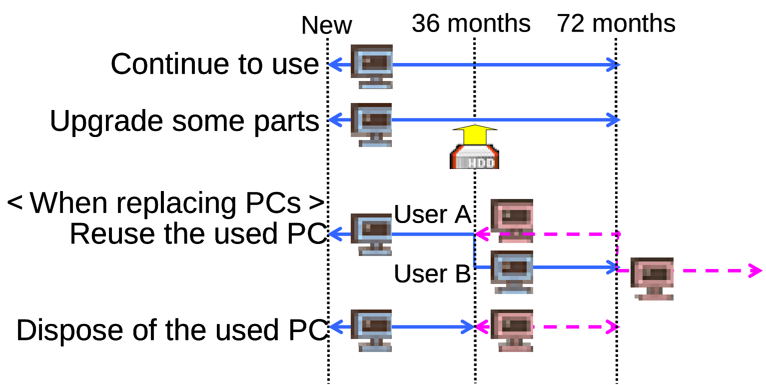

Figure 2. Scenarios set for this study

4. Results and Discussions

4.1. Quantification of Environmental Burden

To quantify the environmental burden from each stage of a PCs life span, we calculated the amount of CO2 emission per one desktop PC and a CRT display by LCA[6][7][8] (Figure 3). Normally the old production has heavier environmental burden over new production, particularly in the use stage, because of technology innovation of manufactures over the years. However, in our research we assumed that old and new PCs are equivalent in environmental burden. The reasons are: (1) computer hardware upgrades much quicker than other productions, and three years of difference may not be significant; and (2) we randomly sampled the PC users from a wide range of use periods to survey their PCs, therefore, we had to decide to calculate the environmental burden from the "average" personal computer. Figure 4 shows the environmental burden of each scenario by the functional unit. As a result, we confirmed that CO2 emission was the least in the case of "continue to use" scenario. CO2 emission was higher in the case of "reuse the used PCs" scenario than "continue to use" due to transportation for reusing it. The cases of "upgrade some parts" and "dispose of the used PCs" scenarios followed.

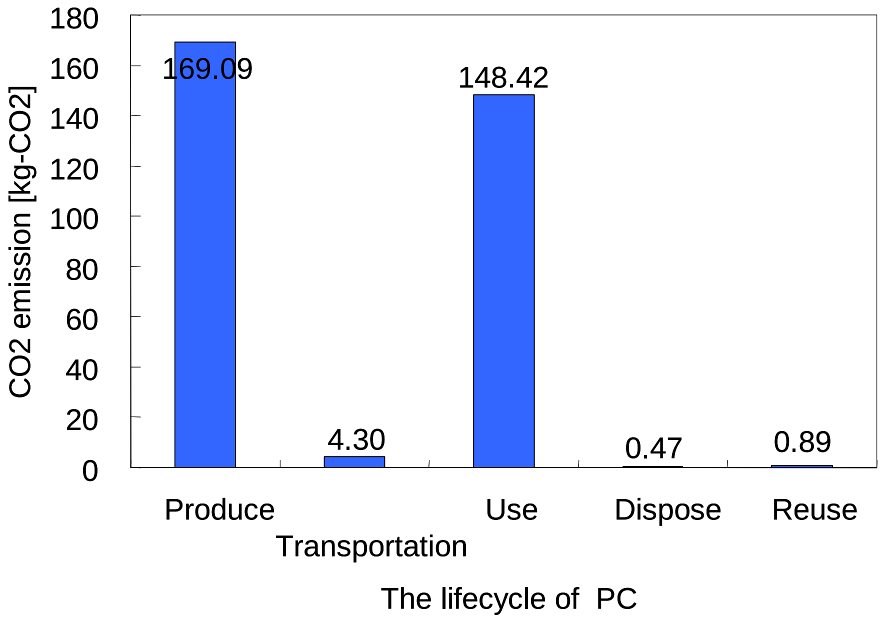

Figure 3. CO2 emission of each life stage

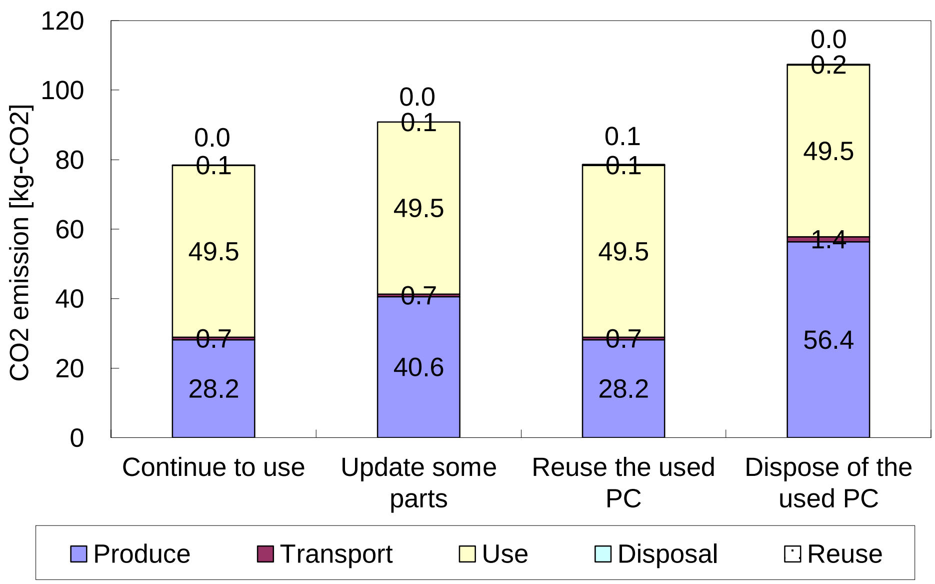

Figure 4. CO2 emission of each scenario

4.2. Quantification of Product Value

We conducted a questionnaire for 400 people to quantify the product value consumers have toward them. Questions are:
(1) Suppose that the value of a brand new product is 100,
a) How much would you place on your PC?
b) How much would you place to the PC of the same level if it is sold?

(2)
a) For how much would you want to sell your PC?
b) How much would you pay for the PC of the same level if it is sold?

Consumers answered by placing any number between 0 and 100 for question (1), and price for question (2). We divided the price by the price they actually paid for the brand new.

As a reference, we evaluated a product value by market price. For this purpose, we gathered used PCs' prices and trade-in prices of used PCs on websites and magazines, and calculated them in the proportions to the original price. We fit regression curves represented in Equation (2) to the actual data points (Figure 5, Figure 6).

$$r = 1 - \left(\frac{Pn}{P0} \right)^{\frac{1}{T\max}}$$

$$V = P0 \times rt \qquad \text{….. Eqn (2)}$$

r : Depreciation rate P0: Acquisition price
Pn: Remaining value Tmax: Uable life
V: Cost depreciation t: Time

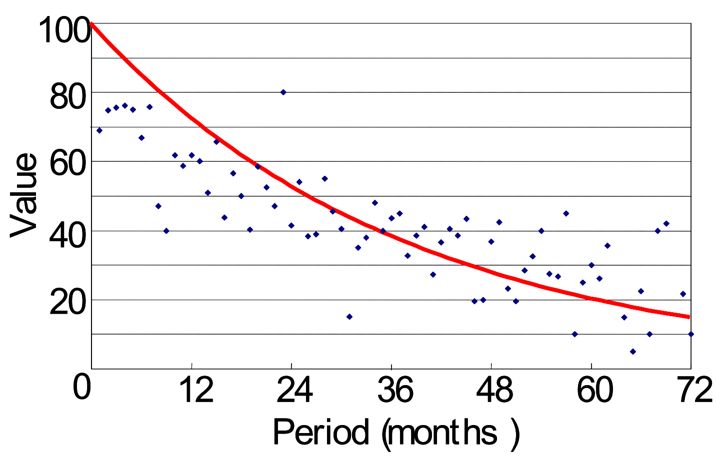

Figure 5. Points from questionnaire and the regression curve

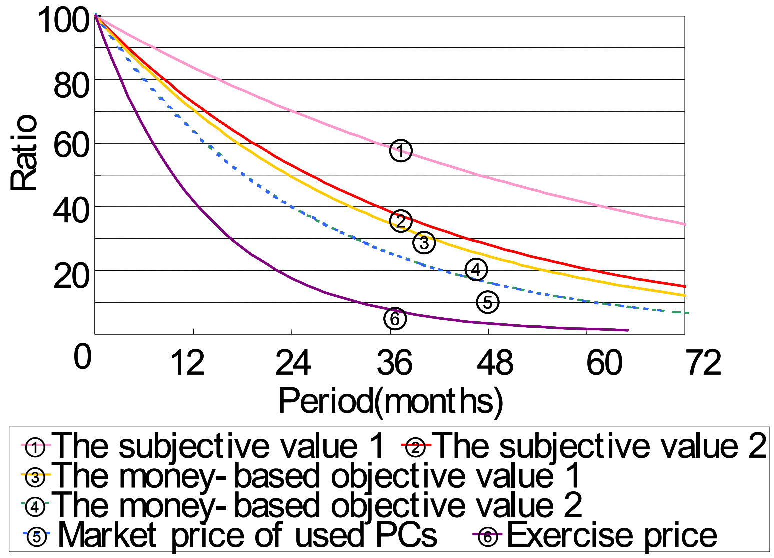

Figure 6. Regression curves obtained from fitting to the actual data points of questionnaire survey results

We integrated each regression curve in Figure 6 to calculate the total value of a PC that a person receives for a year. In order to calculate the total value of "continue to use" scenario, for example, we integrated the curves of the "subjective value 1" (No.1 in Fig. 6), "monetary-based objective value 1" (No.3), and "market price" (No. 5), respectively from 0 to 72 months. In the case of "upgrade some parts" scenario, we calculated two areas (S1 and S2 in Figure 7) separately and combined the two, assuming that the product value increased by upgrading. To calculate the value with the subjective value, for example, the curve No.1 was integrated from 0 to 36 months. According to the survey results, the product value increased from 58.7 to 79.0 at t = 36 due to upgrading. Assuming that the product value traces the line of "subjective value 1," the total value for 36 to 72 months (S2) was calculated by integrating line No.1 from that point.

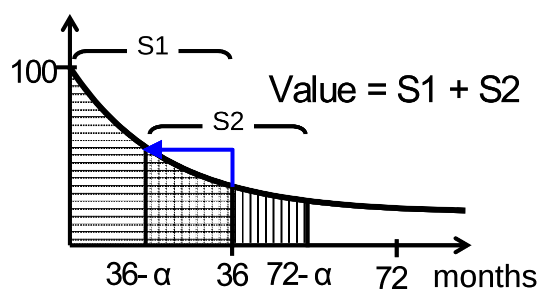

Figure 7. Qualifying the value of "upgrading parts" scenario

Due to the lack of sufficient data, we supposed that the percentage of value rise due to upgrading was equal to that of subjective value when calculating total values with money-based objective value. For market price-based value, we supposed that the value a consumer receives by upgrading is in a linear relation with the amount of money he pays.

For calculation of value, the prices of the parts were divided by the average price to calculate percentage of rise.

In the case of “reuse the used PCs” scenario, two areas were calculated separately and combined. For the area for the first user for the first 36 months, “subjective value 1” (No.1) was integrated for 0-36 months. The area for the second user of the same PC, line No.1 for 36 months was integrated also, but the starting point was the ratio of line No.2 at 36 months as it was somebody else’s PC at the time of purchase. We adopted the same method when evaluating the money-base objective curve. When evaluating the “reuse the used PCs” scenario with market price, supposing that the first user receives the value as much as he receives from the second user, trade-in price line (No. 6 of Figure 6) was integrated for 0-36 months. Assuming that the value the second user of the same PC receives depends on the amount he pays, market price line (No.6) was integrated for 36-72 months. As a result, the total value is higher in the case of “dispose of the used PCs” when evaluated with all of 3 values (Figure 8).

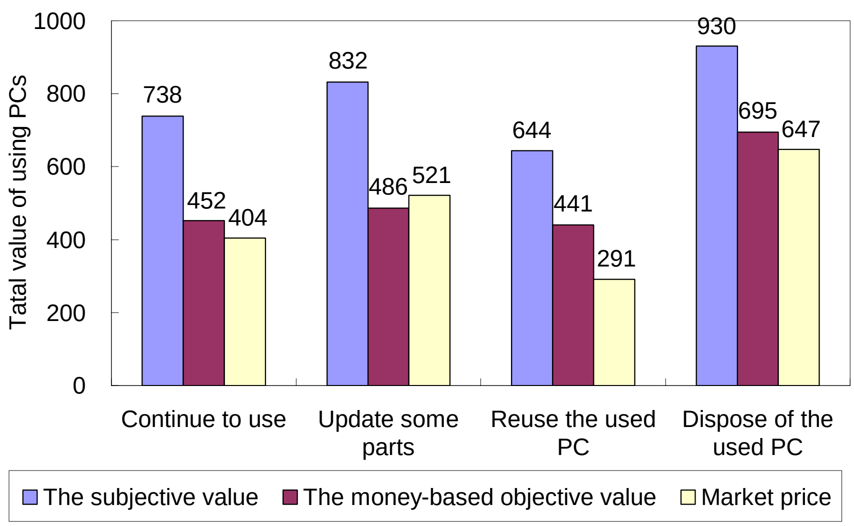

Figure 8. Qualifying the product value of each scenario

5. Results

Figure 9 shows the eco-efficiency of each scenario with three different values. When evaluating the product value with the subjective value, the highest eco-efficiency was “continue to use” and it was followed by “upgrade some parts,” “dispose of the used PCs,” and “reuse the used PCs”. However when evaluated with the money-based objective value, the highest eco-efficiency was found in the case of “dispose of the used PCs” and it was followed by “upgrade some parts,” “continue to use,” and “reuse the used PCs.” When evaluated with the market price, the highest eco-efficiency was found in the case of “dispose of the used PCs”, followed by “upgrade some parts,” “continue to use,” and “reuse the used PCs”. From the above results, the eco-efficiency was found to be the highest for “continue to use” with the subjective value, and “dispose of the used PCs” with the market price. It strongly suggests that the scenario of “dispose of the used

PCs" is more preferable in eco-efficiency as consumers take market price in consideration. It was suggested that the difference was caused by the gap between the subjective value and market price, and filling the gap may be helpful in turning this current society into a more sustainable one.

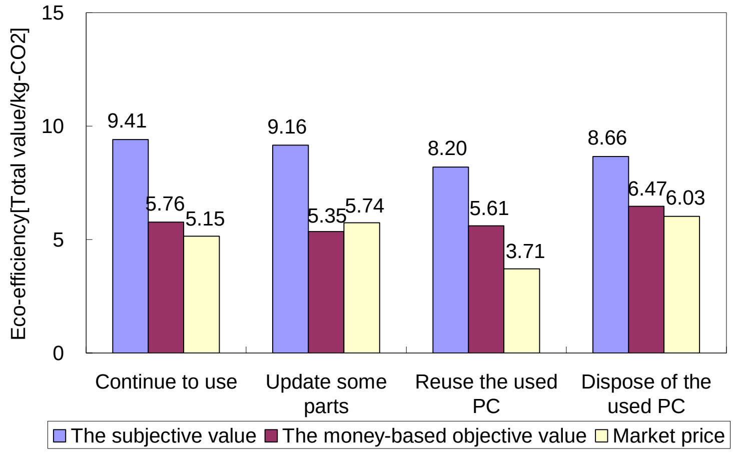

Figure 9. Eco-efficiency of each scenario

The "dispose the used PCs" scenario is not preferable from the environmental perspectives and polices need to be implemented to shift it to more "continue to use" or "reuse the used PCs" scenario, strategically. One possible solution is the technological innovation in reduction of the environmental burden in the production and disposing processes of PCs. Another possibility is to either promote reusing PCs by giving incentives or taxation on brand-new products. Further research is necessary to discuss and propose the strategies regarding this effect.

We focused on PCs in this study. However, PCs are particular products with the characteristics of fast moving innovation and tend to have short detention time in households. Such characteristics may have been reflected in the results of this study. Therefore, such case studies on other kinds of products are necessary.

6. Conclusions

We demonstrated that eco-efficiency considering the economic, social and environmental aspects is a useful indicator to evaluate the product quantitatively focusing on the consumers' use stage, rather than evaluating the environmental aspects alone. We found a gap between the subjective value and market price, suggesting that filling the gap may help turning this un-sustainable society into a more sustainable mode.

Moreover, the result of this study may reflect the characteristics particular to PCs, which has fast advancement rate and short detention time in households. We are currently applying this methodology to other types of products, such as cars and refrigerators to validate this methodology.

7. References

[1] “Law for Promotion of Effective Utilization of Resources,” http://www.meti.go.jp/.

[2] Nikkei Ecology, “Recycling of House-Originated Personal Computers,” No. 10, p44-p47, (2003).

[3] Hendric A. Verfaillie, Robin Bidwell, “Measuring Eco-efficiency – A Guide to Reporting Company Performance -, WBCSD, (2000).

[4] The society of Non-Traditional Technology (SNTT), “Research on the Development and Utilization of Indicators for Sustainable Consumption (FY 2003 Summary),” (2003).

[5] Nikkei PC, “A PC’s ‘lifetime’ is 3 years – even so they want to know why the others decide to change a new PC,” Nikkei BP, p76-p93, (2002).

[6] Shigeyuki Miyamoto, Tegawa Masahumi and Atsushi Inaba, “Life Cycle Assessment for Designing a Personal Computer”, Energy and Resource, Vol.19 No.1, p.75-p80, (1998).

[7] Soeda, S.,Higuchi and H., Ohara, S., The Third International Conference on EcoBalance, p.277-281, (1998).

[8] Kensuke Sugita, “The Study for the Method of Inventory Analysis of home Electric Appliances. Bachelor’s Thesis, Waseda University, School of Science and Engineering, Department of Resources and Environmental Engineering, (2000).

Development of a Quantitative Evaluation Method for Social Acceptance of Products and Services: Comprehensive Review on Outcomes, Problems and Possible Applications

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Abstract

One way of turning an un-sustainable society into a more sustainable mode is to increase environmental efficiencies of technologies and consumer acceptance of environmentally efficient products/services concurrently. Our research team proposed the development of a quantitative evaluation method to predict consumer acceptance of products/services by applying Quality Function Deployment (QFD). The main features of this model are that: (1) it requires neither many input data nor conducting survey to predict consumer acceptance of products/services; and (2) it estimates social acceptance based on the pre-defined importance levels of consumer requirements and characteristics evaluation of the alternatives with physical and engineering scales.

The hypotheses of this research are: (1) the importance levels of consumers' elementary requirements for products/services are the same for the activities in the same cluster and could be defined quantitatively; and (2) once the importance levels of elementary requirements have been quantified, they are deployed to the importance levels of secondary requirements specific to the activity, according to the correlations between the elementary and secondary requirements. If the above hypotheses are correct, it would be possible to estimate the social acceptance of alternatives for any ordinal activities, using the mechanical feature of this model. In order to test the above hypotheses, social acceptance values for 27 activities were estimated from the multiplication of importance levels of consumer requirements obtained from survey results and measurements of the characteristics of requirements with engineering scales determined by authors. The estimated acceptance values were then compared with the values directly obtained from the survey results for the verification of the suggested method. For many activities, the estimation was close to reality while there were cases where the suggested methodology did not estimate the reality properly.

This paper shows the comprehensive overview of the results and insights from this study on the important components above and remaining problems with this method. We also discuss the possible application of this methodology in the context of sustainable consumption.

1. Introduction

Major streams of initiatives against global warming for at least a decade have been mainly on the production side, especially measures and strategies including technological progress that increases the eco-efficiency[1][2] of technologies in plants, development of energy-saving products and services and cleaner production approach. In the private consumer side, however, attempts to reduce household carbon dioxide (CO_2) emissions have shown limited success. Household energy use has been steadily increasing every year, as well as vehicle fuel consumption in the transportation sector, both of which contribute to an increase in CO_2 emission.

Our concept and approach to sustainable consumption and production are summarized in Figure 1. In order to turn un-sustainable consumption pattern to more sustainable manner, it is essential that producers keep improving the eco-efficiency of processes in plants and products, and consumers accept sustainable lifestyles by choosing energy-saving home electric appliances and automobiles, as well as to improve the way they use such goods. It is thus necessary for the industrial sector to have clear idea of consumers' needs, and develop products that are eco-efficient and meet those needs. Therefore, we proposed developing a quantitative evaluation method to predict social acceptance of products and services. This new method adopts "Quality Function Deployment" (QFD)[3] which has been used commonly in the field of industrial product design. The main features of this model are: (1) that it requires neither many input data nor conducting survey to predict consumer acceptance of products and services; and (2) that it estimates social acceptance based on the importance levels of consumer requirements and characteristics evaluation of the alternatives with physical and engineering scales. Once this methodology has been developed, it will be made possible to estimate consumers' decision-making process in choosing a product or service among many alternatives.

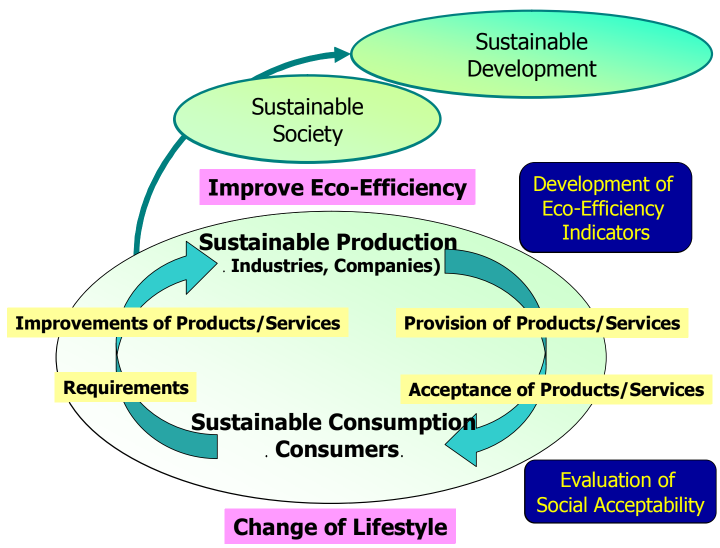

Figure 1 Schematic diagram of the concept of sustainable consumption and production in relation to this study

This method was first proposed by Yagita *et al.* (2002).[4] Progress has been made since then. In this paper, we present comprehensive review on the outcomes of this research, obstacles and possible applications of this predicting tool toward suitable consumption.

2. Suggested Evaluation Methodology

Consumers use products and services as a means of achieving a certain purpose of activity and choose that increase more ultimate utility for them. For example, commuters use cars, trains, and other means of public transportation for the purpose of going to the office or school. In addition to the original purpose, they select the alternative that provides the greater benefit, such as "low cost," "comfort," or "punctuality." Our assumption is that consumers select products and services based on the specific and specialized requirements for each consumption activity, and that the specific and concrete requirements for each activity can be conceptually summarized into few numbers of upper-level requirements, such as “economy” and “convenient.” In this paper, the upper conceptual requirements are called “elementary requirements,” while the specific and concrete requirements for each consumption activity are called “secondary requirements.”

Figure 2 shows a conceptual example of the suggested quantitative evaluation methodology of social acceptance of products/services. If we could extract the elementary requirements and quantify the importance value of each item, it might be possible to evaluate social acceptance of a certain product (e.g. Alternatives 1 - k) quantitatively. In specific, where the importance level of an elementary requirement is expressed as $\{A_i.i = 1 \cdots i\}$ (such as economical, healthy, convenient, safe, comfortable, environmentally-friendly and reliable), and the importance level of secondary requirement is expressed as $\{B_j.j = 1 \cdots j\}$ (such as low price, less wasting, good for health, good nutrient balance, quick preparation, etc.), and the correlation levels between the elementary requirement and secondary requirement is $\{X_{i,j}.i = 1 \cdots i.j = 1 \cdots j\}$, the secondary requirements of the products and services would be expressed as:

$$B_j = \sum_{i=1}^{i} A_i X_{ij} \quad (1)$$

Then, the social acceptance of product could be evaluated by the summation of the acceptance values of the product on each secondary requirement, which is obtained by multiplying the importance level of secondary requirement by the characteristic evaluation of the product on each secondary requirement measured by physical or engineering criteria. When the characteristic of the alternative on each secondary requirement is expressed as $\{C_{kj}.j = 1 \cdots j, k = 1 \cdots k\}$, the acceptance values (V_k) of the mean would be expressed as:

$$V_k = \sum_{j=1}^{j} B_j C_{kj} \quad (2)$$

The hypotheses of this research are: (1) the priorities of the consumers' elementary requirements for products and services are the same in the same cluster (e.g. purchase of durable goods, purchase of expendable supplies, dining, energy consumption, information and communication, and leisure, in this paper) and could be defined quantitatively according to clusters; and (2) once the importance levels of elementary requirements have been quantified, the importance levels of secondary requirements for products and services could also be quantified according to their correlations. If the above hypotheses are correct, it would be possible that the user can estimate the social acceptance of given alternatives with using the importance levels of elementary requirements according to the cluster that the concerning activity belongs. Testing the hypothesis requires a full establishment of the following components of this suggested methodology: (1) selection of appropriate secondary requirement items and brushing up the wording/phrasing; (2) determination of the correlations between elementary and secondary requirements; (3) determination of measuring method of the importance levels of requirements; and (4) determination of the evaluation method of requirements with engineering viewpoints.

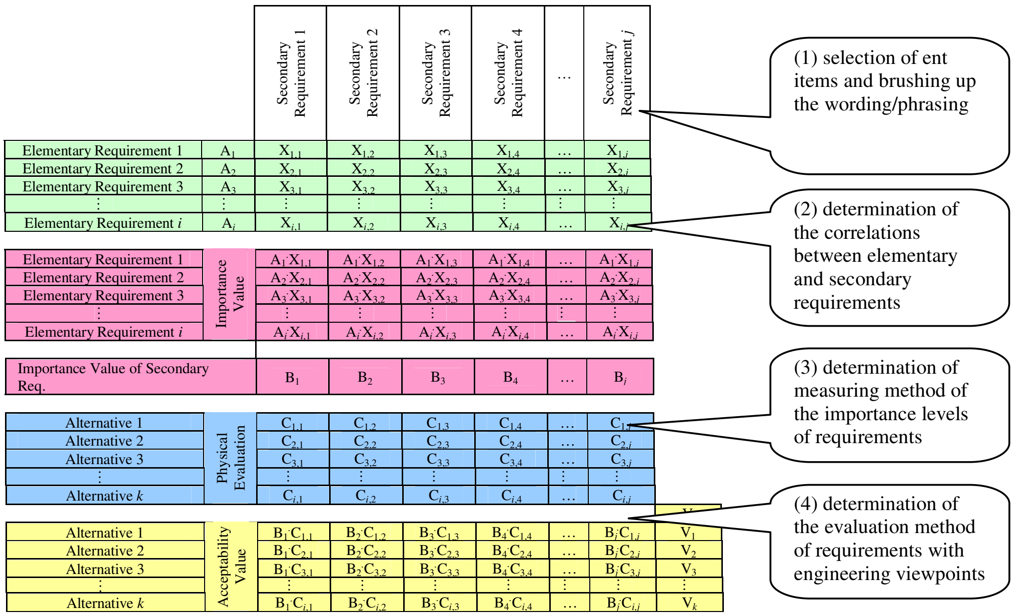

Figure 2. Conceptual example of the suggested quantitative evaluation methodology of social acceptance of products/services.

Attempts have been made in the last three years to develop all the above components; some of them yielded results and reported at the International Workshops on Sustainable Consumption in the past years. However, other parts were not developed sufficiently due to obstacles.

3. Research Methods

The following is a brief description of the necessary components of the proposed method and procedures to establish them.

3.1. Determination of Life Scenes and Consumption Activities

Social acceptance of products has been studied in the field of marketing research but usually to the specific target groups of consumers who have similar characteristics. To distinguish the target group, consumers were usually classified into a few clusters by certain attributes, such as demographic, social, economical, geographical, psychological, behavioral attributes. These experiences suggest that consumers in the same cluster have similar attitude in purchasing products, and that their elementary requirements to a certain product are universal in the same cluster. Our assumption was that if we could extract their elementary requirements and quantify them, it might be possible to evaluate social acceptance of a certain products quantitatively in the same cluster. To this end, classification of clusters with respect to the importance levels of elementary requirements is necessary. There are at least a few ways of classification of clusters with respect to the patterns or priorities of the importance levels of elementary requirements depending on: type of products, purposes of the consumer's activities, or life scene.

As the first step of this research, Yagita *et al.* (2003)[5] used "life scene" as a standard to classify a person's life into six clusters, such as "closing life," "dietary life," "housing life," "intellectual life," "leisure life" and "work life," based on the report of the *Survey on Time Use and Leisure Activities* (2001) by Statistics Bureau, the Ministry of Public Management.[9] Twenty-two activities were chosen from the six life scenes for the evaluation of the appropriateness of the proposed method in 2003 (see Table 1). However in 2004, we reorganized the clustering because the results from analysis suggested the possibility that classification of activities by life scene may not be applicable for this method. The activities were classified into six clusters according to "relationship with products and services" as a new criterion (See Table 2). Each of the clusters are sub-grouped into choices of system and product, to be more specific in evaluation of the characteristics of activities.

Also, the results suggested that this method is not applicable to certain consumption activities. They include, i.e., choice of transportation means, choice of place or channel of purchasing goods, and how to take a bath, in which the consumers' decision is by large constrained by infrastructure or other prevailing factors. We attempted only two criteria to classify the activities, and are still searching an appropriate criterion.

Table 1. Consumption activities chosen for study in 2002

Life Scenes	Consumption Activities
Housing	Means of transportation for daily shopping
	Heating equipment
	Type of residence
	How to bathe
Dietary	How to enjoy dinners on holiday evenings
	How to enjoy dinners on weekday evenings
	Means of transportation for eating out on holiday evenings
	Vegetables
	How to obtain coffee
Clothing	How to wash your ordinary clothes
	Where to purchase underwear
	Where to purchase formal clothes
Leisure	Means of transportation for travel
	Where to purchase a PC
	Where to stay when traveling
	Automobile
Intellectual	How to access information when traveling
	How to communicate with friends
	How to learn English conversation
Working	How to commute to the office / school
	How to communicate in business activities
Other	Drink container

Source: Yagita *et al.* (2003)[5]

Table 2. Consumption activities used for the study in 2003 and 2004

Cluster	System/ Product	Activity
Purchase of durable goods	System	1. Choice of housing
		2.How to use a car
	Product	3.Choice of car
Purchase of expendable supplies	System	4.How to do the laundry
		5. Choice of living room lighting
	Product	6. Choice of camera
	System	19. How to clean a house
	Product	20. Choice of TV type
		21. How to kill mosquitoes
Dining	System	7.How to enjoy dinner
		8. How to obtain a coffee
	Product	9. Choice of vegetable
Energy consumption	System	10.Choice of a boiler
		11.Choice of heating device
	Product	12. Choice of cooling device
	System	22. How to dry laundry
	Product	23. Choice of grill/stove
		24. How to obtain hot water for tea and coffee
Information and Communication	System	13. Means of communication with friends
		14. Choice of the Internet connection
	Product	15. Choice of personal computer
	System	25. Printing of greeting cards
		26. How to obtain information on restaurants
		27. How to obtain weather forecast
Leisure	System	16.How to enjoy movie
		17.How to learn English conversation
	Product	18. Choice of accommodations

Source: Ozawa *et al.* (2004)[12]

3.2. Extraction of Elementary and Secondary Requirement Items

In order to identify the elementary and secondary requirements appropriate for achieving consumers' purpose, we conducted the Internet survey on the three major daily activities of "commuting," "eating dinner on weekends," and "doing laundry."[4] Responses obtained from 242 people consisted of 40 to 50 words for each activity, and they were extracted by combining similar words and omitting words unrelated to the study. These words were then integrated into more general words with the Laddering Theory[6][7], and nine words considered to be elementary requirements were extracted. These words are "economical," "healthy," "convenient," "comfortable," "environment-friendly," "interpersonal relationships", "unusual," "time-saving," and "reliable". The results of the laddering suggested that the requirements of consumers for all products and services can be integrated into these elementary requirements even if the importance or ranking of each activity is different for the products and services in this survey. A list of secondary requirement items categorized by elementary requirements in the case of "how to wash your ordinary cloth" is shown in Table 3. For the 19 consumption activities not included in the pre-test, and any new activities tested, we defined the secondary and elementary requirement items through discussions using the results of the pre-test as examples.

Table 3. A list of secondary requirement items categorized by elementary requirements in the case of "how to wash your ordinary cloth"

Elementary Requirement items	Secondary Requirement items
Economical	No monetary cost required each time
Convenient	Does not take much effort
	Possible to wash a lot of clothes at one time
Comfortable	Bactericidal
	Feel pleasant
	Clean
	Become clean
	Give no smell
Environment-friendly	Washable with a little detergent
	Energy saving
	Quiet sound
	Space saving
Time-saving	Washing is completed in a shorter time
Reliable	No damage in the clothes
	Clothes will not be wrinkled
	No shrinking of the clothes
	No dependence on the weather

Source: Kawashima *et al.* (2003)[6]

3.3. Determination of Directly Asked Social Acceptance and Importance Levels of Secondary Requirement Items

3.3.1. The Internet Survey

After conducting a pilot-scale survey to be sure of the appropriateness of the survey method in 2002, we conducted the Internet full-scale survey to measure the directly asked social acceptance and importance levels of the requirement items defined for 22-27 patterns of consumption activities. Full-scale survey was conducted three times in three years every time we made major improvements to our proposed method. The survey panel was Internet consumer monitors (total number approximately 50,000 people) of Nikkei Research, Inc. A request for survey cooperation was sent by e-mail, and the survey panel responded by directly accessing the questionnaire on the server. For every survey, the response rate was 40% average and collected responses were approximately 300-350 people per activity surveyed. Using an example of "how to enjoy dinner on holiday evening," the questionnaire is explained in the following. We asked questions in the order of "preference for consumption activities (Q1)","importance level of the requirement items (Q2)" and "frequency of consumption activities (Q3)." In this study, the answer obtained from Q1 will be called "directly asked social acceptance value."

4.3.2. Determination of Directly Asked Social Acceptance

In order to determine directly asked social acceptance (share of preferences), alternatives were provided in Q1 of the survey, and the respondents were asked to choose only one alternative that the respondents would most likely be choosing in reality. The question and the results from survey in 2003 are shown in Table 4.

Table 4. Survey results on the choice of "how to enjoy dinner on holiday evening" 2004

Q1: Assume you are going to have dinner with your family or friends on holiday evening. Which of the following dinner will you pursue?	(%)
Cook whatever available in the house	7.60
Go grocery shopping and cook	42.10
Buy everyday dish	3.40
Order a house delivery	6.60
Eat out	40.30

Source: Ozawa *et al.* (2004)[12]

3.3.3. Determination of the Importance Levels of Secondary Requirement Items

Three different methods were tested in determination of the importance levels of secondary requirements.[5][10][11] In the questionnaire survey in 2002, we asked the respondents to evaluate the importance levels of secondary requirements by Semantic Differential (SD) method according to the seven levels from "place great weight" to "place no weight." These seven levels were given the scores of +3, +2, +1, 0, -1, -2, and -3, respectively, and the mean score of each respondent was calculated. However, results suggested that respondents had found comparative evaluations between items to be difficult to make when the absolute evaluation method was used, and that responses inclined to choose on the middle-point scale response. Therefore, we chose relative evaluation method (to be referred to as the "ordinal method") for the studies in 2003[10] and 2004[11]. Respondents were asked to rank requirements in order of importance so as to clarify differences among levels of importance across different requirements to the extent possible. Based on the responses that are chosen by respondents as important, requirements are ranked in a manner shown in the following example:

When rank order j is repeated successively for m times in the same rank, its mean rank order $\frac{1}{2}(2j+m-1)$ is used as a substitute. When the total number of requirements is N, and the number of requirements chosen as important factors is n, the temporary score t for the rank order j among the requirements that are considered to be important is computed as follows:

$$t = 20 \times \frac{n+1-j}{n(n+1)} \tag{3}$$

The score for requirements that are not considered to be important is 0. Score s, which represents a standardized score that is computed by assigning all requirements a mean score of 5 points, is computed as follows:

$$s = 20 \times \frac{n+1-j}{n(n+1)} \times \frac{5 \times N}{10} = 10 \times \frac{N(n+1-j)}{n(n+1)} \tag{4}$$

The results are shown in Table 5. However, the question was raised that the scores of the importance levels only show results in the ordinal scale rather than interval scale, due to the fact that the responses are obtained basically using an ordinal method, even though a relative comparison is made among items. Nagano *et al.* (2004)[11] compared the difference of the scores between ordinal method and share method. When the total number of requirements is N, and the score of the ith requirement obtained in a response is t_i, the score s_i, which represents a standardized score obtained by assigning all requirements a mean score of 5 points, is computed as follows:

$$s_i = \frac{t_i}{T} \times 5 \times N \quad (\text{Where } T = \sum_{i=1}^{N} t_i) \tag{5}$$

Table 5 The results of the mean values of the importance levels of secondary requirement items

Secondary Requirement	Score	Secondary Requirement	Score
Low price	1.43	Good taste	2.21
Less wasting	0.79	Variety in kind	1.19
Good for health	0.94	Can relax at home	1.00
Good nutrient balance	1.06	Good atmosphere	0.97
No need of cleaning	0.78	Can enjoy hand-made taste	0.68
Quick preparation	0.83	Fit my liking	1.11
Does not take much effort	0.91	Less garbage production	0.32
Safe	1.18	Can trust the shop/restaurant	0.60

Source: Ozawa *et al.* (2004)[12]

When results were verified based on the scores that were thus standardized, no major differences were found between the ordinal method and the share method. The probable reason for this was that scores were for relative evaluation among requirements that had already been selected as important, even when responses were given using the share method, and thus extreme differences did not emerge. Nagano *et al.* concluded that the use of ordinal method would be preferable due to simplicity and less of a burden on the respondents.[11]

3.4. Evaluation of Requirements by Physical/Engineering Scales

The quality of products and services was evaluated by at least four experts using physical/engineering scales rationally. For the activity of "heating equipment," for example, the evaluation of the characteristics of secondary requirements from physical/engineering scales is shown in Table 6. In 2003, the evaluation standards are applied when determining the correlation factors between secondary requirements and each means of alternatives.[10] The correlation factors were set as 0, 1, 3, and 9, depending on the degree of correlations based on the characteristics evaluation of items with physical and engineering scales as often seen in the quality expansion table of QFD.

Table 6. Physical evaluation standards of the secondary requirements in "selection of heating equipment"

Secondary Requirement	Evaluation Unit
Low equipment price	Initial cost (equipment price + installation cost) / Yen
Low fuel cost	Yen/month
Does not pollute the air	CO_2 concentration (ppm)
	NO_x concentration (ppm)
Operation is simple	Yes or No
Can be used right after purchase	Yes or No
Compact	External dimensions (HxWxD) (mm)
No need to add fuel	Yes or No
Range of heating is wide	Yes or No
No danger of causing fire	Yes or No
No worry about getting burning	Maximum temperature (°C)
No bad odors	Yes or No
Relaxing	Floor temperature (°C)
Heats quickly	Speed to warm room air (minutes)
Entire room can be heated	Vertical temperature difference (°C)
Room does not become dry	Humidity (RH%)
Eco-Friendly	CO_2 emission (kg)
Reliable manufacturer	Yes or No
Less trouble	Yes or No
Good after-sales services	Yes or No
Variety of colors and designs	Yes or No

Source: Yagita *et al.* (2003)[5]

In 2004, in order to determine the correlation matrix of the alternatives versus secondary requirement items, at least five experts met and discussed on each correlation value following the concept of Delphi Method. In this way, the values were determined rationally and based on the general consent among all the participating experts. The evaluation criteria of the secondary requirements vary, depending on scales of the characteristics, such as numerical, ordinal, and nominal measures. All the scales were normalized to ordinal scale, and the correlation values were set including 0 being no correlation, 10 being mostly correlated, and any numbers between the two, according to the relative correlations. When the experts could not differentiate the correlations, 5 were placed on every alternative.

3.4. Evaluation of the Appropriateness of the Suggested Methodology

The preference ratio (in percent) of the sum of the acceptance value was calculated based on the importance levels of secondary requirements and evaluation of requirements with physically/engineering scales. The calculated social acceptance values were then compared with the directly asked social acceptance from Q1 of the survey. The evaluation of the appropriateness of the prediction power of the suggested method was conducted by calculating the correlation coefficient (r) of the two values instead of a square of the correlation coefficient (r^2). In some activities the results showed negative correlations between the estimated and measured acceptance values, which would have been made difficult to differentiate if r^2 had been used.

4. Results and Discussion

4.1. Estimation Power of This Method

The matrix to determine the acceptance values for "how to enjoy dinner on holiday evening" is shown in Figure 3. The secondary requirement items were categorized by elementary requirement items, the importance levels of secondary requirement items were obtained from Q2 or the questionnaire survey by ordinal method, and the physical evaluation of requirements and alternative were determined by authors in normalized scales. The appropriateness of the suggested methodology was evaluated by comparing the calculated social acceptance values to the directly asked social acceptance from Q1 of the survey, using the correlation coefficient (r). In this case, correlation was 0.92 which is among the highest of all tested activities.

		Economical		Healthy		Convenient			Safe	Comfortable						Env. Friendly	Reliable			
		Low price	Less wasting	Good for health	Good nutrient balance	No need of cleaning	Quick preparation	Does not take much effort	Safe	Good taste	Variety in kind	Can relax at home	Good atmosphere	Can enjoy hand-made taste	Fit my liking	Less garbage production	Can trust the shop/restauran			
Secondary Requirement from survey		1.43	0.79	0.94	1.06	0.78	0.83	0.91	1.18	2.21	1.19	1.00	0.97	0.68	1.11	0.32	0.60			
Cook whatever available in the fridge	Physical Evaluation	10	5	7	5	0	2	1	5	5	0	10	5	10	5	5	5			
Go grocery shopping and cook		6	5	10	5	0	0	0	5	5	10	10	5	10	10	0	5			
Buy everyday dish		4	5	5	5	7	7	8	5	5	5	10	5	0	0	3	5		R=	0.9165
Order a house delivery		0	5	0	5	9	9	10	5	5	5	10	5	3	2	9	5		R*R=	0.8400
Eat Out		0	5	0	5	10	10	10	5	5	8	0	5	4	10	10	5			
																		Calculated	Ratio (%)	Actual (%)
Cook whatever available in the fridge	Acceptability Value	14.28	3.96	6.61	5.28	0.00	1.66	0.91	5.92	11.03	0.00	9.95	4.85	6.80	5.55	1.60	3.00	81.41	19.40	7.60
Go grocery shopping and cook		8.57	3.96	9.44	5.28	0.00	0.00	0.00	5.92	11.03	11.90	9.95	4.85	6.80	11.10	0.00	3.00	91.80	21.88	42.10
Buy everyday dish		5.71	3.96	4.72	5.28	5.44	5.82	7.31	5.92	11.03	5.95	9.95	4.85	0.00	0.00	0.96	3.00	79.90	19.04	3.40
Order a house delivery		0.00	3.96	0.00	5.28	6.99	7.48	9.13	5.92	11.03	5.95	9.95	4.85	2.04	2.22	2.88	3.00	80.69	19.23	6.60
Eat Out		0.00	3.96	0.00	5.28	7.77	8.32	9.13	5.92	11.03	9.52	0.00	4.85	2.72	11.10	3.20	3.00	85.80	20.45	40.30
																	Total	419.59	100	100

Figure 3. Calculation method for social acceptance in the case of "how to enjoy dinner on holiday evenings" using the expansion table of QFD.

An expansion table as shown in Figure 3 was developed for each of the activities surveyed, and the correlation coefficient (r) between the two acceptance values was calculated. A full survey for 22-27 activities was conducted in 2002, 2003 and 2004. However, the results from the survey in 2002 were omitted in this paper because the tested activities and the criteria for clustering of the activities were different from the following years, making it impossible to evaluate the improvements in estimation power of the suggested method. The conditions and parameter settings of three analyses are shown in Table 7, and the results of correlation coefficients (r) are shown in Table 8. The calculation of social acceptance was done three times (2003, 2004a and 2004b); however, survey was conducted twice in these years. The difference between 2003 and 2004a in analytical condition was only evaluation method of requirements by physical/engineering scales. For some activities, the estimation was close to reality for some activities while there were cases where the suggested methodology did not estimate the reality properly in any of the analysis. The estimated values vary by consumption activity, and the patterns of change in the estimated values vary by analytical conditions.

Table 7. Conditions and parameter setting of three analyses.

Component	Item	2003	2004a	2004b
Parameter setting	Number of Activity	27	27	22
	Determination of question phrases and alternative means	Determined by authors through discussion	---	Modified by authors through discussion
	Determination of the wordings of secondary equipment items	Discussed among the authors. Some items of subjectivity were purposely included.	---	Brushed up and made more specific
Survey	Survey Type	Internet	---	Internet
	Survey Dates	Nov.14-18, 2003 & Feb. 5-9 2004	---	Dec.17-20 2004
	Respondents' attribute	Men and women 20-59 in age	---	Men and women 20-59 in age
	number of respondents (persons / activity)	350	---	500
	method to calculate importance level	Ordinal method	---	Ordinal method
Evaluation of Requirements by Physical/Engineering Scales	Evaluation method	4 researchers (authors)	Delphi Method (3 different types of groups x 5 persons)	Delphi Method (integrated the matrix into one by 4 researchers, considering three matrices)
	Scaling	Normalization (0-10 scale; all 5 for items impossible to evaluate)	Normalization (0-10 scale; all 5 for items impossible to evaluate)	Normalization (0-10 scale; delete any items impossible to evaluate)

Table 8 shows only cluster, choice of system or product, activity, and results of r in three different analytical conditions. However, other variables and attributes besides the analytical conditions shown in Table 7 are omitted due to the limited space. The omitted variables includes number of secondary requirement items, number of alternative means for each activity, results of the directly asked acceptance values, frequencies, degree of involvement, involvement of subjectivity, etc. While evaluating the appropriateness of the suggested method, these variables and attributes need to be considered. Also, effects of methodological aspects, such as uncertainties of the evaluation of requirements by physical/engineering scales, respondents' knowledge, information and experiences in decision-making, brushing up the wordings for secondary requirements and choice of alternatives, will be looked into. The analysis was carried out to identify the attributes and effects that explain the differences with regard to the level of estimation performance of this suggested method. The results will be presented at the international workshop on sustainable consumption.

Table 8. The result of the appropriateness of the suggested methodology expressed by correlation coefficient (r) between directly asked and estimated acceptance values for different analytical conditions

			r		
			Analysis 1	Analysis 2	Analysis 3
Cluster	**System/Product**	**Activity**	**2003**	**2004**	**2005**
Purchase of durable goods	System	01. Choice of housing	0.93	-0.50	N/A
		02.How to use a car	0.36	0.98	0.85
	Product	03.Choice of car	0.79	0.70	0.60
Purchase of expendable supplies	System	04.How to do the laundry	0.50	0.61	0.85
		05. Choice of living room lighting	0.79	0.77	N/A
	Product	06. Choice of camera	0.71	0.64	0.94
	System	19. How to clean a house	0.94	0.92	-1.00
	Product	20. Choice of TV type	0.94	0.92	0.88
		21. How to kill mosquitoes	0.99	0.30	N/A
Dining	System	07.How to enjoy dinner	0.93	0.61	0.98
		08. How to obtain a coffee	0.98	0.91	0.57
	Product	09. Choice of vegetable	0.95	0.64	0.58
Energy consumption	System	10.Choice of a boiler	0.64	0.71	N/A
		11.Choice of heating device	0.22	-0.07	-0.09
	Product	12. Choice of cooling device	-0.19	-0.55	0.21
	System	22. How to dry laundry	0.88	0.71	0.79
	Product	23. Choice of grill/stove	0.92	0.81	0.77
		24. How to obtain hot water for tea and coffee	0.99	0.84	0.33
Information and Communication	System	13. Means of communication with friends	0.81	0.32	0.85
		14. Choice of the Internet connection	0.93	0.91	0.92
	Product	15. Choice of personal computer	0.90	0.53	0.43
	System	25. Printing of greeting cards	0.44	1.00	N/A
		26. How to obtain information on restaurants	0.53	0.94	0.68
		27. How to obtain weather forecast	0.69	0.80	0.73
Leisure	System	16.How to enjoy movie	0.56	0.81	0.80
		17.How to learn English conversation	0.60	0.78	0.22
	Product	18. Choice of accommodations	0.91	0.86	0.95

4.2. Correlation between Elementary and Secondary Requirement Items

The hypotheses of this research is that once the importance levels of elementary requirements have been quantified, they are deployed to the importance levels of secondary requirements specific to the activity, according to the correlations between the elementary and secondary requirements, then it enables the estimation of the social acceptance of alternatives for any ordinal activities. However, the importance scores for the secondary requirement items within the same elementary requirements vary. For example, there are two secondary requirements items, such as “initial cost” and “running cost” under the elementary requirement “Economy” and the scores vary. Consolidation of the importance scores of secondary requirements to elementary requirements was attempted with two different calculation methods: mean score and total score. However, neither one was found to be feasible. The results will be shown during the oral presentation at the Oslo Workshop.

Moreover, even if the importance scores of the two secondary requirements were consolidated properly, there is no method to split the score explicitly into underlining secondary requirements when applying the model to the case of other consumption activities to estimate the social acceptance. Therefore, we could not reach the stage which enables us to test our hypothesis.

5. The Potential Application of the Suggested Methodology

The suggested method consists of two matrices: first for the correlations between elementary requirements and secondary requirements, and secondly the correlations between secondary requirements to alternative means. With given resources and expertise up to date, we have not elucidated the first matrix. Therefore, it is unable to consolidate the importance scores of secondary requirements to elementary requirements or vice versa. If the latter matrix from secondary requirement items to the acceptance values for each alternative is utilized alone, it is applicable to only certain consumption activities.

Even so, this quantitative evaluation method can be useful in some certain purpose. For example, for particular consumption activities that we surveyed for this research, the importance levels of secondary requirement items have been empirically quantified. When one needs to know the potential consumer acceptance of a newly developed environment-friendly product prior to coming onto the market, conducting a consumer survey does not provide the necessary information because consumers cannot evaluate this new product due to lack of information regarding the product and experience of using it. Using our suggested methodology, one can predict quantitatively the social acceptance of new product along with existing products, based on the importance levels of consumer requirements which have been already quantified.

Moreover, if a newly designed environment-friendly technology is predicted to be unpopular among the consumers despite its drastic reduction of energy use, one can re-design the technology based on consumers' secondary requirements in order to increase its popularity among the alternatives for the same consumption activity. Therefore, as long as within the consumption activities surveyed, one can evaluate the acceptance values of a product yet to come using the results of this study. These usages make this suggested method of a high utility value.

Fortunately, we have complied the importance levels of secondary requirement items for 22-27 consumption activities, including the activities that may have negative impacts to the environment, within three years of research. At least nine among all the activities surveyed, the latter matrix of our suggest evaluation methodology are useful for above purpose.

6. Conclusions and Future Studies

1. An attempt was made to consolidate the importance scores of secondary requirements to elementary requirements with two different calculation methods: mean score and total score. However, neither one was found to be feasible. At the same time, there is no relevant method to split the elementary requirements to secondary requirements explicitly. Therefore, we could not reach the stage which enables us to test our hypothesis.

2. Despite the obstacles, the results suggest that this evaluation method may be applicable to certain types of activities when the acceptance values were calculated from the importance levels of secondary requirement items.
   - One of the general tendencies is that the appropriateness of this suggested method was higher for the activities in "purchase of expendable supplies" and low for those of "energy consumption".

- The activities that make our method feasible have positive factors: leisure-related, high in frequency, higher tendency in switching the choice of alternatives by occasions.
- The activities that make our method inapplicable are those that have negative factors: large price differences between alternatives, few numbers of requirement items with physical/engineering scales, and alternatives that are rarely chosen.
- There were some activities, such as "how to obtain hot water for tea and coffee" that have positive and negative factors and not clear reasoning could be withdrawn for the high/low appropriateness of the suggested method.

3. Even though it is not the usage of this method foreseen, this suggested method has a high utility value in predicting the potential social acceptance of a newly developed environment-friendly product prior to coming onto the market, without conducting a consumer survey.

4. Our research team will discontinue the work on this particular topic for the time being. However, we may resume in the future if a new potential solution is suggested to the current obstacles.

References

[1] Livio D. DeSimone and Frank Popoff with the World Business Council for Sustainable Development. (1997). "Eco-efficiency: The Business Link to Sustainable Development", MIT Press

[2] OECD Workshop on Sustainable Production and Consumption: Clarifying the Concepts, Final Report of Workshop (1995).

[3] Akao,Y. (1990). *Quality Function Deployment*, Productivity Press, Cambridge, Massachusetts, USA.

[4] Yoshie YAGITA, Yoshihiro AIKAWA, Atsushi INABA. (2002) "A Proposal of the Quantitative Evaluation Method for Social Acceptability of Products and Services", The Fifth International Conference on EcoBalance, Tsukuba, pp.635-638

[5] Yoshie YAGITA, Yoshihiro AIKAWA, Atsushi INABA. (2003) "Proposal of a Quantitative Evaluation Method for Social Acceptability of Products and Services", The First International Workshop on Sustainable Consumption, Tokyo, pp. 299-306.

[6] Reynolds,T.J. (1988). "Laddering Theory, Method, Analysis, and Interpretation", *Journal of Advertising Research*. 28(1): 11-31.

[7] Yoshito Maruoka. (1998). "Present of Laddering Method: Research manner, analytical method, exploitation of upshot and a future problem." *Journal of marketing science*. 7(1/2): 40-61.

[8] Fumie KAWASHIMA, Atsushi KURAUCHI, Kiyoshi FUKAI and Kimiyuki SATO. (2003) "A Marketing Research for Consumer' Behavior", The First International Workshop on Sustainable Consumption, Tokyo, pp. 323-340.

[9] *Survey on Time Use and Leisure Activities.* (2001). Statistics Bureau, the Ministry of Public Management. (http://www.stat.go.jp/english/data/shakai/index.htm)

[10] Toshisuke OZAWA, Kiyotaka TAHARA, Noboru NOMURA, Atsushi KURAUCH, Fumie KAWASHIMA, Takahiko NAGANO and Atsushi INABA. (2003) "Quantitative Evaluation of Social Acceptability of Products and Services", The Second International Workshop on Sustainable Consumption, Tokyo, pp. 213-227.

[11] Takahiko NAGANO, Atsushi KURAUCHI and Fumie KAWASHIMA, Toshisuke OZAWA, Kiyotaka TAHARA, and Atsushi INABA. (2004) "Technical Improvements on the Quantitative Evaluation Method for Social Acceptance of Products and Services", The Third International Workshop on Sustainable Consumption, Tokyo, pp. 107-112.

[12] Toshisuke OZAWA, Kiyotaka TAHARA, Atsushi KURAUCH, Fumie KAWASHIMA, Takahiko NAGANO and Atsushi INABA. (2004). "Quantitative Evaluation Method of Social Acceptability of Products and Services" The Sixth International Conference on EcoBalance, Tsukuba, pp.413-416.

How can business identify capabilities and opportunities for sustainable production and consumption improvements? A Proposition for a Triple Bottom Line Innovation Audit Tool

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Abstract

Among many actors, businesses carry high level of responsibility for the "encouragement and promotion of the development of 10-year framework of programmes in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production (SCP) to promote social and economic development[…]" (WSSD, 2002). This calls for significant efforts for understanding systems of production and consumption, which businesses have direct or indirect effects, and for locating priority areas for improvements in the system. While, system improvements, in other words innovations for SCP, require changes in socio-technical systems beyond an alteration in technical components, since technical improvements (such as efficiency improvements) have not been sufficient (Adriaanse, et. al. 1997; EC, 2000).

The success of system innovations for SCP depends on the capabilities of business to mobilize its societal resources beyond technical capabilities. In fact, leadership for innovation requires extraordinary capabilities such as thinking beyond business-as-usual practices and understanding of local priorities, interdisciplinary thinking, etc. Realization of radical thinking in corporations is a highly complex process and requires involvement of many actors (Mol and Sonnenfeld, 2000). For example, in the case of product-service system (PSS) developments, corporations would be in need of novel mechanisms to raise awareness, to develop dynamic skills for creativity and would require an innovative institutional framework with incentives.

Despite the importance of understanding processes of innovation in the production and consumption system, factors for innovation have not yet been thoroughly studied in the sustainability literature. While several authors mention drivers of eco-innovations (for example Beard and Hartmann, 1999; Rennings, 2000) or social innovations, a Triple Bottom Line (TBL)[1] performance approach on the production and consumption system is missing. The conditions for TBL innovations stay as a „Black Box". We believe that a through study of this black box is required (See Figure 1). Only after then, the relevant organisational factors and processes can be addressed by the policy makers or managed

[1] The agenda of sustainable development for business emphasizes the importance of addressing all three pillars of sustainable development i.e. economic justice, environmental quality and social justice (Elkington, 1997). Being considered as any other activity of business, the system of innovation shall also have positive implications on all three pillars of sustainability.

by business in order to achieve radical improvements for SPC. This study has been proposed as an initial attempt in this vein.

In the scope of the overall project, entitled "Life Cycle Approaches to Sustainable Consumption"[2], which was commissioned by the National Institute for Advanced Industrial Science and Technology (AIST) in Japan, our overall goal was to study the determinants of triple bottom line innovations and introduce an initial framework for a tool, which can allow corporations to identify areas of opportunity for system innovations by locating improvement areas at the management level and at the resource use and/or triple bottom line impact level. We have taken the development of product-service mix applications in the Information and Communication Technology (ICT) sector as our focus in this study. We propose that corporations can work on these factors in a stakeholder process in order to develop product-service mixes, which would ultimately lead to macro level performance improvements for SCP.

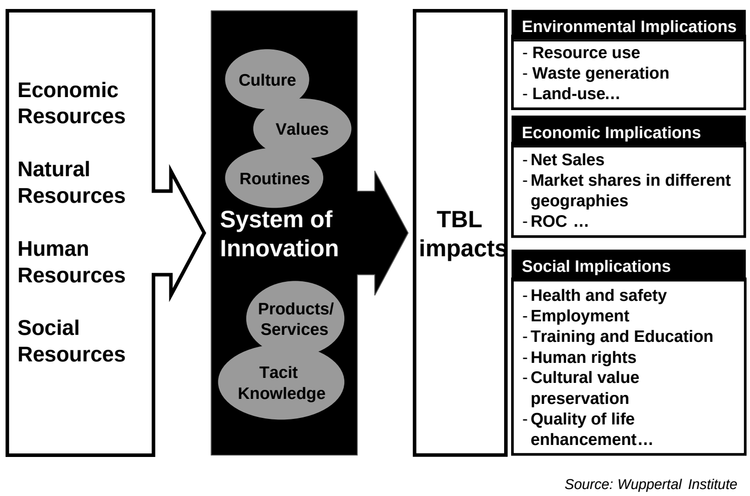

Figure 1 - The resource use and creation of triple bottom line improvements by the system of innovation.

In the route of the study, theories of resource-based view of the firm, in relation to institutional economics and evolutionary economics, were utilized to explain the major factors that need to be supported to initiate innovations with triple bottom line significance. Two different analytical levels are suggested to differentiate between the single actor level and multi-actor level. At the micro level, dynamic and static capabilities are situated, while at the meso level, informal and formal institutions are situated. It is argued that support for the static capabilities shall provide set up of routines to manage the triple bottom line, whereas support for the dynamic capabilities shall enhance the knowledge in the systems of innovations via set up of communication channels and collaborative actions. It is also discussed that informal institutions, as shared norms of

[2] This study intends to examine new ways to reduce CO_2 emission and environmental loads from the viewpoint of the consumer.

behaviour, creation of trust, informal agreements and shared visions among actors and formal institutions, as legally binding rules shall all provide a supportive environment for TBL innovations.

The determinants of triple bottom line innovations are not any different than traditional economically significant improvements. However, incorporation of environmental and social concerns to these aspects is vital for sustainability. This would mean an increase in the complexity of management of innovations, since establishment of more routines and a diverse range of stakeholder engagement are foreseen for triple bottom line innovations.
Depending on the results of the innovation management literature review, concentrating on the initiation stage of the innovation process, we suggested a two-step procedure. "Capability Scan Tool" aims at assessing whether the organisational capabilities and institutions surrounding the organisation are suitable to achieve innovations with sustainability performance. In parallel, an organisation can locate innovation potential of product-service concepts and ideas using the "TBL Significant Scan Tool", which integrates stakeholder sustainability concerns and enable a comparison for social and economic value creation and environmental improvement potential.

1. Background: Why is there a requirement for system level innovations for sustainable consumption (SC)?

Sustainable Consumption: dealing with a triple pillar problem

A wide range of actors from intergovernmental organisations such as UNEP, UN DESA, UNDP, UNIDO and OECD to NGOs, industry and governments have been working on the issue of sustainable production and consumption in the last decade. In the Johannesburg Plan of Implementation adopted in the World Summit for Sustainable Development in August 2002, *§14* of Chapter III refers to the "encouragement and promotion of the development of a 10-year framework of programmes in support of regional and national initiatives to accelerate the shift towards *sustainable consumption and production (SCP)* to promote social and economic development[…]" (WSSD 2002). As a follow-up of the Johannesburg, the European Institutions and the European Commission, in particular, has determined development of 10-year framework of programmes on sustainable consumption and production as a key area of action.

Many authorities have reflected on the fact that eco-efficiency improvements are overrun by the limits to efficiency gains and over consumption (overuse) of environmental resources is happening. For example, the review of the European Union's 5th Environmental Action Plan concludes that growth in environmentally damaging sectors simply outweighs the improvements attained by better technology and stricter environmental controls (EC 2000). According to the comprehensive study by the World Resources Institute of five advanced economies (the US, Germany, Japan, Austria and the Netherlands) conducted in cooperation with the Wuppertal Institute, the pollution and waste have continued to rise exponentially, despite the much-vaunted shift towards knowledge-based economies. Materials intensity as traditionally measured (based on direct material inputs or DMI to GDP ratio) has levelled off over the past decade. (Adriaanse, et. al. 1997:2) This surely implies that use of natural resource commodities may now be growing in parallel with economic growth[3] and "eco-innovations" (Beard and Hartmann 1999, Rennings 2000) are required in order to create a decoupling effect.

On the other hand, increasing levels of absolute resource consumption is combined with an extreme inequality of resource consumption. The evidence for the "distorted geography of consumption" indicates that the overall consumption of the richest fifth of the world's population is 16 times that of the poorest fifth (OECD 2002:12). Consumption disparities launch the question whether equality means for the third world "catching up with the first world" on the economic and social terms.

In this regard, regional differences such as cultural needs and local priorities for quality-of-life gain importance. Most of the world is disconnected from the most basic services and products. For example, UNDP Human Development Reports delivering a wide range of indicators covering issues as health, education, access to resources for a decent standard of living, personal security, equality for women and mean and human and labour rights point at significant differences in macro level societal priorities between the first and third world. (UNDP 1998) Hence, reach out of the services as well to the poor beyond the rich world is a major SCP aspect[4].

Besides the problem of addressing local issues, considerable attention is drawn at social implications of the act of consumption[5]. Researchers state that as product chains get more global and complex (Moltke and Kuik 1998, Kuhndt, et al. 2003a) satisfaction of needs get more material intensive, unquestioned and often homogenized departing from „humane consumption" (Ger 1997).

Sustainable Consumption: dealing with management of change at multiple levels

Management of triple pillar challenges of SC requires a change in patterns of production and consumption. From another perspective, change is crucial at the individual scale (i.e. among individuals at large based on interpersonal interdependence), at the organisational scale (within organisations and among organisations to maximize adaptability of individual organisations) and also at the societal scale (among operationally autonomous functional systems with its own operational code).[6]

Rotmans et al. (2000:19) states that "transition of a system is a gradual process of societal change in which society or an important subsystem of society structurally changes". According to him, the transitions are not caused by single variables such as a policy act, a price change or a new technology, but are the results of developments in various

[3] In emerging economies, which have more rapid growth trends, it is most likely that the picture would get even worse.
[4] This aspect is mentioned as „social effectiveness" by Dyllick and Hockerts (2002).
[5] This issue is often referred in the scope of „sufficiency" debate (Schumacher, 1974; Sachs, 1993). For corporations, it would mean rather than fuelling the demand for more unsustainable products, they might try to channel demand towards less problematic areas.
[6] The levels of scale are taken from Jessop (1997) in Parto (2003).

domains, which sustain each-other: technology, economy, institutions, behaviour, culture, ecology and images/paradigms (Rotmans et al. 2000:20)

Summing up the above given arguments, our underlying proposition is that management of sustainable consumption requires, in fact, management of triple pillar change. This change ought to happen along, what we name, a system of production and consumption, which is built around a product life-cycle chain (from extraction of raw materials to use and end-of-life management phases) providing a certain function[7]. The system encompasses many societal actors interacting with the product chain actors (i.e. raw material extractors, producers, retailers, consumers and end-of-life managers). Involvement of these actors such as communities, financial institutions, governmental institutions, technology providers, non-governmental organisations, waste processors and recyclers are essential to achieve system wide changes.

As any change in a system, the system of production and consumption shall possess a direction for change. Change implies a transition from one dynamic equilibrium to another dynamic equilibrium. In our opinion, the main objective of the system can be defined as sustaining the value of the environment and creating value for the society and the economy. This means that Triple Bottom Line (TBL)[8] performance improvements at the resource use or the impact side of the system have to be realized. (See Figure 1)

In continuum to our argument that sustainable consumption requires triple pillar changes in the system of production and consumption, we suggest to study change from the perspective of innovation management. As we will shortly discuss in the forthcoming chapter, innovation is nothing indifferent than performance improvement. In this regard, study of systems innovation would a practical starting point for studying change in the production and consumption systems for sustainable consumption.

Our focus: Crucial role of business in driving sustainable innovations for SC

In the system of production and consumption, businesses as designers and marketers of the production and consumption system deserve considerable attention. The success of system innovation depends on the capabilities of business to mobilize available societal resources to attain the objective of TBL improvements.

Leadership for innovation requires extraordinary capabilities: thinking beyond business-as-usual practices and full awareness of the sustainability demands on the system. Realization of radical thinking in corporations is a highly complex process and requires involvement of many actors (Mol and Sonnenfeld 2000). As in the case of product-service system (PSS) developments, corporations would be in need of novel mechanisms

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[7] Supported as well by UNEP, “functional-based approach” aims at tracking consumption patterns in each need area such as mobility, food, energy, housing, clothing, leisure, etc.

[8] The agenda of sustainable development for business emphasizes the importance of addressing all three pillars of sustainable development i.e. economic justice, environmental quality and social justice (Elkington, 1997). Being considered as any other activity of business, the system of innovation shall also have positive implications on all three pillars of sustainability.

to raise awareness, to develop dynamic skills for creativity and would require an innovative institutional framework with incentives. Innovative pathways towards sustainability require drastic changes in corporate visions, in addition to all sorts of internal organisational and managerial changes.

However, in the sustainability literature, how the process of innovation in the production and consumption system occurs is not well studied. Capabilities and skills, in other words, conditions required to achieve innovations, which would improve TBL performance are rarely addressed. While several authors mention drivers of eco-innovations (for example Beard and Hartmann 1999, Rennings 2000) or social innovations, a TBL approach on the production and consumption system is missing. As shown in Figure 1, conditions for systems innovations remain as a „Black Box", which requires to be studied. This paper introduces an initial attempt in this vein.

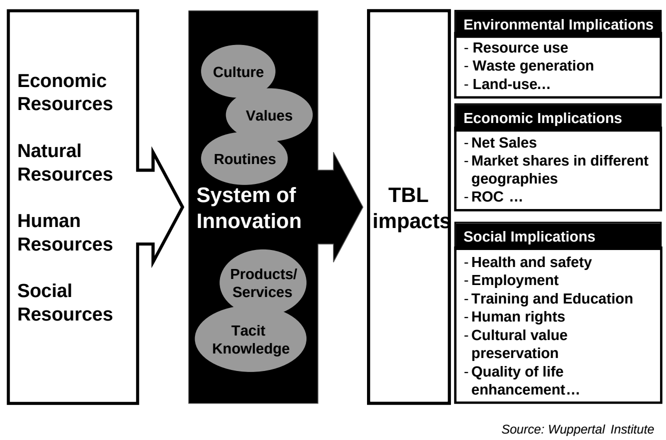

Figure 1 - The resource use and creation of triple bottom line improvements by the system of innovation.

Hence, following an initial study of this "black box", our **overall goal**[9] stays as developing an initial framework for a tool, which can allow corporations to identify areas of opportunity for system innovations by locating improvement areas at the management level and at the resource use and/or triple bottom line impact level. We propose that corporations can work on these factors in a stakeholder process in order to develop product and service ideas, which would ultimately lead to macro level performance improvements for SCP.

For this purpose, we focus on the information and communication technology (ICT) sector, whilst the following are identified as relevant research questions:

[9] This study is, in fact, carried out in the scope of the overall project, entitled "Life Cycle Approaches to Sustainable Consumption"[9], which was commissioned by the National Institute for Advanced Industrial Science and Technology (AIST) in Japan. The overall study intends to examine new ways to reduce CO_2 emission and environmental loads from the viewpoint of the consumer.

- What are the sustainability demands on ICT companies for the development of product-service mix applications?
- Which internal factors are relevant for ICT companies in developing products and services with superior environmental, social and economic performance?
- How can ICT companies assess (measure) their strengths and weaknesses or level of knowledge and skills for the development of product-service mix applications?

2. Triple Pillar System Innovation: what's behind it in theory?

In order to realize our objective, we initially started with a **review of the innovation management** literature focusing on the work of researchers, who have studied the nature of innovation concept, system innovations, eco-innovations and social innovations. This review aimed at setting the ground to introduce a **definition of TBL innovations**, explaining the significance of each TBL pillar and **micro and meso level aspects** that needs to be considered for system innovations.

2.1.Innovations in General

Broad definitions for innovations emphasize its novel nature and economic significance. According to Edquist (1997:1) "Innovations are new creations of economic significance. They may be brand new, but more often new combination of existing elements". Another major aspect of novel improvements is emphasized as its collectivistic nature. Innovations are developed in very complex processes with participation of different actors. Due to this complexity, firms never innovate in isolation. Edquist (1997) states that resource generation i.e. competence, knowledge and capital, needed for the development and diffusion of innovations occur in processes with a plurality of actors. Hence, the generation of the necessary resources takes place through interactive learning processes and collectively between actors.

Driving from the interactive nature of innovations, systems approaches to innovations have become common. For example, a cluster of systems approaches such as input-output analysis, national innovation systems (Miles, 1999), sectoral innovation systems, local industrial systems (Ayres and Simonis, 1994) and technological systems can be identified (Carlsson et al, 1999 in Orozco, 2002). Regardless of the type of approach, systems of innovation are usually defined as network of institutions[10] or a system of actors (firms, organisations and government agencies) (Gregersen and Johnson, 1998). Summing up the discussion on the generic innovation literature, innovations can be considered as systems aiming at novel improvements developed within a network of institutions.

2.2. Triple Bottom Line Significance of Innovations

Focusing on novel improvements or processes of innovation, most of the innovation management literature does not have concerns for establishing a "direction". For example, Reenings (2000) states that general definitions of innovation are neutral

[10] The network of institutions is composed of organisations (i.e. formal structures with an explicit purpose and consciously created) and institutions (i.e. set of common habits, routines, established practices, rules, laws that regulate the interactions among individuals, groups and organisations) (Edquist, 2001) and learning networks (Lindegaard, 1997).

concerning the content of change and open in all directions and this should not be the case regarding innovations aimed at sustainable development. Hence, the only direction commonly mentioned can be stated as the economic dimension, whilst environmental dimensions are rarely being mentioned and social dimensions are often ignored.

The agenda of sustainable development for business emphasizes the importance of addressing all three pillars of sustainable development i.e. economic justice, environmental quality and social justice (Elkington 1997). Innovations, as novel creations of business or improvements in their processes, can also be assessed as any other activity of the business. Hence, all innovation bottom lines shall be balanced and the systems of innovations shall have positive implications on both input and output sides (See Figure 1). What would that mean for business? How can innovations satisfy economy, environment and society, simultaneously?

The significance for the *environment bottom line* of the innovations can be evaluated in terms of their use of natural capital (Lovins et al. 1999) and the impact created on the environment. Hence, all stages of development of innovations shall take into consideration that the capacity of ecosystems and the biological engines of the planet are declining. Acknowledging the limits of the ecosystems, business can then follow an eco-efficiency strategy encompassing improvements in all environmental aspects such as energy, water, raw materials and land use, whilst enhancing recyclability, product durability and closing the material loops (Weizsäcker 1997). This would in turn mean reduced air emissions, water discharges, waste disposal and elimination of toxic substances.

Additionally, *environment bottom line* for innovations can pursue a cradle-to-grave approach. Life-cycle focus of a product, which begins and ends outside the boundaries of the company's operations, allows a full assessment of all inputs to the product and examine how customers use and dispose it. In this regard, a diverse set of concepts and approaches for environmental product stewardship in line with a life-cycle emphasis such as life cycle assessment, design-for-environment, eco-design, eco-innovations, sustainable product design can be followed.

However, resource efficiency improvements for a single product unit even along its life-cycle are insufficient to conserve the capacity of ecosystems. As mentioned in the introduction, this is due to the fact that increases in consumption units may hamper eco-efficiency improvements per product unit. Hence, assessments regarding the environmental bottom line shall focus on absolute improvements. Otherwise, rebound effects will enhance depletion of natural capital.

The *social bottom line* significance can concentrate on use of the societal resources and the impacts created on the society. Systems approaches to innovation can be considered as the initial point of departure for developing a link to societal actors. On one hand, similar to any business processes, innovations would require use of a certain level of human resources such as knowledge and skills of the employees or networks and social resources such as community infrastructure, public services and cultural values. On the other hand, processes of innovations would have impacts on the internal workforce and the society at large.

Social performance of systems of innovation has not been well studied. The social dimension is often mentioned depending on its relation to knowledge requirement and learning through innovation processes (Orozco, 2002), while the impact side of the innovation system stayed out of focus. Recently, consideration of social aspects, simultaneously with environmental concerns, is in discussion and on the policy agenda in relation to the concept of Corporate Social Responsibility (CSR)[11].

Hence, the demand for social assessment tools is increasing. In this respect, ethical labelling initiatives for products, ethical screening by the financial institutions and initiatives by social non-governmental organisations (NGOs) might provide tools for business to understand the relevancy of social aspects for innovative conducts.

In search for the significance for the *financial bottom line*, firms can concentrate on the effect of innovation activities regarding the economic resources of the corporation. However, in doing that, sustainable innovations need to move well beyond traditional understandings of economic capital, namely physical or fixed capital and financial capital. Assessing the significance of innovations requires a forward-looking approach rather than an evaluation of the past performance of the firm. Therefore, traditional forms of assessment of economic capital would not be sufficient. Economic sustainability definitions may embrace more diverse forms of economic capital such as "financial capital (i.e. equity and debt), tangible capital (i.e. machinery, land, stocks) and intangible capital (i.e. reputation, inventions, know-how, organisational routines)" (Dyllick and Hockerts 2002:11).

In the light of the above discussion, a formal definition of TBL innovation can be expressed as follows:

”Triple bottom line innovations are novel improvements developed within a network of institutions aiming at preservation of absolute amount of natural resources and enhancement of social and economic capital”.

2.3. Significant Factors for TBL Innovations

Having developed an understanding of the characteristics of triple bottom line innovation, theories of resource-based view of the firm in relation to institutional economics and evolutionary economics can be used to explain the factors playing role in the set up of the system innovations.

As TBL innovations occur within a network of institutions, both institutional and evolutionary economics are found relevant for the search of factors. The orientation of

[11] CSR mainly refers to business decision-making linked to ethical values, compliance with legal requirements and respect for people, communities and environment. It aims to operate a business in such a way that it meets or exceeds the ethical, legal, commercial and public expectations that society has of business.

institutional economics is towards the set of factors that mould and define humane interactions, both within organisations and between them. On the other hand, "much of modern evolutionary economic theorizing is focused on the processes of technological advance", in other words the routines[12] within which production and technological development is organised (Nelson and Sidney 1982).

It is found useful to have two different levels of factors i.e. micro and meso to start developing an understanding of the important categories that shall exist inside and around the corporation for developing innovations with TBL significance (See **Error! Reference source not found.**2). At the micro level, the focus is on the corporation. Micro level approach has a look from inside to outside of the organisation. On the other hand, at the meso level, we do not separate the organization from its environment and try to define the factors at the societal level.

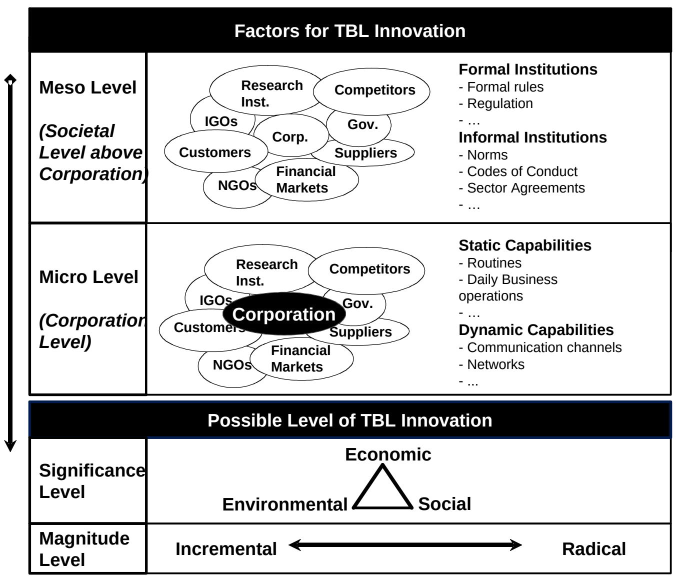

Figure 2 – The framework of factors important in the initiation of TBL innovations and assessment of significance of triple bottom line innovation (Source: Wuppertal Institute).

The micro level factors are based on evolutionary economics (Nelson and Sidney 1982), where *"static capabilities"* and *"dynamic capabilities"* are suggested for the attainment of an innovative organisation. Routines of an organisation are central elements in determining its *static capabilities*. Major function of routines is often understood as the co-ordination of the skills of an organisation (Dosi 1988:5). Routines in corporations would also refer to daily business operations. Thus, how an organisation makes use of its financial, social and natural capital in its day-to-day business is relevant for an understanding of its static capabilities. Development of static capabilities for TBL innovations would mean set up of systemic working procedures in an organisation and rearrangement of them, where necessary.

[12] According to evolutionary economics, understanding of how innovations emerge within organisations requires an understanding of how organisational routines are developed and improved. It is assumed that this argumentation is also valid for innovations with a sustainability direction.

On the other hand, "communication channels, information filters and problem-solving strategies that develop between groups within an organisation and between organisations" (Henderson and Cockburn 2000) are relevant for *dynamic capabilities*. Hence, collaborations[13] through horizontal and vertical networks within the organisation and co-operation with other organisations are crucial for successful system innovations.

At the meso level, we focus on the interactions between societal actors, which affect the working conditions of business. The conditions of the institutional set-up would also influence the orientation of micro level capabilities. Institutional economics, which is oriented towards the set of factors that mould and define humane interactions, specifically within organisations and between them, has been the focus for deriving meso level factors.

According to North (1990), institutions consist of both *"informal constraints"* and *"formal constraints"*. He explains them along a continuum from customs and traditions at one end to written regulations at the other (North 1990:46) (See **Error! Reference source not found.**). *Formal constraints* imposed by the stakeholders on the corporation, which may include all political and judicial rules, economic rules and contracts, can directly affect the micro capacity development. On the other hand, *informal constraints* such as codes of conduct, norms of behaviour, creation of trust, shared visions and informal agreements affect the implementation routes or outcomes of the formal institutions[14].

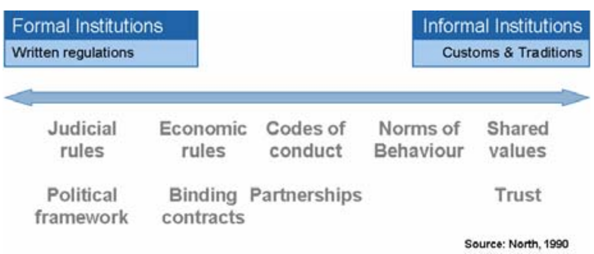

Figure 3 – The spectrum of formal and informal institutions.

As illustrated in Figure 3, the performance in terms of the micro and meso level factors can directly affect the level of *enhancement of social and economic capital and to which extend, absolute amount of natural resources is preserved; hence, TBL innovation*

[13] The importance of inter-organisational and intra-organisational links and learning networks in corporate environmental management has been mentioned many times in the literature (Gray, 1989; Clarke and Roome, 1995; Hartman et al., 2002). This has been also mentioned by the "stakeholder theory", which advocates the need for companies to be responsive to concerns of a broader range of "stakeholders" (Freeman 1984, Mitchell et al. 1997, Zadek et. al. 1997, Hopkins 1999). Similarly, theories of "organizational learning" (Agyris and Schön 1978, Senge 1990, Agyris 1993) stresses the importance of internal communication channels, external multistakeholder dialogue, partnerships with the NGOs and "social learning" as a crucial mechanism through which firms could acquire the knowledge, values and competencies needed for success.

[14] For example, it can be said that stakeholder dialogue based Dutch environmental policy making procedures enhanced informal institutions for eco-innovations. The Ministry of Housing, Spatial Planning and the Environment (VROM) aims at preservation of a collaborative environment based on stakeholder dialogue, which was initiated with the preparations of the first National Environmental Policy Plans in 1989. (VROM 1998)

significance. Further on, this deduction will affect the magnitude of the TBL innovation ranging from incremental to radical innovations. Once again, we believe that an ultimate discussion on the magnitude of TBL innovations is relevant for businesses if they would like to have a meaningful contribution to sustainability.

Next section discusses the innovation process and how the opportunities for TBL improvements can be detected in the process of product-service mix applications in the ICT sector.

3. TBL Innovation Audit Tool: How is it constructed? How does it work?

3.1.Innovation Process and the Development of the TBL Innovation Audit Tool

The previous chapter reviewed the concept of TBL innovation, while examination of the **innovation process** is crucial for understanding and managing TBL innovations. Innovation process is sketched in various ways in the literature referring to different types of innovation processes such as product innovations (McKee 1992, Dougherty, 1990), innovations in organisations (Roger 2003), technology innovations (Spath et al. 2003). A simplistic overview, which stays common to all, can be expressed in three major steps: strategic identification of innovation potential, preparation for innovation and realization of innovation and management of innovation (Spath et al. 2003). **Strategic identification** refers to both identification of opportunity areas to innovate and development of ideas. Then, feasibility of the ideas shall be tested and the organisation needs to be prepared to realize the innovation, since all resources may not be in place. Finally, **realization** refers to the assessment of an action plan and implementation of the innovation.

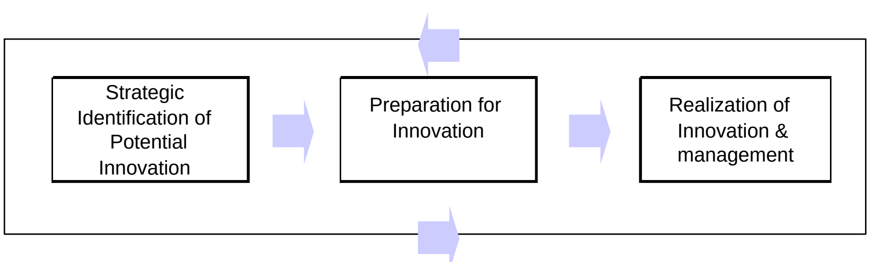

Figure 4 – Phases of the innovation management process (Source: Spath, et al., 2003, p. 11).

For the development of our tool, we adopted Roger's (2003:420)[15] five stages model of innovation process in an organisation. His model is quite well accepted in the organisational innovation management literature (See for example Ven 1986, Monge et al. 1992, Damanpour 1996). On the other hand, as his approach fails to include characteristics of system innovation, we have extended his model and concentrated on the initiation stage. A short explanation of Roger's model and our comments for extention is provided in Appendix 1.

[15] His well-known diffusion model first appeared in the first edition in 1962. In our study, we use the fifth edition of Roger's work published in 2003.

As illustrated in Figure 6, we have focused on the initiation stage of Roger's model and foreseen steps required for system level innovations. At the Agenda Setting stage, the condition is **recognition of the need for system innovations with TBL significance**. Regular scan of market opportunities and risks can direct the company for taking action on TBL improvements. As an illustration, strategic assessment of the market opportunities existing in terms of functional sales can lead to initiation of the innovation process[16]. Senior management, operational or marketing department can take the lead for the development of new concepts or product ideas in this context. Recognition of business risks along the production and consumption system can also trigger this process. For example, recognition of GHG emission risks might urge corporations to pay particular attention for lessening their air emissions. Regarding the social bottom line, recognition of the information access problem of local communities can be a motivation for the development of new product and service ideas. Following the need identification, the organisation can generate new innovation ideas using its existing capabilities and resources.

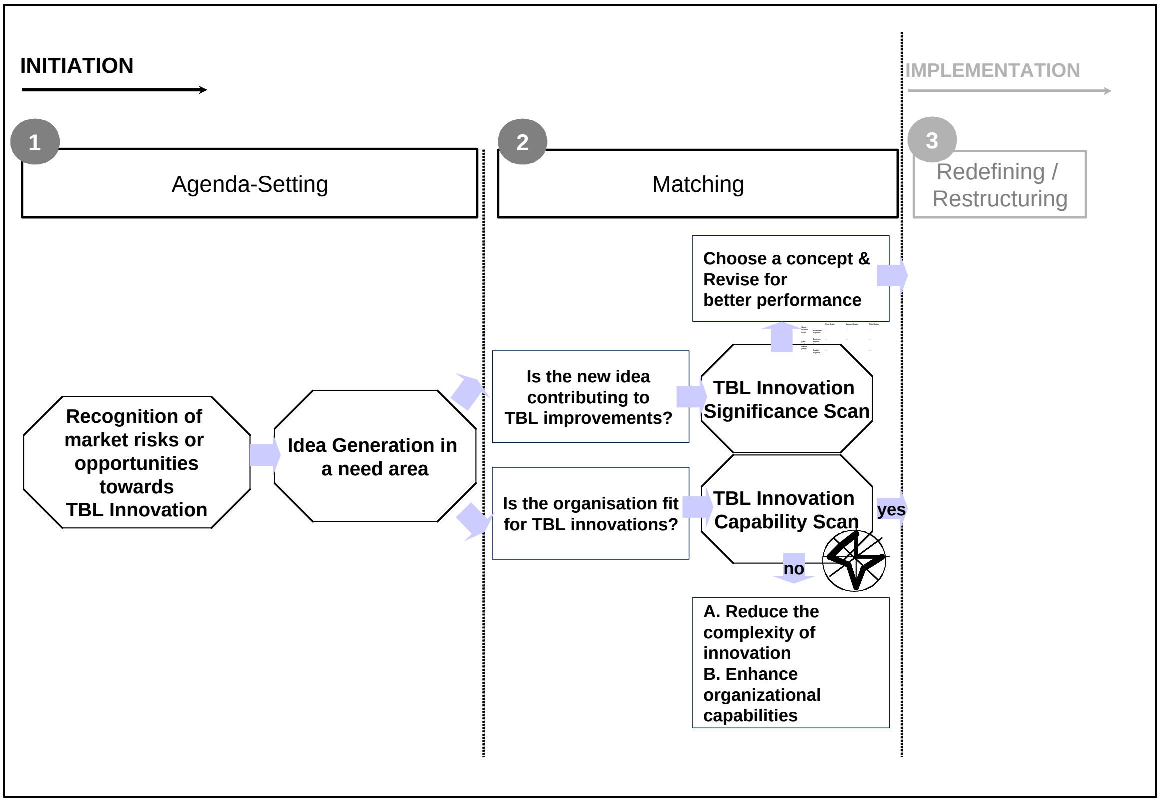

Figure 5 – An overview of the TBL Innovation audit tool.

At the matching stage, an organisation can **locate innovation potential** of these concepts and ideas using the **"TBL Significant Scan Tool"**, which integrates stakeholder

[16] For example, in the area of Commercial Cleaning Equipment, Electrolux euroclean in Sweden has a product-service line shifting from supplying products to providing function. The ownership of the product is retained by the company and the conventional sales strategy has been replaced by leasing and service contracts (Agri *et al*, 1999).

sustainability concerns. This would enable a comparison for social and economic value creation and environmental improvement potential. This tool also helps the organisation to place the idea in the context of the production and consumption system. In parallel, **"Capability Scan Tool"** aims at assessing whether the organisational capabilities and institutions surrounding the organisation are suitable to achieve innovations with sustainability performance. Construction process of both tools and suggestions for practical applications are discussed in the following sections.

3.2.TBL Capability Scan Tool: Story behind and its operationalisation

Anticipating the benefits and difficulties that the new product and service idea will encounter is an important aspect at the matching stage. While assessment of opportunities and threats on the impact side is important for the TBL performance of the innovation, success also depends on readiness in terms of corporate capabilities and surrounding institutional framework (See Figure 3 and Figure 4). This means that the ability to put first, second and third order impact improvements into practice shall be need in place, otherwise institutionalization [or according to Rogers (2003), routinization] of innovation can not take place.

The aim of the "TBL Innovation Capability Scanning Tool" is to allow a corporation to test its capacity to innovate. This tool can also be perceived as an awareness-raising audit for the corporation, which can be completed with its stakeholders. The corporation can identify its strengths and weaknesses for TBL innovation management reviewing its strategies, corporate culture, management routines, stakeholder involvement capabilities and so on.

A systematic process of concept specification is used to find the ultimate list of issues to be reviewed. These are actually sub-categories driven from major categories of innovation factors, which are then driven from factors of innovation. As illustrated in Figure 6, factors of innovation are taken from our review of evolutionary and institutional economics, which was explained in Chapter 2 of this paper. Following for each factor of innovation, categories are deducted from innovation management literature. Finally, sub-categories are listed for each category of innovation factors. subcategories are derived based upon the scanning criteria collected from five major socially responsible investment (SRI) analysis organisations *(FTSE4Good Index Series Criteria, Dow Jones Sustainability Indixes-SAM Questionnaire, Ethibel Sustainability Index, Ethical Screening Criteria, DOMINI400),* two rating indices *(Corporate Responsibility Index 2002 Business in the Community, Social and Environment Risk Management Model)* indicators for sustainability reporting *(the GRI Telecom Sector Supplement)* and indicator lists developed by research institutes working on innovation management *(Erasmus Research Institute of Management Report, SIID-Phase 2).*

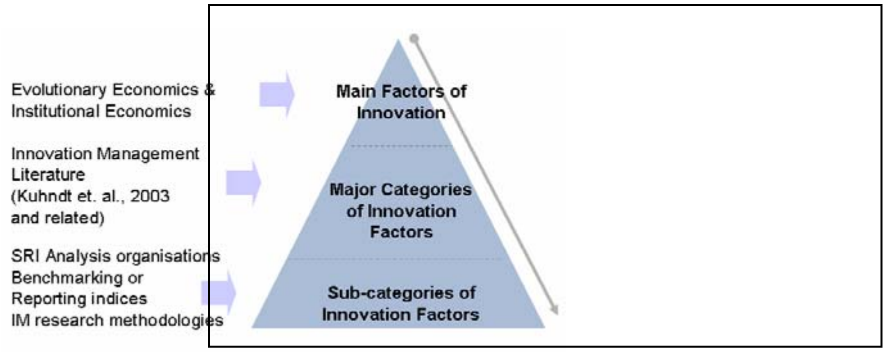

Figure 6 – The systematic process of concept specification for the derivation of TBL capability assessment tool categories.

A complete list of factors of innovation, categories and sub-categories are given in Tale 1 of Appendix 2. For example, dynamic capabilities of a corporation are related to categories: top management leadership, corporate culture, organisational learning, internal stakeholder involvement and external multistakeholder involvement. Each category is then characterized for triple bottom line innovation management based on the references from financial and benchmarking indices. For example, under corporate culture, company openness and dynamism and existence of a belief in collective decision-making for a TBL vision and strategy are questioned.

We suggest that the **operationalisation of the Capability Scan Tool** can include three major steps involving an inter-departmental team. Initially, a multi-disciplinary team including staff from different business units and hierarchical levels i.e. senior management, middle management and production floor shall be established. To identify the status quo of their capabilities, the team shall provide answers according to the performance scale running from one to five under each listed sub-category. The results of the evaluation can then be placed and illustrated on a spider-web scheme. (See Figure 8 of Appendix 2 for an illustration of the procedure)

Following, the team can select top priority strengths and weaknesses at the capability level and top priority opportunities and threats at the institutional level. Then, they can brainstorm to develop an action plan on how to overcome the weaknesses and how to face the threats. The findings with regards shall provide input to the development process of the product and service idea. For example, if a company is significantly lacking action to identify possible environmental, social and economic impacts along the life-cycle of its products, the probability to develop a product-service mix concept, which can score high in the significance scan tool and gain acceptance in the evaluation network, would be low.

As the team gets an overview of the capabilities, they can proceed with the Significance Scan tool to develop ideas and follow the procedure to select the idea with the highest potential of TBL improvements.

3.3.TBL Innovation Significance Scan Tool: Story behind and its operationalisation

Due to the scope of our study, the aim of this tool is given as assessment of the innovation potential of ICT sector based products and services by focusing on all relevant

TBL impacts. Innovation potential is defined in the context of the sustainability demands and concerns put forward by the stakeholders on the ICT sector. These issues might correspond to resource use or TBL impacts created along the product cycle.

Stakeholder concerns are collected from the state-of-art documents (GRI 2002, Kuhndt, et al. 2003c, Charter and Clarke 2003, Fichter 2003, GRI 2003) discussing the environmental, social and economic implications of ICT products and services. All resources aim at categorizing the TBL or sometimes solely environmental impacts of the ICT sector products and services in terms of first order, second order and third order effects. Even though the definitions used by these publications differed, consensus definitions are written for each level of impact. Then, a list of major environmental, social and economic concerns for each impact level is constructed, which is also included in Table 2 of Appendix 3.

The Innovation Significance Scan tool consists of a questionnaire based on the three pillar concerns and a score comparison table. Following the derivation of ICT product-service mix concept ideas, the corporation can use this tool to compare them and choose the most favourable one i.e. with the highest TBL improvement potential.

An inter-departmental team can carry out the process: evaluate the concept ideas by seeking answers to the questionnaire. Assessment of first, second and third order triple bottom line impacts surely requires multi-disciplinary expertise. Through discussion, the team can choose among positive improvements, negative improvements or neutral development on the impact side. Following, scores can be calculated for each impact level of the triple bottom line and visualized on a graph. The reader can find an illustration for scoring in Figure 9 of Appendix 3.

Subsequently, in collaboration with external experts, the team can discuss the results for various product and service concept ideas and decide on the most favourable one. At this stage, participation of the network of the organization and parties that will be involved with the production, processing, use and end-of-life of the product-service mix is essential to make a sound selection of the concept idea to be developed further by the leading organization. This is due to the fact that regardless the order of the effect of assessment, judgement by a single actor is extremely difficult due to weak empirical evidences on the cause and effect relationships and, as discussed in the theoretical part of the report, innovations are creations of networks.

Particularly, getting a grasp of tertiary effects is a difficult task for the company and assessment process would require expert input. It might be argued that structural changes in the economy might fall beyond responsibilities of a corporation. In our opinion, as discussed in the introduction, product chains go global and interdependencies increase, corporate responsibilities have to expand. Corporations shall also assess probable aggregated impacts of their products and services on the production and consumption patterns, since single product unit assessments do not make a meaningful contribution to sustainability process. Finally, as illustrated in Appendix 4, the matching stage for the development of a product and service idea can be finalized with the selection of one of the concept ideas and suggestions for improvement.

3. Conclusions and Learnings

The challenge of making a change in the patterns of production and consumption is a problem of achieving systems innovations. This would once more imply that a blend of product innovations, organisational innovations and technological innovations is required. In this study, we have focused on the abilities of organisations to mobilize their resources to achieve a change in the production and consumption system. While staying economically competitive, business have to holistically address the challenge of decoupling material flows from growth and increasing social disparities. At the environmental level, corporations shall strive decreasing their absolute resource consumption i.e. not only internal or first order operations or not only that of a single product chain, but that of all services provided to the society. On the social side, corporations have to reflect more on local quality-of-life priorities, regional differences such as equity of access to basic needs, cultural distinctions, when they are developing new product-service ideas / concepts. Consequently, business is in need of approaches, which can allow incorporation of TBL factors into their organisational structure and processes to address these concerns.

In this study, concentrating on the initiation stage of the innovation process, we suggested a two-step procedure, which can function in collaboration with a corporations stakeholders. “Capability Scan Tool” aims at assessing whether organisational capabilities and institutions surrounding the organisation are suitable to achieve innovations contributing to sustainable consumption edge. In parallel, an organisation can locate innovation potential of these concepts and ideas using the “TBL Significant Scanning Tool”, which integrates stakeholder concerns. This would enable a comparison for social and economic value creation and environmental improvement potential. This tool also helps the organisation to place the idea in the context of the production and consumption system.

The “TBL Capability Scan Tool” and the “TBL Significance Scan Tool” can be valuable sources also for other sectors. The Capability Scan can be tailored to sector specific capability requirements. Even in this case, the list is neutral and has been not adapted to the ICT sector specific capabilities. A further research on these capabilities might also provide setting up the initial links between the impact side and the capability requirement as discussed in the previous point.

On the other hand, in the Significance Scan, the impact points surely have to be adapted according to stakeholder priorities and concerns in another need area. The first, second and third order effect separation can also be valid for other need areas. For example, for provision of mobility, assessment of the new product chain is possible at the first order level, while at the second order implications of this new form of mobility on other sectors can be assessed. At the third level, the change in daily habits, pros and cons of creation of new life-styles can be assessed.

Assessment of relative importance of impact areas is another unclear matter, requiring further research. In our study, the Significance Scan tool does not consider the relative importance of different product-chain phases or listed impacts i.e. each question is weighed equally. For example, in terms of environmental first order evaluation, gain in the energy use at operation/use phase can be more valuable compared to the disposal or recycling phase. This weakness of the tool should be well comprehended by the team, which is interpreting the results.

Last but not least, government can have a key role in creating the framework to stimulate and to encourage change at micro, meso and macro levels. In this study, we have shown that attainment of skills, knowledge and communication with societal actors is essential for corporations, which have a direct role in the design and management of production and consumption systems. However, it is seldom that governments handle the issue of improving organisational capabilities linked to product-service system development.

Policy makers aiming at facilitating change at the organisational scale, which would in turn lead to a transition at the macro level, can use the two tools discussed in this study. As illustrated in Figure 1, policy makers can concentrate on understanding the factors located in the "Black Box", where organisational factors and processes are found. A change in these factors would eventually lead to resource use and impact side improvements.

Possible applications can be listed as follows:

- Establishment of a benchmarking medium based on a more advanced version of the TBL Innovation Capability Scan tool, where organisations can compare their performance. These scores can be further aggregated to identify sector level TBL innovation potential.

- Facilitation for the development of TBL Significance Scan tools for different industries and facilitation of the process of discussion for the identification of impacts. Working groups in each need area can be established. Instead of individual organisations forecasting risks and opportunities regarding their products and services in a need area, a collective process can then be created.

- Preparation of a guidebook introducing business TBL innovation. Ministry of the Environment in collaboration with another ministry (e.g. Ministry of Trade) can prepare this guidebook. This publication can be similar to the environmental accounting guidebook prepared by the Japanese Ministry of Environment, while competition workshops can be organized to illustrate its application.

References

- Adriaanse, A., Bringezu, S., Hammond, A., Moriguchi, Y., Rodenburg, E., Rogich, D., Schütz, H. (1997): Resource Flows: the Material Basis of Industrial Economies. Washington D.C.: World Resource Institute
- Argyris C. (1993): Knowledge for Action – A Guide to Overcoming Barriers to Organisational Change. Jossey-Bass Publishers: San Francisco.
- Ayres R. U., Simonis H. E. (1994): Industrial Metabolism - Restructuring for Sustainable Development. United Nations University Press: New York.
- Beard C., Hartmann R. (1999): Eco-Innovation. Rethinking Future Business Products and Services. In *Greener Marketing – A Global Perspective on Greening Marketing Practice*, Charter M., Polonsky M., J. (eds.). Greenleaf Publishing.
- Berkhout, F., Hertin, J. (2001): Impacts of Information and Communications Technologies on Environmental sustainability: Speculations and Evidence, Report to the OECD, Brighton, UK.
- Bilderbeek, R., Brouwer, E. (2000): Innovation indicators for the technical engineering industry: a meso perspective. SIID project phase 2. Utrecht: Dialogic.
- Champell, B., McGrath, G. M. (1997): Organisational learning in a rapidly changing high-tech environment: A system dynamics view. Joint Research Centre for Advanced systems Engineering, Macquarie University, Sydney, Australia. Available at www.jrcase.mq.edu.au/ANZAM97.doc
- Charter, M., Clarke, T. (2003): SUSPRONET Status Report : Area 2: Product Service Systems to Information Users. The Centre for Sustainable Design.
- Clarke S.F., Roome N. (1995): Managing for Environmentally Sensitive Technology: Networks for Collaboration and Learning, Technology Assessment and Strategic Management, London: Regency Press Corporation.
- Damanpour, F. (1996): *Organisational complexity and innovation: Developing and testing multiple contingency models.* Management Science. Vol. 42. No. 5. 693-716.
- Dosi, G. (1988): Technical Change and Economic Theory. London: Pinter Publishers Limited.
- Dougherty, D. (1990): *Understanding New Markets for New Products.* Strategic Management Journal (11), p. 59-78.
- Dyllick, T., Hockerts, K. (2002): Beyond the Business Case for Corporate Sustainability. Business Strategy and Environment. Bus. Strat. Env. 11: 130-141.
- Edquist, C. (1997): *Systems of Innovation Approaches – Their Emergence and Characteristics*, in: Charles Edquist, Systems of Innovation – technologies, institutions and organisations, Pinter, London.
- Edquist, C. (2001): The Systems of Innovation Approach and Innovation Policy: An Account of the State of the Art. *DRUID Conference*, Aalborg, June 12-15, 2001.
- Elkington, J. (1997): Cannibals with Forks: the Triple Bottom Line of Sustainable Development. Chapstone Publishing.
- European Commission. (2000): Global Assessment of Fifth Environmental Action Programme.
- European Information Technology Observatory (EITO). (2002): The impact of ICT on sustainable development.
- Everdingen, Y., Waarts, E. (2003): A Multi-country Study of ERP Systems: The Effect of National Culture. ERIM Report Series Research in Management. Rotterdam.
- Fichter, K. (2003): E-commerce sorting out the Environmental Consequences. Journal of Industrial Ecology. Vol. 6. No. 2. MIT Press.

- Fichter, K., (2001): *Sustainable Business Strategies in the Internet Economy*, In: Loreny, H., Gilgen, P., (Eds.) Sustainability in the Information Society, Marburg, 2001.
- Ger, G. (1997): Human Development and Human Consumption: Well-being Beyond "Good Life". Journal of Public Policy and Marketing. Vol. 16(1). 110-125
- Gray, B. (1998): Collaborating: Finding Common Ground for Multiparty Solutions, San Francisco: Jossey-Bass.
- Gregersen B., Johnson B. (1998): How do innovations affect economic growth? Some different approaches in economics in Lars, H. (ed.). Aalborg University Press.
- GRI. (2002): Sustainability Reporting Guidelines.
- GRI. (2003): GRI Telecommunications Sector Supplement. For Use with the GRI 2002 Sustainability Reporting Guidelines. July 2003.
- Hartman C. L., Hofman P.S., Stafford, E.R. (1999): Partnerships: A Path to Sustainability, Business Strategy and the Environment, 8 (5): 255-266.
- Henderson R., Cockburn I. (2000): *Measuring Competence? Exploring Firm Effects In Drug Discovery*. Dosi G. Nelson, RR. Winter S.G. (eds.). In The Nature and Dynamics of Organisational Capabilities. Oxford University Press.
- Kuhndt, M, Tuncer B., Andersen, S., Lietdke, C. (2003a): Responsible Corporate Governance. An Overview of Trends, Initiatives and State-of-the-art Elements. Forthcoming Wuppertal Paper. In publication.
- Kuhndt, M. Tuncer, B. Lietdke, C. (2003b): Life-Cycle Approaches to Sustainable Consumption Matching Consumer Acceptance and Business Preparedness. Final Report.
- Kuhndt, M., von Geibler, J., Türk, V., Moll, S., Schallaböck, K. O., Steeger, S. (2003c): Virtual Dematerialization: Ebusiness and Factor X. Final Report to the European Commission. Wuppertal Institute. Wuppertal, Germany.
- Kuhndt, M.; Tuncer, B. (n.d.): Social Innovations in Global Product Chains. In Publication.
- Lindegaard, K. (1997): State-of-the-art of Innovation System Analysis. Sudesca Research Paper No.7.
- Lovins A. B., Lovins L. H., Hawken P. (1999): A Road Map for Natural Capitalism. Harvard Business Review. May-June.
- McKee, D. (1992): *An Organizational Learning Approach to Product Innovation.* Journal of Product Innovation Management (3), p. 232-245.
- Miles, I. (1999): *Services in National Innovation Systems: from Traditional Services to Knowledge Intensive Business Services.* In Transformation Towards a Learning Economy The Challenge for the Finnish Innovation System, Schienstock G., Kuusi O. (eds.) Helsinki: SITRA 1999.
- Mol, A.P.J., Sonnenfeld, D.A. (2000): Ecological Modernization Around the World - An Introduction, *Environmental Politics* 9(1): 3-14.
- Moltke, K.; Kuik, O. (1998): Global Product Chains: Northern Consumers, Southern Producers and Sustainability. Part 1 Global Product Chains and the Environment. Institute for Environmental Studies Vrije Universiteit. UNEP Programme.
- Monge, P. R., Cozzens, M. D., Contractor, N. S. (1992): Communication and motivational predictors of the dynamics of organisational innovation. Organisational Science. Vol. 3. No. 2. 250-274.
- Nelson, R. R., Sidney, G. W. (1982): An Evolutionary Theory of Economic Change. The Belknap Press of Harvard University Press.
- North, D.C. (1990): Institutions, Institutional Change and Economic Performance. Cambridge University Press.

- OECD. (2002): Policies to promote sustainable consumption: An overview. Policy case studies series.
- Orozco, J. (2002): Innovation and Performance Improvements in the Cooperative Sector, Costa Rica. Department of Development and Planning. Aalborg University. Phd. Thesis
- Parto, S. (2003): Economic Activity and Institutions: Taking Stock, MERIT-Infonomics.
- René, K., Loorbach, D. (2003): Governance of Sustainability through Transition Management. Paper for EAEPE Conference. Nov. 7-10, 2003. Maastricht, the Netherlands.
- Rennings (2000): *Redefining innovation: eco-innovation research and contribution from ecological economics.* Ecological Economics. Vol.32 (2) p. 319-332
- Research Memorandum Series (2003-007).
- Rogers, E.M. (2003): Diffusion of Innovations. New York: Free Press. Fifth Edition.
- Rothmans, J., Kemp R.,Asselt, M., Geels, F., Molendijk, G. (2000). Transitions and Transition management for the 4th National Environmental Policy Plan (NMP-4) of the Nerherlands. October 2000, ICIS & MERIT, Maastricht.
- Sachs., W., Loske, R., Linz, M, et al. (1998): Greening the North A Post-industrial Blueprint for Ecology and Equity. London: Zed Books.
- Schumacher, EF. (1974): Small is beautiful. London: Abacus.
- Senge P. (1990): The Fifth Discipline – The Art and Practice of the Learning Organisation. DoubleDay: New York.
- Spath, D., et al. (2003): Integriertes Innovationsmanagement-Erfolgdfaktoren, Methoden, Praxisbeispiele. (Integrated Innovation management-Success factors, Methods and Cases). IAO: Germany.
- UNDP. (1998): Human Development Report 1998. London and New York. Oxford University Press.
- UNEP. (2003): UNEP/AIST Scientific Expert Meeting – Life-Cycle based Policy Tools for Sustainable Consumption. Paris, France, 3-4 March 2003. Meeting Report.
- Ven, A. H. V. (1986): Central problems in the management of innovations. Management Science. Vol. 32. No. 5. Organisation Design. 590-607.
- VROM. (1998): Silent Revolution – Dutch Industry and the Dutch Government are Working together for a Better Environment. VROM: The Netherlands.
- Weizsäcker, E.U. von, A.B. Lovins, L. Hunter Lovins (1997): Factor Four – Doubling Wealth, Halving Resource Use, Earthscan Publications Ltd, London).
- WSSD. (2002): World Summit on Sustainable Development – Plan of Implementation. Available at http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm.

- **Two appendices are available from the authors upon request**

Does Immaterialization Satisfy the Sustainability Imperative? A Life Cycle Approach

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Abstract

Following an introductory review of literature, we clarify the concept of immaterialization of consumption. We show that the well-known life cycle assessment (LCA) method is applicable to the investigation of consumer behaviour. Presenting a screening LCA of a theatre visit and a visit to a pub we demonstrate that a time based functional unit can serve as a basis for comparing individual consumer behaviour. Future LCA studies on consumer behaviour must expand the system boundaries to include infrastructure, parallel consumption as well as transportation to and from the activity.

1 Introduction

The economic reality of limited resources and increasing environmental problems has prompted public as well as scientific discussion on sustainable concepts of consumption. One integral element of the debate is to shift consumers' demands from material-based to resource-saving patterns of consumption.

The roadmap of immaterialization implies the substitution of material products by adequate non-material services and promotes immaterial needs instead of material wants, thus advancing social change to achieve sustainability.

Here, we present general findings geared towards promoting immaterial consumption based on an ongoing waste prevention project in Vienna. Following an introductory review of the literature, we present an approach to assess the environmental impacts of immaterial patterns of consumption in a holistic life cycle perspective.

1.1 Immaterialization for sustainable consumption

Material consumption means using or consuming goods and therefore consuming resources and generating waste. Many of our basic needs can only be satisfied through material consumption, e.g. food, clothing, housing, infrastructure etc.

Im(non-)material consumption, however, at least in its "purest form," does not require material goods, but it cannot take place before the basic needs mentioned above have been satisfied. This includes, for example, various forms of communication between people, such as private talks or discussions, games, etc.: in all the various fields, however, the satisfaction of these non-material needs is always linked to the use of certain material goods.

For example, a concert hall with the appropriate acoustics as well as a large number of instruments are needed for the "consumption" of a classical concert. In this case, satisfaction focuses on the artistic performance of the musicians and the conductor on the one hand, and on the ability of the audience to assess and enjoy the high quality of the performance on the other.

This means that immaterial consumption is always linked with material goods, even if they only play a minor role in the entire consumption process. Examples include the massage oil used for a massage or, in the case of the first violinists of the Vienna Philharmonic Orchestra, the violins that have been used for the same purpose for 200 years and that therefore represent a negligible amount of material consumption from the concertgoer's point of view.

The demand for immaterial goods can increase to almost infinity without damaging the environment and without reducing resources. Since overall purchasing power remains the same in a certain region, an increase in the demand for immaterial goods will automatically lead to reduced demand for material goods. Moreover, as immaterial goods in the form of social and cultural services cannot be imported, they also have a positive influence on the labour market of the region in which these goods are "produced".

First results from a waste prevention project carried out in Vienna show that 20-25% of households in the testing area participate in the promoted immaterial consumption options. The following figure exemplarily shows the results of replacing material consumption (drinking imported mineral water in small, heavy, non-returnable glass containers) with immaterial consumption (immaterialization - Nordic walking and shiatsu).

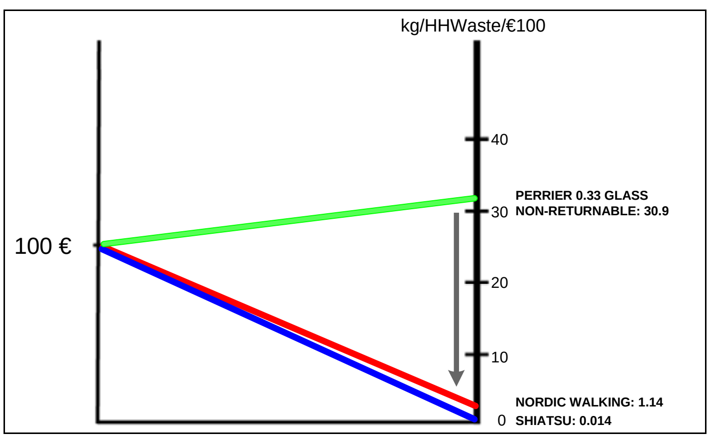

Fig. 1: Compared to spending €100 on mineral water in heavy, non-returnable containers, the same expenses for Nordic walking or shiatsu save 30 kg of waste.

Therefore, the new demand (immaterialization) will contribute significantly to sustainable development.

The aims of the immaterial consumption lifestyle are: edification, appreciation, well-being, delight and pleasure. This new life style should on the one hand reduce resource consumption, reduce energy consumption (CO2 emissions), reduce waste generation and reduce damage to the environment, and on the other hand maximize the number of jobs, maximize the consumption of leisure time and maximize the consumption of the leisure budget.

1.2 Purpose of the study

The results of the calculating an optimal immaterial consumption process can be graphically represented as a complete spider's nest:

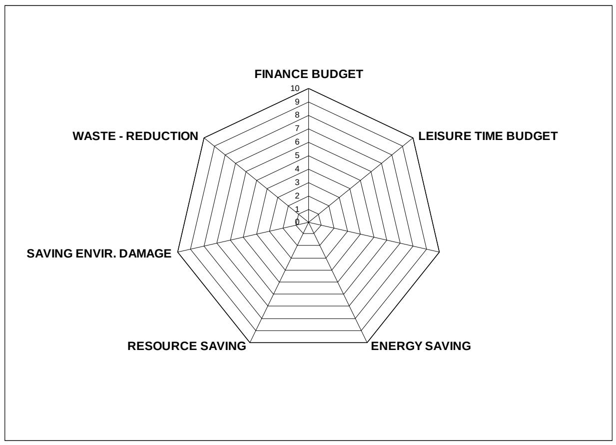

Fig. 2: Calculating an optimal immaterial consumption process, represented here as a spider's nest.

Unfortunately, the scientific work to calculate the holistic advantages in life cycle assessment (LCA) studies has only been carried for a few processes. LCA analyzes environmental impacts of products and services from the cradle to the grave. Therefore, this method can be used to provide the necessary information for immaterialization indicators. The emphasis of most LCA studies is on assessing products and comparing product-related impacts. Life cycle approaches for services and consumption systems, however, have been neglected so far.
Here, we present a new approach to use LCA as a tool to estimate environmental impacts of immaterial consumption. The new LCA method should provide environmental information about substitution in consumer preferences. The environmental effect of replaced consumer goods or services, even beyond the provision of functional equivalence, needs to be evaluated.

2 A very brief review of immaterialization in sustainability research

The concept of immaterialization in the sustainability debate is very young compared to well-known terms such as dematerialization or eco-efficiency. Considerations related to immaterialization are becoming increasingly significant due to the need for effective measures for a sustainable development. Numerous proposals have discussed different approaches to this topic. In the following, the concept of immaterialization is explained by reviewing selected scientific publications.

2.1 Decoupling welfare and growth

Malaska & Kaivo-oja (1996) present three directions of sustainable development. First, dematerialization of production, which means less use of resources for simultaneously more and better production, secondly, population management for putting an end to the population explosion and, thirdly, immaterialization of consumption. In their early attempt towards immaterialization, the authors state that economic growth and material consumption – using GDP per capita as a measure of commercial material consumption – related to human welfare, cannot be the ultimate aim of well-being. They define immaterialization as an increase in the welfare productivity of GDP, thus achieving a decrease in material consumption. They also mention the rebound effect as one serious obstacle to immaterialization, and underline the analysis of this effect as a current challenge in sustainable development.

The welfare productivity from material consumption, or in other words the potential of more welfare from less production, is presented in a macro-economic perspective for Finland (Kaivo-oja et al. 2001). Using different welfare indices, this study concludes that the welfare productivity of GDP has not improved in Finland since the late 1980s. In fact, discernible immaterialization trends are very sensitive to the chosen indicators: Kaivo-oja et al. (2001) conclude that economic growth cannot be equated with an increase in welfare.

Tapio (2002) adjusts the previous definition of immaterialization to the transport sector. By dematerialization, he means the decoupling of road traffic volume and its emissions; by immaterialization, he means the decoupling of traffic volume and GDP. In his thesis, Tapio (2002) shows a unique development towards immaterialization in Finnish transport by proving that the volume of traffic (compared to increasing GDP) is decreasing. This development is explained by two factors: the rise in fuel prices and the progressive urbanisation in Finland on the one hand, and the fact that lower-income groups are unable to purchase a car on the other. Therefore, sustainable development can be viewed from an ecological and economic perspective, but the social aspects continue to deteriorate.

2.2 The immaterial Information Society

The emerging Information Society (IS) and ICT- (Information Communication Technologies) and IST- (Information Society Technologies) based economies carry high potential for sustainable development. Immaterialization of consumption in the IS mainly means replacing a material product by an immaterial, not necessarily functional equivalent, service (Hilty & Ruddy 2002). Malaska et al. (2004) refers to this effect as amaterialization.

Rullani & Micelli (1997) studied the potential of immaterial production towards sustainable economic development of the Venetian area (Italy) in a Local Agenda 21 process. The economy of Venice is confronted with limitations in infrastructure and major environmental problems, both related to the unique topography, and a resulting decrease in value creation. The authors illustrate the opportunity for the immaterial production sector in Venice to move towards virtualisation and the sector's adaptability to the information- and knowledge-based economy. A selected scenario towards a transition to "post-Fordism" shows Venice's advantage over other cities, depending on the speed of this transition. Value creation can be increased by becoming a significant global player in the networked economy.

Extensive results about immaterialization in the Information Society are available from the ASSIST project. This project compiled comprehensive scenarios for the successful implementation and durable establishment of ICT-led processes towards immaterialization. The study extends the concept of immaterialization, taking into account its specific rebound effect. Immaterialization is described as systematically different from dematerialization. Emphasizing the consumer's decision, immaterialization is "a 'switch' in consumption behaviour from more material to less material"; correspondingly, the "Rebound-I" is an income effect (Simmons 2002a). As immaterialization depends on the informed consumer and his or her choice, immaterialization is a lifestyle change rather than a substitution effect. The implementation of immaterialization depends on three issues: First, an IST-based lifestyle change needs to enhance quality of life; second, the attractiveness of ICTs must be perceived and promoted by marketing; and third, a sufficient amount of time must be available to let the new generation that lives an immaterial lifestyle take over (Simmons 2002b).

Policies for an IST-based transition towards immaterialization rely on information about all human activities that have an impact on the potential for sustainable development. Heinonen et al. (2001) see a requirement in what they call "Information Society Assessment (ISA)". Necessary steps of ISA would include detailed life cycle analysis of ICT products and their applications. The resulting indicators would be a toolkit for policy-makers. In their paper, Heinonen et al. (2001) show the benefit of environmental transparency for planning the sustainable Information Society.

3 Measuring the environmental impact of immaterial consumption – an approach

In a screening LCA, the environmental impacts of two leisure activities were compared - drinking beer in a restaurant and going to the theatre. This initial study examined the requirement towards the functional unit and system boundaries in a LCA to assess the sustainability of individual patterns of consumption.

3.1 Specifying the functionality of consumption

All comparative LCA studies are founded on at least one common function of the analysed products. This leads to the deduction of a proper functional unit. All environmentally relevant inputs and outputs are then applied to this adequate unit.

Eating or drinking in a pub or restaurant fulfils many different functions. Warde & Martens (2000) recognize the reason for eating out both in necessity (e.g. preventing hunger) and in pleasure (e.g. getting a break from cooking, experiencing something different from the everyday, relaxation or having a treat). Compared to this, a theatre visit is a cultural service and satisfies cultural needs. Further reasons for going to the theatre lie in the experience of entertainment, socialization or merely the need for change.

The above-mentioned functions of leisure activities may be comparable from some point of view, but cannot be measured, thus eliminating them as the basis for an adequate functional unit in LCA. Nonetheless, equivalence of consumer goods, for example, can be determined by user acceptance (International Organization for Standardization 2000) and, similarly, functional units can be represented by the duration of a service (Hofstetter 1996). The time aspect of consumption can unambiguously be measured; time is therefore already used as indicator in sociologic studies and economic theories on consumption.

The duration of consuming a product or a service can be expressed as consumers' time-use. Similarly, the amount of consumable units – made available by a service provider or a product – can be calculated from the number of consumers and their devoted time budget:

service performance [ph] = number of consumers [p] x applied time budget [h]

The functionality of any consumer good can be considered as the inherent capability to supply some sort of service. A determined amount of obtained service – measured in units of time – can be defined as the functional unit, e.g. one person hour.

The present case study analyzes environmental data from a Vienna inner-city theatre (Theater in der Josefstadt Betriebsgesellschaft mbH 2003), the available data for the production of beer (Andre 1993), and data for the operation of a restaurant (Schib 2001). These data were applied to one person hour of utilized service, this being the defined functional unit.
The first step was to determine the average length of a theatre performance. For the time-use of a theatre visit, 100 premieres from 1960 to 1971 at the Vienna Burgtheater were considered. The duration of these 3,340 stage performances were taken from a 'Theaterzettel' collection. The median theatre performance lasted 150 minutes. Along with the number of theatre-goers per season, that amounted to 145,343 persons and a utilization ratio of 84.4% (Deutscher Bühnenverein 2004); the annual service performance of the 'Kammerspiele' playhouse yields 430,518 offered person hours (ph_o) and 363,358 utilized person hours (ph_u).

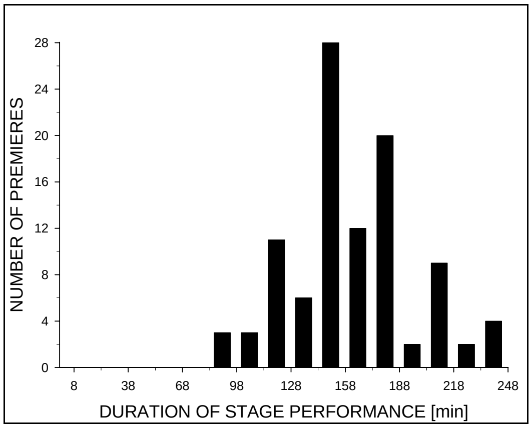

Fig. 3: Time-use for a visit to the theatre
Duration of 100 performances (premieres), including duration of intermissions. Data presented in 15 min. time intervals. Data range: min: 90 min., med: 150 min, max: 240 min.

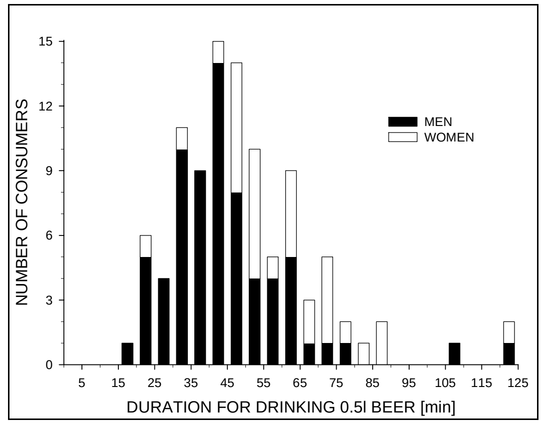

Fig. 4: Time-use for drinking beer in a pub
Average time-use for consuming 0.5l beer, excluding breaks to start on another beer (arithmetic mean: 9 min). Data presented in 5 min time intervals. Data range: 1) total: min: 19 min., med: 45 min., max: 120 min., 2) men: 19 min., med: 41 min., max: 120 min., 3) women: min: 23 min., med: 58 min., max: 120 min.

The service performance of the 'Stockwerk' restaurant was calculated from the number of 65 available seats (Schib 2001) and the opening hours, which amount to 3,328 hours per year. The calculated service performance yields 216,320 ph_o. The ratio of utilization of the restaurant can be estimated from the number of 23,911 sold meals per year (Schib 2001) and from the assumption that a visit to the restaurant takes, on average, as long as a theatre performance (Fig. 3). The conclusion is that the annual utilized service performance is 59,778 ph_u. The calculated service performances were later used to elaborate the reference flows of the observed consumption systems and are summarized in table 1.

	service performance		utilization ratio
	offered [pho]	utilized [phu]	[%]
theatre 'Kammerspiele'	430.518	363.358	84
restaurant 'Stockwerk'	216.320	59.778	28

Tab. 1: Annual service offer in person hours

To identify the reference flow for the consumed beer in compliance with the chosen functional unit, the consumers' time-use for drinking beer was observed as well. Here, we present time-use data for drinking beer in a pub (Fig. 4). The time-use data were assessed at a Vienna students' pub. Observations were carried out on twelve days (Oct. & Nov. 2004) from 6:30 pm to 1:30 am. Thirty-one women and 69 men were taken into account. Their total consumption comprised 164 selling units or 76.4 litres of beer. The median duration to consume 0.5 litres of beer amounted to 45 minutes.

3.2 Screening life cycle impact assessment

The Material Intensity Analysis (MAIA) is used to estimate the environmental impacts of a visit to the theatre and to the restaurant. The MAIA is used to calculate the cumulative material demand for a product over its entire life cycle. The method does not provide any quantitative information on toxicity or land use. Therefore, the MAIA can only be used as a screening method in LCA (Bringezu et al. 1996). Here, various sources of Material Intensity (MI) Factors (Loske & Bleischwitz 1996, Society Factor 4+ et al. 2001, Ritthoff et al. 2002, Wuppertal Institut 2003) were used to calculate the Total Material Requirement (TMR). The TMR is the sum of the cumulative abiotic and biotic raw materials as well as the erosion. As mentioned above, the amount of one person hour (ph) serves as the functional unit. Based on the findings of the screening LCA, the initial system boundaries were extended for the application of a full LCA.

The initial system boundaries for a theatre-visit provided the basis for calculating the material intensity per person hour of the theatre operation (continuous energy and materials consumption), the theatre administration (theatre office), the process of storing and transport of the décor, the production of the décor and costumes as well as the MI of the programme. The MIs were calculated for the effective utilization ratio of 84% (TMR/ph_u) and the ideal utilization ratio of 100% (TMR/ph_o). The results are presented in figure 5 (TMR/ph_o in brackets). The MI of 1.53 kg/ph_u of the theatre operation can be completely (94%) reduced to the direct electricity and heat consumption. Considering that the produced décors are reused in numerous performances, their high specific MI of 107 t/t becomes insignificant. The MI per person hour of the décor amounts to 0.59 kg/ph_u, and the MI of the related storing and transport processes to 0.14 kg/ph_u. Similarly, the MI of costumes amounts to merely 0.05 kg/ph_u. Compared to the overall resource consumption involved in a theatre visit, the production of the programme has a substantial impact. Here, the amount of consumed paper has been calculated based on two of three theatregoers buying a programme. The related MI of the programme amounts to 0.5 kg/ph and remains unbiased to the degree of occupancy. Compared to this, the MI of the administrative processes yields the low value of 0.38 kg/ph_u. In accordance with the outcome of the screening LCA, the total material requirement of a theatre visit amounts to 3.19 kg/ph_u. This value can be reduced by an increase in utilization. A rise in the utilization rate from 84% to full occupation decreases the MI by 14%.

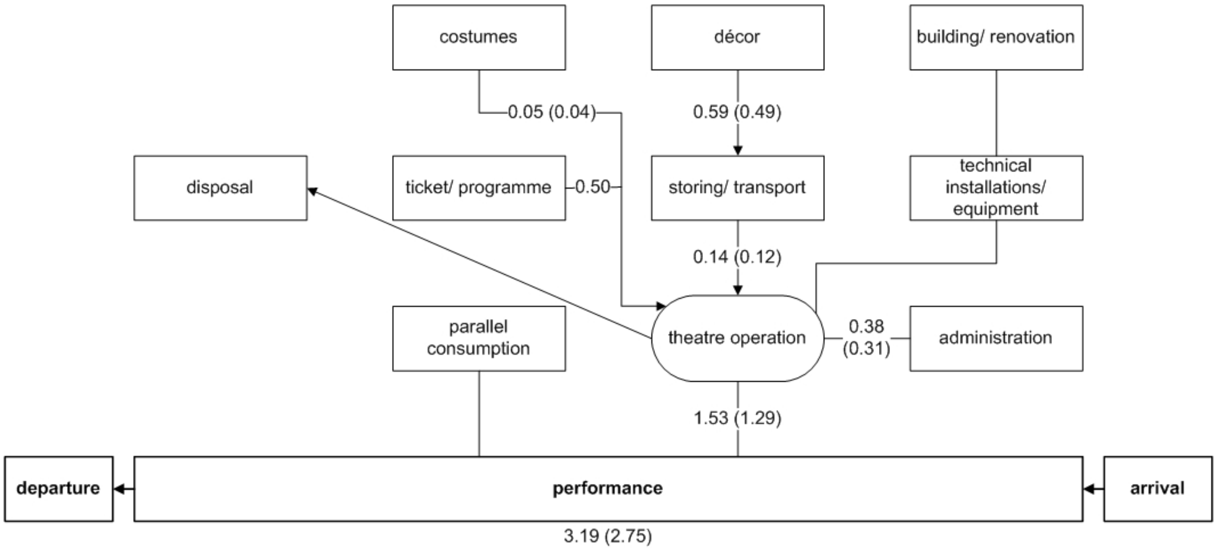

Fig. 5: Total material requirement of a theatre visit [kg/ph]; values in parentheses indicate the benefit of full occupation

The screening LCA of eating out covered the energy (electricity, gas) and water consumption for the preparation of meals, the storage and refrigeration of food, as well as the amount of consumed cleaning agent. The production, packaging and transport of beer as well as the use of a beer mug have been taken into account as an example of the food production chain. The resource consumption of the restaurant has been calculated for 28% utilization (TMR/ph_u) and full utilization (TMR/ph_o) (Fig. 6). The MI from food consumption in a restaurant does not depend on the occupancy rate. The reference flow of beer according to the functional unit was calculated from the collected time-use data (Fig. 6) – including a corresponding number of breaks to start on another beer – and amounts to 0.56 litres per person hour. The MI of beer – omitting the container and transport – is 1.6 t/t. This yields a TMR of 0.89 kg/ph. The MI of a glass bottle that undergoes 20 reuse cycles amounts to 0.02 kg/ph. In addition, a 50-kilometre transport (from a local brewery) causes a TMR of 0.02 kg/ph. The full Material Intensity of drinking beer in a restaurant amounts to 2.84 kg/ph_u. This value is based on the high MI of the restaurant operation, which comes to 1.88 kg/ph_u, and the MI of the consumed beer. Transporting the food only minimally impacts the MI, but its impact will be much higher in a non-local supply scenario. The potential to reduce the MI by increasing occupancy is limited by the fact that environmental impacts are attributable to direct food consumption and that full utilization will not be reached constantly over the entire opening hours.

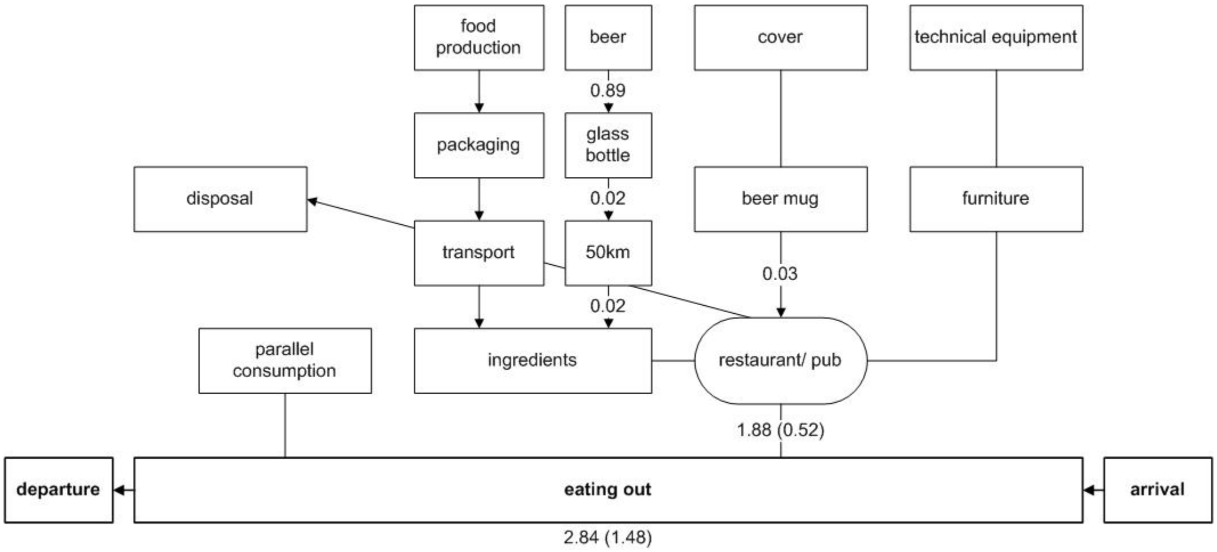

Fig. 6: Total material requirement of eating out [kg/ph]; values in parentheses indicate the benefit of full occupation

Comparing the outcome of the two screening LCAs would lead to the conclusion that spending time by drinking beer is a better choice for resource conservation than going to the theatre. This, however, may not necessarily be true according to figure 5 and 6, which show that the screening LCA ignored numerous components of the consumption systems. In extended system boundaries, the environmental load of the employed infrastructure (e.g. technical equipment and furniture in the restaurant and the theatre) need to be included. The impacts of potential parallel consumption, e.g. consuming food in the theatre buffet or smoking cigarettes in the pub, need to be examined. The process of waste disposal has been omitted so because of the limited input orientation of the MAIA method; it should be considered in a full LCA. Special importance must be drawn to personal transportation, which is inseparably linked to the consumption system.

4 Conclusion

Immaterialization is a concept designed to reduce resource use in current life styles. This calls for drastic changes in consumer behaviour. Demonstrating the effectiveness of such altered consumer behaviour requires developing new methodological approaches.

Based on a comparative examination of two leisure activities – a theatre visit and a visit to a pub – we show that the well-known life cycle assessment method is also applicable to the investigation of consumer behaviour.

In an initial step of the screening LCA, the time use of consumers was used to define an appropriate functional unit. The precise time use data collected in our study, in contrast to diary-based data collections, provide the detailed information on individual consumer behaviour required for such evaluations. We demonstrate that a time-based functional unit can serve as a basis for comparing individual consumer behaviour in LCA.

In the second step of the screening LCA, the requirements of the system boundaries were determined. In an ecological analysis of the consumption of services, it is insufficient to rely solely on corporate data. LCA studies on consumer behaviour must expand the system boundaries to include infrastructure, parallel consumption as well as personal transportation to and from the activity.

References

Andre, Otto (1993): Ökobilanz einer typisch österreichisch-deutschen Bierbrauerei, 1993

Bringezu, Stefan, Stiller, Hartmut, Schmidt-Bleek, Friedrich (1996): *Material Intensity Analysis - A Screening Step of LCA.*, in: Proceedings of the Second International Conference on EcoBalance, 1996

Deutscher Bühnenverein (2004): *Theaterstatistik 2002/2003*, 2004

Heinonen, Sirkka, Jokinen, Pekka, Kaivo-oja, Jari (2001): *The ecological transparency of the Information Society*, Futures, 33, 3-4, 2001

Hilty, Lorenz M., Ruddy, Thomas (2002): *Resource Productivity in the Information Age*, FUTURA, 2, 2002

Hofstetter, Patrick (1996): *Time in life cycle assessment*, in: Braunschweig, A., Förster, R., Hofstetter, P., Müller-Wenk, R.: Developments in LCA Valuation, IWÖ-Diskussionsbeitrag, 32, 1996

International Organization for Standardization (2000): *ISO/TR 14049: Environmental management – Life cycle assessment – Examples of application of ISO 14041 to goal and scope definition and inventory analysis*, 2000

Kaivo-oja, Jari, Luukkanen Jyrki and Malaska Pentti (2001): *Sustainability Evaluation Frameworks and Alternative Analytical Scenarios of National Economies*, Population and Environment, 23, 2, 2001

Loske, Reinhard, Bleischwitz, Raimund (1996): *BUND und Misereor. Zukunftsfähiges Deutschland. Ein Beitrag zu einer global nachhaltigen Entwicklung*, 1996

Malaska, Pentti, Kaivo-oja, Jari (1996): *Science and Technology for Sustainable Development*, GAIA, 5, 6, 1996

Malaska, Pentti, Vehmas, Jarmo, Kaivo-oja, Jari, Luukkanen, Jyrki, Hietanen, Olli, Aarras Nina, Peltonen, Katja (2003): *Thematic analysis report on Information Age Sustainability. Deliverable final report: D14.1. Work Package 14 (Theme 3): Information Age Sustainability*, http://www.tukkk.fi/tutu/terra2000/reports/Terra_report_080404.pdf, 8.4.2004

Ritthoff, Michael, Rohn, Holger, Liedtke, Christa, Merten, Thomas (2002): *Calculating MIPS. Resource productivity of products and services. Wuppertal Spezial 27e*, http://www.wupperinst.org/Publikationen/Wuppertal_Spezial/ws27e.pdf, 2002

Rullani, Enzo, Micelli Stefano (1997): *The immaterial production in Venice: towards a postfordist economy*, in: Musu I. (ed.): Sustainable Venice: suggestions from the future, 1997

Schib, Erich (2001): *Umwelt Check und Oekobilanz Restaurant Stockwerk Bern. Oekologie nicht nur auf dem Teller*, http://www.gammarus.ch/gammarus-case-stockwerk.html, 8.3.2001

Simmons, Stephen (2002a*): Locating Immaterialisation in the Sustainable Development Debate*, Communication and Cognition, Vol. 35, 1 & 2, 2002

Simmons, Stephen (ed.) (2002b): *ASSIST. Achieving Sustainability by using Substitutive Information Society Technologies. Deliverable D12. Results of the Study*, http://immaterialisation.org/Assets/web files - 070702/2 - ASSIST Final Results D12.doc, 17.8.2002

Society Factor 4+, ENEA, SERI (2001): MIC - Material Input Calculator, 2001

Tapio, Petri (2002): *Are There Limits to Traffic Volume Growth? Lectio praecursoria – The introductory lecture of public defence of doctorate thesis*, FUTURA, 2, 2002

Theater in der Josefstadt Betriebsgesellschaft mbH (2003): *Umweltbericht 2003*, 15.10.2003

Warde, Alan, Martens, Lydia (2000): *Eating out: social differentation, consumption and pleasure*, 2000

Wuppertal Institut (2003): *Material intensity of materials, fuels, transport services, version 2*, http://www.wupperinst.org/Projekte/mipsonline/download/MIT_v2.pdf, 28.10.2003

Overcoming the implementation gap – Chances (Challenges?) and limitations of a common research agenda

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In the preparation of this conference, the organiser provides us with four sensible and clear questions unfortunately less easy to answer.

(1) What are the most important insights about consumption? What do we know as a result of past research?

(2) What do we need to investigate? What are the interesting research questions? How would we go about conducting these investigations?

(3) What we should do to reduce the impacts of consumption?

(4) What do we know about implementing sustainable consumption measures/policies? Where are the gaps?

The paper tries to give some of the answers and indicate at least some directions of further development.

The variety of influences on (sustainable) consumption

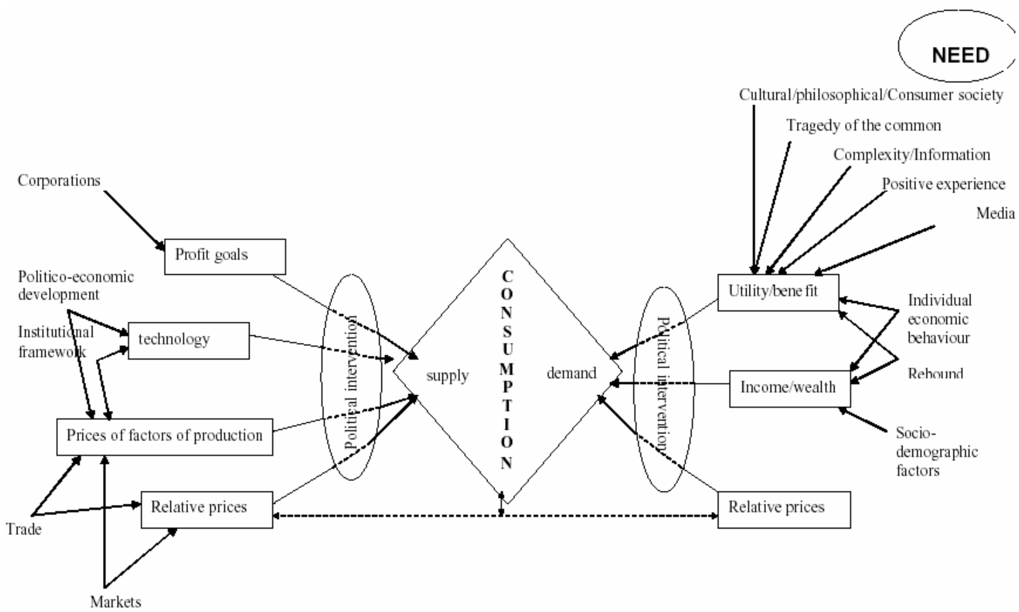
During the last years sustainable consumption research has focused on a broad range of issues. For instance, Life Cycle Analysis concentrating has been on products, life style analysis on economic and social background of consumer behaviour, cost-benefit-analysis on monetary cost aspects, Multi-Criteria-Analysis on complex decision making under uncertainty, the study of attitudes and values on the interaction of the individual and the social level, etc.

A broad inquiry of literature that explicitly deals with sustainable consumption identified the following determinants as influencing for consumption decisions thus its sustainability or unsustainability.

Unfortunately studies, projects, conferences, and papers have to focus on a single or at least a limited number of aspects of the influencing factors. This leads to a multitude of research approaches which still remains rather fragmented, with no systematic links established. While standard economics has only limited meaning in such a multi-factor, multi-criteria setting, the relevant research results are dispersed over different scientific communities (e.g. ecological, evolutionary and institutional economics, environmental psychology, consumer socioology) instead of being comprehensively presented, and even within their respective disciplines they fulfil a niche function only.

Today, insight is increasing from scientific and political side that sustainable consumption matters points to the urgent need for a better and more coherent research infrastructure.

Figure 1 Determinants of consumption



Source: Fuchs & Lorek, 2000

With more or less effort and funding various projects have started (end partly already finished) bringing together researcher devoted to improve sustainable consumption with different approaches (SusHouse, ToolSust, SCORE, etc.). While they managed to organise exchange between researcher of these specific projects they failed to build proper linkages that last and can serve as models for a common research agenda so far.

What might be the reasons? And more important: What to do to overcome hindrances?

Due to the diversity of theoretical paradigms and resulting research questions, regarding

- facets of individual and collective behavioural patterns impacting on consumption,
- approaches to analyse consumption
- approaches to influence consumption towards a more sustainable realisation,

the definition of a necessarily limited standard set of methodologies faces serious difficulties. Although pursued y many, it is reasonable first of all to ask if this is a desirable objective at all. From our point of view, in a rather field of research without a fixed set of established and successful methodologies, it would be at least premature to define a methodological canon. The disciplines paying attention to the various determinants of sustainable consumption are fortunately manifold on one hand but differ significantly on the other. Methods to gain psychological insights can not be made comparable to economic approaches and tools for measuring environmental burden do not make sense when asking for social interaction. Due to this multi-faceted character, research on sustainable consumption can only gain in relevance (and its political application in effectivity) if insights from a broad variety of disciplines are integrated. As these are produced according to the methodological standards of these disciplines, however, there cannot be such a thing as a common denominator defined by consumption research. Consequently, consumption research would loose access to relevant insights if it restricted itself to a specific methodology. Therefore we conclude that for a foreseeable time, standardisation of methodologies in sustainable consumption research will neither be possible, nor is it desirable. Thus methodological pluralism is a necessity if all new and emerging insights relevant to sustainable consumption are to be taken into account.

What can be developed, however, are reporting standards as a basis for interfaces between disciplines and research groups, permitting to combine insights from different fields of research. Three examples shall be given for approaches (1) where bridges are already build, (2) questions are at least formulated but also (3) problems are not even recognised in an adequate way.

(1) Bridging micro and macro assessment of consumption

Household consumption can either be assessed based on macro-level economics with national accounts SNA according to the premise that goods and services are produced to meet needs of end-users. This serves the purpose of monitoring the entire life-cycle of the consumption of goods and services from cradle to grave. But it gives no hints in which way households might be in a position to influence the environmentally relevant resource consumption.

Another approach of evaluating household consumption is coming from the domestic science. It is counting the equipment of a household and the in-house consumption of energy and water, domestic appliances and labelled products. It tries to give advice for purchase decisions or behaviour, however, without being able to quantify the environmental impacts before and behind.

A significant problem arises from the frequent mixture of these two approaches, without explicitly clarifying which one has been used to establish which aspect of households' environmental performance. As a result, e.g. the average per capita energy consumption is reported alongside the households' equipment level with a microwave or other applications (OECD Environment Directorate 1998). The environmental relevance of such reporting remains open as it is unclear – to stay in the example - whether the ownership of a microwave might cause positive or negative effects.

While the macro-economic reporting does not deliver advice to the consumer supporting her or his day-to-day decision making, the approach of domestic science often overacts, offering households books and brochures with hundreds of hints for an environmentally friendly behaviour.

Lorek/Spangenberg dealt with this problem and developed an approach toward sustainable consumption that covers the important aspects of both different approaches described. Their concept base on the identification of main driving forces driving of environmental pressure, identifies the prior consumption clusters where changes are necessary develops actor oriented indicators towards sustainable household consumption. This concept permits to compare the environmental impact the goods and services and is able to guide consumers, as well.

Haas et al also realised the necessity to bridge micro and makro data and developed a combination of quantitative and qualitative methods to meet that need.

(2) Linking household consumption and globalisation

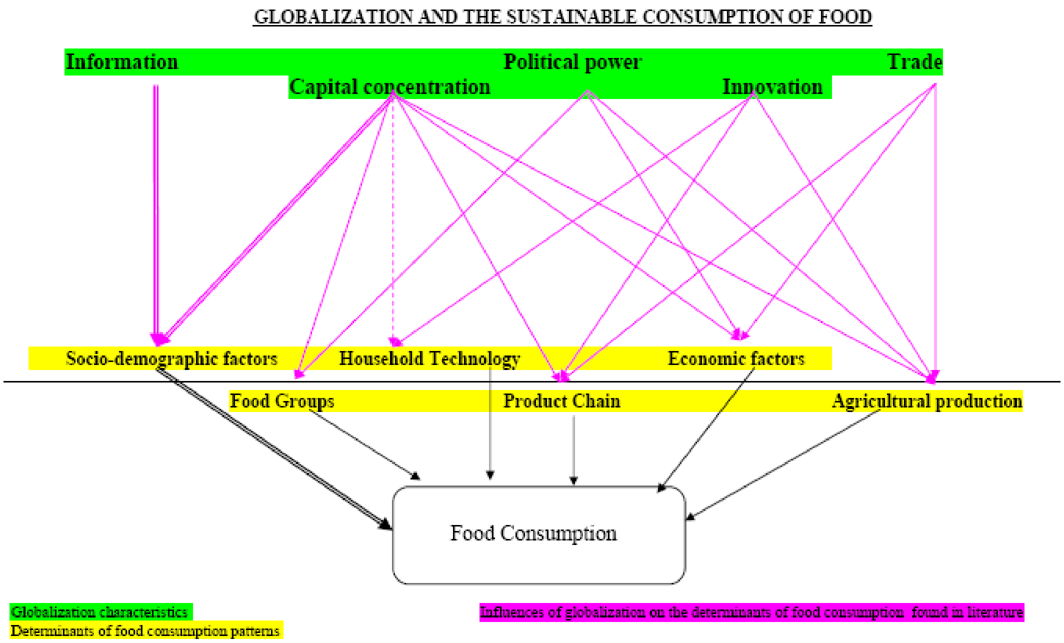
The influence of globalization on the sustainability of consumption is a frequent topic in academic and political debates. Some scholars and practitioners argue globalization will mainly lead to increasingly unsustainable consumption patterns and levels because of the spread of materially intensive means of needs satisfaction and the decreasing access of consumers to information about the sustainability of their consumption choices. However, in the view of other scholars, globalization is leading to a dematerialization as the post-modern economy develops and spreads across the globe.

Up to now scholars have not been able to agree on the extent and direction of changes in the sustainability of consumption due to globalization. A thorough understanding of the influence of globalization on the sustainability of consumption is lacking. But it would be a requirement for the design of future governance strategies in pursuit of sustainable consumption.

The challenge is to link determinates of globalization to those of sustainable household consumption. Five core elements of globalisation can be identified: the increase in flows and liberalization of trade; shifts in political power; capital concentration and mobility; technological innovation and diffusion; and the diffusion of information and values. Connecting them to the determinants derived from sustainable consumption literature allows identifying a number of general guidelines for governance strategies in pursuit of sustainable consumption. To illustrate the approach here some results from the analysis of (sustainable) food consumption.

It can be seen that most of the influences of globalization on the sustainability of consumption take place before the household makes its decision. Globalisation strongly influences agricultural production and other stages of the product chain.

Figure 2. Linking Globalisation and Consumption Determinants



Arguing as an example form the basis that market share of organic food would be an element of sustainable consumption two central questions for future research are:

1. How can the influences of globalization be structured and used to increase the share of organic food products consumed by households?
2. How can the influences of globalization be structured and used to reduce levels of meat consumption?

This leads to sub-questions

with respect to the influence of trade:

1. Which trade laws and processes inhibit an increasing market share of organic production?

2. Which political mechanisms exist to modify trade laws in favour of organic production?

with respect to the influence of capital concentration:

3. Which structural or cultural factors inhibit an increasing share of organic production in the context of agro-business corporations and how can they be overcome?

4. If positive examples of the influence of capital concentration on organic production exist, how can they be supported and transferred to other cases?

with respect to the influence of shifts in political capacity:

5. Which power constellations inhibit an increasing share of organic production?

6. How can political coalitions be built and used to foster an increase in the share of organic production?

with respect to the influence of the acceleration of technological innovation:

7. Which current technological developments promise to induce an increase in the share of organic production?

8. How can political means be used to support the global diffusion of these developments?

(3) Work and consumption

One of the so far rather unexplored aspects of sustainable consumption is its relation to work. On the one hand, this refers to the paid word (keywords from the ongoing research are work-life-balance, compensatory consumption, status consumption, etc.). On the other hand, more than half of all working hours in industrialised societies in Europe and Japan are unpaid work, mainly performed by women, with its environmental relevance and the factors determining it either completely or at least in the context of sustainability and consumption rather unexplored.

Unpaid work includes caring and education, voluntary work in the community, plus the work as a self-provider. All of these kinds of work contribute significantly to the real standard of living, thus competing with or replacing paid market transactions, or vice versa (there is a dynamic process replacing paid by unpaid work, e.g. in self service and internet banking, but also the opposite directing through professionalisation of caring services etc.). How such unpaid work related to positive and negative feeling, to the self realisation of the producer and the consumer of such services, which kind of physical resources are used (and thus have an environmental impact), which are the determinants of the resource use, which kind of information policy is necessary to address voluntary workers (advertising and in-shop information will not work in this field as in the consumers market), all this remains rather open questions.

What we do know is

- that the volume of unpaid work is significantly higher than that of paid work,
- that the gender distribution of paid and unpaid work, although highly different by country, is extremely unjust in all countries,
- that neoliberal policy strategies reduce the time available for unpaid work, and its contribution to the standard of living,
- that sustainable development strategies as we have modelled then have a positive impact on the contribution of unpaid work to the standard of living,
- thus that economic assessments of different possible futures are heavily biased against sustainability, as they only account for that part of the standar5d of living, which is reflected in market based consumption,
- that consumption of goods and services from the unpaid economy is not necessarily sustainable, neither socially (exploitation of unpaid work) nor environmentally (inefficient production processes),

- that products from unpaid work usually have a better reputation and higher esteem, which might help to focus on the quality instead of the quantity of the products consumed,
- that in this sense quality also includes social quality,
- that neither the efficiency nor the quality aspect are necessarily dominant, but that framework conditions and thus politics may be decisive to what is realised.

It is rather obvious that the field of work, paid and unpaid, and consumption needs more attention; a new research agenda needs to be defined in this area. Such a new research agenda could draw upon a lot of existing research, but would have to reconsider the results gained from the perspective of sustainable consumption, its determinants, driving forces and supportive framework conditions.

Here economic, social and ecological the effects have to be taken into account, and the statistical data available – mostly based on SNA economic accounting – provide little insight into the mechanisms relevant for this kind of consumption.

Towards a common research agenda

What is described above so far are only (some of the) scientific gaps. Additionally to the scientific community also governmental, intergovernmental and non governmental organisations deal with the environmental and social problems of unsustainable consumption and how to overcome them. Thus beside solving methodological problems within different research disciplines researchers also have to have in mind how to **transfer gained knowledge** towards political and economic decision makers and how to **bridge implementation problems**.

To meet the latter two challenges a common research agenda might raise form a perspective where a common vision is set in the centre of research. This means asking how to reach what limited carrying capacity of earth force us to reach instead of further identifying hindrances and the verification for the urgency of changes, again, with other methods. Identifying best practice is a necessary step but the first only.

What can be taken as broadly accepted is that a consequent development towards sustainable consumption needs a multi actor as well as a multi level approach: Regulation, financial incentives and information (among others) have to pull into the same direction and from production to final consumption all involved actors have to be targeted and have to take their share.

Figure 3: A matrix of sustainable consumption

	International Organization (EU, UN)	Governments	Public Institutions	Primary Production	Processing Industry	Service providers	Retailers	Civil Society
Regulation								
Financial Incentives								
Giving Good Examples								
Marketing								
Information								
Education								
Campaigns								

Central research questions might be:

On the horizontal axe dealing with the different actors:

How can insights gained form network analysis be used to influence and to create trust building among the necessary actors.

On the vertical axe dealing with different instruments:

How can insights gained from communication science be used to increase clarity of the message towards the consumers, citizens and all other relevant actors from price signal via education to marketing strategies?

Regarding the specific fields of the matrix:

How can the adequate mix of insights gained from individual sciences (e.g. political science and psychology) develop best practice via the identification and **reproduction** of success factors towards reproducible practise?

Another aspect might be interesting when thinking about common development of the SC research community. Giving the fact that lots of knowledge is hidden within academic circles it might also be interesting as well as useful to develop a kind of common marketing agenda. One element could be a stronger cooperation with civil society. Taking the goal of changing consumption patterns towards more sustainability civil society can be seen as kind of born partners for SC research. While sustainable production research address business SC has to address NGO's to transfer and spread their knowledge but also to get aware of the practical/actual questions.

Grappling with hybrid structures in sustainable consumption models – disentangling urbanity and lifestyle

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Abstract

The notion of sustainable consumption has ecological, economic, social and technical features. Therefore any kind of comprehensive assessment approach to be applied on sustainable consumption is bound to be some kind of hybrid system, even though one of the disciplines may have a leading role depending on the purpose of the assessment system.

The hybrid character of assessment systems in conjunction with the leeway in definitions of key characteristics causes the purpose of the assessment systems to become the prime driver in system design, while standardisation incentives are weak. Depending on the dominant discipline and purpose, well known available methods are: MFA (ecologic), LCA (product technical), input-output (economic), and systems dynamics (ecological-economic). All these approaches as such still lack behavioural input with respect to consumption. Economic models of consumer expenditures can be connected relatively easily to input-output and MFA models. However, such expenditure models do not provide complete information on the actual way of consumption. Furthermore, these models can capture only some of the social-cultural driving forces in consumption. One way to alleviate the limitations of the expenditure models, especially with respect to *actual* consumption, is to add a model for the time use of household members, with links between time use and expenditures. This still leaves the social-cultural dynamics less well integrated. Careful scenario-construction can give some assistance here. Another solution is to use information from actual households about their revealed or stated preferences concerning sustainable products and sustainable ways of consumption proposed to them.

In the Finnish KulMaKunta study the modelling of the environmental impacts of household consumption aims to integrate the several aspects mentioned above. A household expenditure model is linked to a household time use model, while in turn these model blocks are linked to both a module describing the quantity and technical features of the building stock and surrounding infrastructure *and* an input-output module enabling to calculate the indirect impacts at the production side. Furthermore, in order to go beyond a predominantly technocratic modelling approach of household behaviour, the study also involves the use of surveys of selected households with respect to their interest in sustainable household operations. The surveys consist of interviews guided by a questionnaire, in which both revealed preferences *and* stated preferences are inquired.

The results of the surveys are used in the simulation studies to indicate plausible upper and lower levels of adoption of new technologies and use patterns. The model system on the other hand allows for checking to what extent changes can be introduced simultaneously and what would be the cumulative effect.

The article starts with a discussion about the roles of consumption with respect to a transition towards a sustainable society. Subsequently a brief review of consumption oriented impact assessment methods is given. The paper continues with illustrations of an integrative approach as applied in the Finnish KulMaKunta project, with special reference to urbanisation and consumption. Finally the paper formulates conclusions and questions, predominantly on the basis of the KulMaKunta research findings, while referring to the framework set out in the initial sections of the paper.

N.B. The paper concerns ongoing research, results liable to modifications

1. Introduction

The notion of sustainable consumption has ecological, economic, social and technical features. Therefore any kind of comprehensive assessment approach to be applied on sustainable consumption is bound to be some kind of hybrid system, even though one of the disciplines may have a leading role depending on the purpose of the assessment system.

Sustainable consumption is only a notion and *not* a well defined concept testable against commonly agreed operational criteria. Furthermore, sustainable consumption is a *dependent* notion, meaning that it also depends on the sustainability performance of the production side, in order to be able to assess whether – overall – a particular way of consuming is contributing to sustainability. The previous phrase also brings to the forefront the easy way in which a *state* of sustainability (and that is what society is aiming for) is often not clearly distinguished from the *transition* towards sustainability. In practice 'sustainability' and the adjective 'sustainable' predominantly refer to the transition and only rarely to the state, that is, they refer to ways of consumption and commodities that are less *un*sustainable than preceding and/or competing versions. In fact, the label 'sustainable' for improvements allegedly contributing to the achievement of sustainability, is only appropriate in case the improvements fit into a feasible trajectory along which a society is supposed to achieve sustainability.

The hybrid character of assessment systems in conjunction with the leeway in definitions of key characteristics causes the purpose of the assessment systems to become the prime driver in system design, while standardisation incentives are weak. Depending on the dominant discipline and purpose, well known available methods are: MFA (ecologic), LCA (product technical), input-output (economic), and systems dynamics (ecological-economic). All these approaches as such still lack behavioural input with respect to consumption. Economic models of consumer expenditures can be connected relatively easily to input-output and MFA models. However, such expenditure models do not provide complete information on the actual way of consumption. Furthermore, these models can capture only some of the social-cultural driving forces in consumption. One way to alleviate the limitations of the expenditure models, especially with respect to *actual* consumption, is to add a model for the time use of household members, with links between time use and expenditures. This still leaves the social-cultural dynamics less well integrated. Careful scenario-construction can give some assistance here. Another solution is to use information from actual households about their revealed or stated preferences concerning sustainable products and sustainable ways of consumption proposed to them.

In the Finnish KulMaKunta study the modelling of the environmental impacts of household consumption aims to integrate the several aspects mentioned above. On the one hand a set of simulation models is used regarding changes in household consumption and in dwelling stock characteristics. In order to go beyond a predominantly technocratic modelling approach of household behaviour, the study also involves the use of surveys of selected households with respect to their interest in sustainable household operations. The surveys consist of interviews guided by a questionnaire, in which both revealed preferences *and* stated preferences are inquired. The results of the surveys are used in the simulation studies to indicate plausible upper and lower levels of adoption of new technologies and use patterns. The model system on the other hand allows for checking to what extent changes can be introduced simultaneously and what would be the cumulative effect.

The article starts with a discussion about the roles of consumption with respect to a transition towards a sustainable society. Subsequently a brief review of consumption oriented impact assessment methods is given. The paper continues with illustrations of an integrative approach as applied in the Finnish KulMaKunta project, with special reference to urbanisation and consumption. Finally the paper formulates conclusions and questions, predominantly on the basis of the KulMaKunta research findings, while referring to the framework set out in the initial sections of the paper.

2. The pivotal role of consumption

Sustainability rests on an ecological, economic and a social pillar. Sometimes cultural or institutional aspects are added to these three classical sustainability dimensions[1]. We could add the notion that achievement of a sustainable society means at the same time the preservation (through revision) of a welfare state. This notion underpins the significance and requirements with respect to the balancing between the ecological pillar and the other pillars. It also means that improvement of eco-efficiency with the aim to achieve sustainability, while preserving a modernised (or re-invented) welfare state, *is eventually about the citizen*. Dramatic improvement of the eco-efficiency needs the understanding and use of the key position of the citizen:

- as a consumer (private and public goods);
- as an educator and judge (schooling, norms/standards/law, culture and media);
- as a decision maker (public authorities, private companies, elections).

[1] . See for instance Heinonen & Lahti 2002. In a plenary speech during the ECEEE 2003 conference (Saint Raphael, 2-7 June 2003) Lee Schipper added the aspect of adequate governance enabling integrated implementation across the three pillars.

If we focus on (natural) resource use the role of the consumer comes to the front. In this case the focus on consumption does not mean just consumption as such, but also the product choice and quality on offer, as well as product design. Hence indirectly production processes are involved as well, yet the analysis starts from the consumption side. Private consumption represents about 50% of the Finnish national economy. In addition a good part of the public expenditures are in fact also meant for the needs of citizens (e.g. health care, public safety). When these public expenditures are added to the private consumption, the figure goes up to 60%~65% depending on the applied delineation. Last but not least export production is directly or indirectly steered by consumption in other countries. As habits and lifestyles are proliferating quickly throughout the world, the consumption trends in other countries will often spill over to Finland and vice versa.

When we think about the improvement of eco-efficiency with the consumer as starting point, the following aspects can be distinguished:

1. *natural resource efficiency* – the use of materials and energy by consumers, either in an explicit way such as when using motor fuel for one's own car or implicitly in case of commodities and services which require materials and energy to be made (so called 'embodied energy, matter and emissions');

2. *the influence of the supply structure* – the range of choice of products available for consumers and thereby limiting or facilitating eco-efficient consumption, as well as the knowledge of consumers and the knowledge provision to consumers regarding impact differences of similar products;

3. *the perception of consumer needs* by producers and intermediate organisations, and the compatibility of the needs with eco-efficiency and sustainability objectives, as well as the inclusion of consumer needs in the product design phase;

4. *the potential of technology* – the various roles technological development can play with respect to achieving eco-efficient consumption and production, i.e. either mitigating the extent of required efforts or troubling it (i.e. clean technologies and rebound effects);

5. *the socio-economic and socio-cultural driving forces* that cause the dynamics in consumption patterns, of particular importance are income development and distribution, commodity prices, tax levels and tax structure, the organisation of time and its (in)flexibility, evolution and influence of peer groups, balance between personal development goals versus societal concerns, and demographic factors (ageing, household formation).

The points 1 – 4 describe the state of infrastructure through which the use of resources is mediated and directed, as well as the opportunities to modernise the infrastructure. Hence points 1 – 4 refer to the stocks of natural and man made resources and how we shape the accessibility to these resources. Point 5 describes the factors driving the process of resource use, as well as the dynamics changing significance and workings of these factors. Up to now many studies and analytical concepts tend to focus on the issues 1, 4 and 5 (in as far the more tangible phenomena). According to Shove and Wilhite (1999) and Himanen et al (2004) the issues 2 and 3 deserve a much better or rather a true integration with those popular issues, as they may help to understand why many policies are much less effective than expected, at least as sustainable energy and transport policies are concerned. Of course to some extent this is taken up in integrated product policies (IPP), but to date the efforts have been still rather piecemeal.

3. Alternative approaches in consumption oriented sustainability impact analysis

After a first wave of attention during the 1990's the role of consumption receives renewed attention in economic and policy oriented research on sustainability. Interestingly in the more recent studies spatial aspects are often more profoundly taken into account (e.g. Heiskanen et al. 2001; Moll and Noorman, 2002; Høyer and Holden, 2003). These studies pay also more attention to the social context as a conditioning factor

The environmental implications of household behaviour can be assessed with several kinds of methodologies. For well defined products and household functions life-cycle analysis can be used (Faist et al, 2001). For wider scoped studies Material Flow Analysis (MFA) is a valid option. MFA also allows for easier linkage with monetary input-output systems, so-called hybrid approaches (see e.g. Moll and Noorman, 2002). A virtually complete bivalent monetary-material flow input-output system has been constructed by Mäenpää for Finland (e.g. Mäenpää and Juutinen, 2002).

Another hybrid approach involves the combination of consumer expenditure models with bivalent input-output systems and/or direct physical linkages (Vringer and Blok, 1995; Jeeninga, 1998; Weber and Perrels, 2000; Ferrer-i-Carbonell and van den Bergh, 2004; Perrels and Sullström, 2005). In comparison to the aforementioned approaches this approach allows for better inclusion of dynamic aspects in the evolution of consumption over time. The earlier - trend setting - study of Vringer and Blok was still static with respect to the consumer expenditure - output impact relation. In the studies of Jeeninga and of Weber and Perrels the models have a hybrid character, including both consumer expenditure systems and lifestyle aspects (see activity based approaches below). The most recent studies contain more refined estimation methods for household consumption. Within the context of a set of QUAIDS expenditure equations Ferrer-i-Carbonell and van den Bergh focus on car ownership and holiday travel. In Perrels and Sullström a multi-layer consumer expenditure model is presented, distinguishing between acquisition of durables and frequently purchased perishable goods as well as separating quality effects (from pure price effects) for some commodities.

Last but not least there is the option of activity based methods, which are well known in mobility analysis (e.g. Pendyala and Ghoulias, 2002), but rather rare outside the transportation research world. Outside transportation research generic time use based studies are carried out, predominantly in conjunction with sociological issues (Van den Broek and Breedveld, 2004) and occasionally in relation to work life and the labour market (Ruuskanen, 2004). Another occasional application has been the so-called 'lifestyle approach' in energy consumption studies (e.g. the aforementioned studies of Jeeninga and of Weber and Perrels). Yet, in those studies only rudiments of activity analysis are used. An exception is Jalas (2002, 2003) who has been using hybrid approaches combing time use data with physical data and consumer expenditure data.

However this approach is less suitable for including the embodied (indirect) environmental impacts (via the goods and services bought).

In addition to technical-economic assessment approaches there have been attempts to involve the social dimension by means of contingent evaluation approaches, more specifically by weighing the valuation that citizens have of environmental impacts and impacts of environmental policies. For example, Steg and Gifford (2005) discuss the Quality of Life (QoL) indicator system which has also been used for OECD studies concerning sustainability policies.

Ritter (2001), when discussing sociological aspects of consumption, introduces the idea that *the means of consumption* are getting more important in modern western societies than the means of production. For commercial success often the production side does not represent the biggest challenge, but instead the consumption side does. In other words, how quickly can one reach as many customers as possible. In that context accessibility becomes a key feature, first via media from producer/supplier to potential client, next from client to supplier to facilitate purchase and physical acquisition. For largely the same reasons time use becomes important. If purchase and acquisition take too much time the throughput of sales (per unit of time) may be limited and thereby curtail commercial success. The solution is to improve the temporal efficiency of consumption (or at least of purchase and acquisition) by minimising the temporal transaction cost. Solutions are for example: spatial concentration of suppliers (shopping malls), automatic payment and credit facilities, and internet shopping. Even though reduction of transaction cost is as such welfare augmenting, the trends are at the same time also troubling both with respect to environmental impacts (more throughput per unit of time) and with respect to actual experienced utility of consumers. The utility of a consumer depends eventually on the enjoyment of a ready-to-consume good or service during a certain spell of time. Notwithstanding the positive utility derived from the sheer possession of goods, there is no reason to assume that enjoyment (utility) is always a monotonously increasing function of consumption intensity (see Winston, 1982). It reminds us of the 'harried leisure class' introduced by Linder (1970).

Next to compressing time, simultaneity is a solution which is also applied, i.e. enabling that processes can run unattended and simultaneously. Nevertheless there are probably some upper limits in the amount of information per unit of time people's minds can sensibly process. Ruuskanen (2004) reports on the basis of an analysis of the Finnish time use survey that higher education levels seem to correspond with a higher likelihood of a more diverse free time activity patterns as well as with a higher likelihood of multi-tasking behaviour. ICT based innovations often have to do with the lowering of temporal transaction cost and/or simultaneity. This is probably the reason why assessments of the eco-efficiency potential of ICT innovations often produce ambiguous results (e.g. Arnfalk, 2004). The innovations usually produce more value added with very little extra material input or even savings, hence the eco-efficiency per unit of GDP improves. However, the improved temporal efficiency and extended simultaneity caused by the ICT innovation imply that the total throughput of energy and/or materials per unit of time (i.e. year) goes up. For those cases where ecological upper limits of carrying capacity or exhaustion are approached the latter – temporal – version of eco-efficiency seems more relevant.

4. An overview of the KulMaKunta project

The KulMaKunta project seeks to identify and clarify the volume, characteristics and feasibility of a sustainability potential within the realm of household consumption. The study aims to take account of behavioural and institutional impacts by linking model exercises with case studies based on dedicated household survey information and stakeholder interviews regarding the innovations in consumption.

The main objective of the study is to outline and analyse models (examples) of eco-efficient consumption and production in Finnish living environments. The model system (see figure 1) on the one hand serves the consumption-innovation case-studies and on the other hand uses the results and insights from these case-studies for the evaluation of policies regarding their eco-efficiency effectiveness. The point of departure is to proceed from existing models.

There will be created linkages between land-use models, time-use models and consumption models, as well as between this cluster of models and macro-economic models. By means of the cluster of models overall impacts are to be analysed with respect to societal structure and household consumption. As regards the technical features of the model system a compromise has to be found between various conflicting demands, such as between economic equilibrium and innovation shocks. The model is hybrid, consisting of both engineering-economic parts and econometric parts.

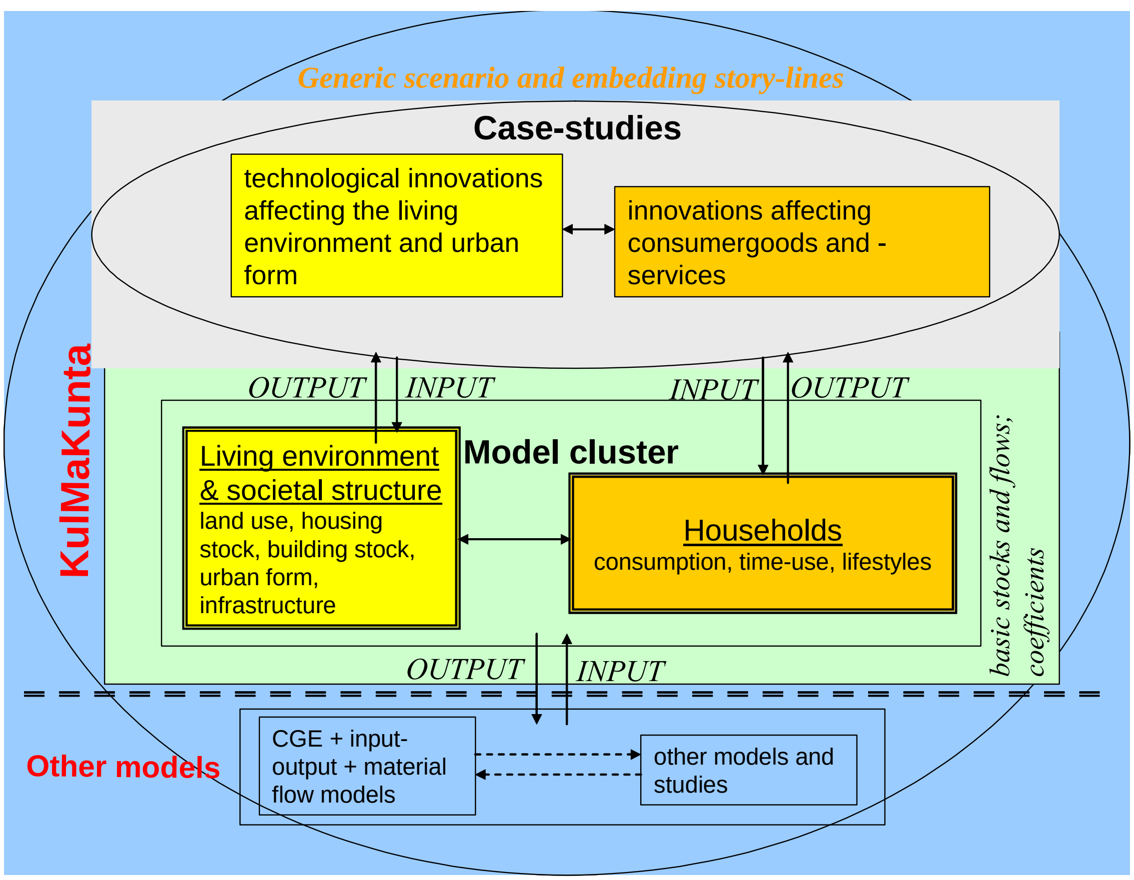


Figure 1. *Causal structure of the KulMaKunta project*

The models used consist of two main clusters (figure 1). One is describing the physical living environment (dwellings, other buildings, infrastructure) in terms of its volume, composition, utilisation and environmental implications (spatial consumption, emissions). The other one, an economic model, is describing the evolution of household consumption, both in terms of expenditures and in terms of time allocation. Furthermore, the consumption model is linked to an input-output model extended with sub-matrices for emissions. Figure 2 provides an overview of the consumption and input-output model cluster. The model components are based on econometric estimations[2], technical-economic identities and an input-output matrix system. This model also contains the social-economic and demographic scenario data. The economic model is somewhat similar to a sustainable consumption model developed in Austria (Kletzan et al, 2002).

The scenario modules are linked both to the economic model and the physical environment model. Both models receive detailed dwelling stock scenario data from a common dwelling stocks simulation covering the period 2000-2030. It provides detailed cross-tables per type of area of the number of homes simultaneously distinguished by type of dwelling (3), household size (4) and the number of rooms (6). Areas are distinguished by degree of urbanisation, with an own categorisation for the conurbation around Helsinki. The models also exchange information on car ownership, appliance ownership and mobility.

[2] . OLS, two tier AIDS and LOGIT. For a description of the model see Perrels and Sullström, 2005.

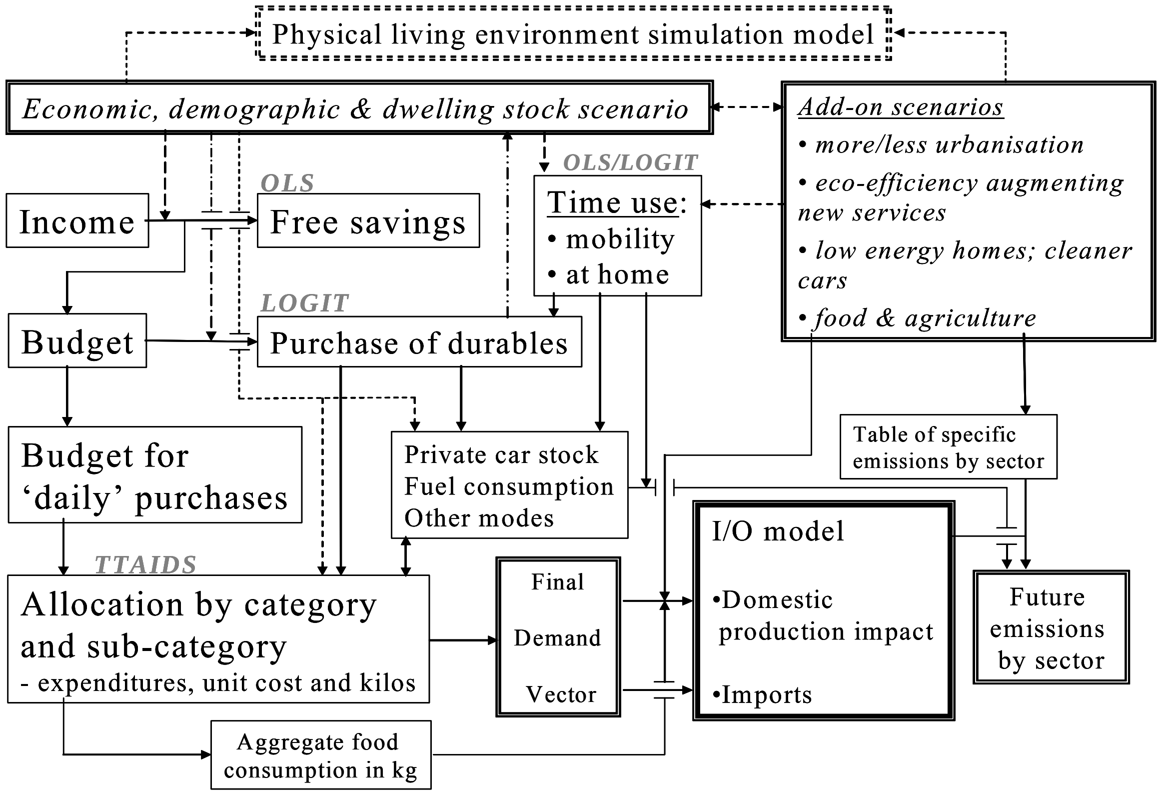


Figure 2. *The consumption and input-output model cluster*

5. Lessons from the case-studies

Two types of households were chosen for interviews, being (1) families (couples with children) that move out of the (inner) city and (2) elderly (here over 55 years of age) who move to city or regional centres. The outward move of the families is incited by the desire to live in a larger detached home and in a green(er) child friendly environment. The inward move of elderly is incited by the wish to live in a place with sufficient comfort and extra services both in-house and in the direct vicinity. So-called senior-homes can cater for these services and conveniences, but it requires a more densely populated, i.e. urban, environment to ensure adequate supply of diverse services.

The survey clarified that there is a demand potential for eco-efficiency augmenting new services, related to the use of ICT, outsourcing and shared use of equipment. However, it should be stressed that the overall effect on eco-efficiency improvement of this kind of new services may fall short of expectations. One reason can be that the in the entire supply chain of the new service more (embodied) transport per unit of final product is required than before. Just as well unfavourable effects can occur at the side of the consumer, for example reallocation of the own car for other uses or relocation of the residence (further) away from the city.

The interviews underlined that the actual realisation of the new services faces various difficulties, especially when sharing of facilities or some sort of outsourcing is involved. The establishment of such new services can be done either through a private (none commercial) neighbourhood initiative or through a commercial initiative. The former type of initiative has vulnerabilities with respect to (1) continuity, (2) responsibility, accountability and maintenance, and (3) dependence on prerequisites regarding (expensive) equipment. The latter – commercial – option has vulnerabilities with respect to (1) accessibility/affordability of the services to a sufficiently diverse client group, and (2) regional selectivity in the establishments of these services. Furthermore, options somehow related to work location and organisation, such as telework and shopping delivery services, usually presuppose a supportive attitude in the workplace about this kind of solutions, not only with respect to the practical organisation of telework, but also regarding work valuation, career planning, etc.

Several participating households reported that the less consumption oriented diversions of a smaller community had an impact on the behaviour on their children, when comparing it to their earlier behaviour in the consumption focused atmosphere of a larger city. The allegedly decreased urge of children for purchasing new items or services was visible in the descriptive statistics of the interviewed families. This is an interesting feature as it ties in with signals from other studies about the interaction effects between types of neighbourhoods and types of dwellers. For example, Van Wee et al (2002) shows that supply of particular infrastructure does to some extent influence people's mode choice, but just as well the type of people selecting a neighbourhood with a particular transport profile shows selectivity effects too. Schwanen and Mokhtarian (2005) also demonstrate the effects of matches and mismatches of a neighbourhood's infrastructure profile and the transport preferences of dwellers. Schwanen (2004) reports about time use for shopping in the Netherlands that (inner) city environments seem to incite extension of the shopping time budget. In the KulMaKunta study is found a similar correspondence (see section 7.2). The observation of the families moving outward the city suggests that the concept of the interaction with the infrastructure supply portfolio may be wider applicable. On the other hand the degree to which there is some sort of selectivity among the families that have moved out of the city, needs to be checked as well. All in all further study of environment induced changes in consumer behaviour would assist to substantiate the hypothesised increased significance of the 'means of consumption', even though the introducer of this term, Ritter, understood it as a much wider concept. In sections 6.3 and 7.3 we return to this issue in connection to urbanity and lifestyle.

6. Linking time use and money expenditures – travel

6.1 Spending intensity of travel

A micro-dataset was obtained based on a Finnish cross-section survey of time use of about 5400 individuals of at least 10 years of age from about 3500 households. The survey period stretches out from March 1999 to March 2000. Since VATT has also micro-datasets available of consumer expenditures in the years 1998 and 2001 it is feasible to construct so-called synthetic matches for particular household types with a cluster of common characteristics, such same household size, age bracket, income bracket, and living environment. The synthetic matching analysis produces valuable insights when it comes to understanding cohort effects, e.g. due to age or income. This can be of help when fine tuning the scenarios in later stages of the study. Figure 3 provides an example of the spending intensity for travelling in two-person households (adults only).

Spending intensity is defined as the average amount of travel time per day x 365 divided by the average annual transport expenditures divided by the number of adult household members. Due to the simplifications in the calculation (no personal expenditures) and different survey years (time: 1999/2000 vs. money: 2001) the figures should be interpreted with caution. Only obvious tendencies and substantial differences can be regarded as being significant. Surprising is that over a large range of incomes (from the 3rd to 8th decile) the effect of age – within each quintile – on raising transport expenditures per travelled hour seems to larger than that of income. The reason why same age categories in lower deciles have slightly higher spending intensities is due to the lower amount of total travel time, whereas the fixed cost of owning vehicles stays the same.

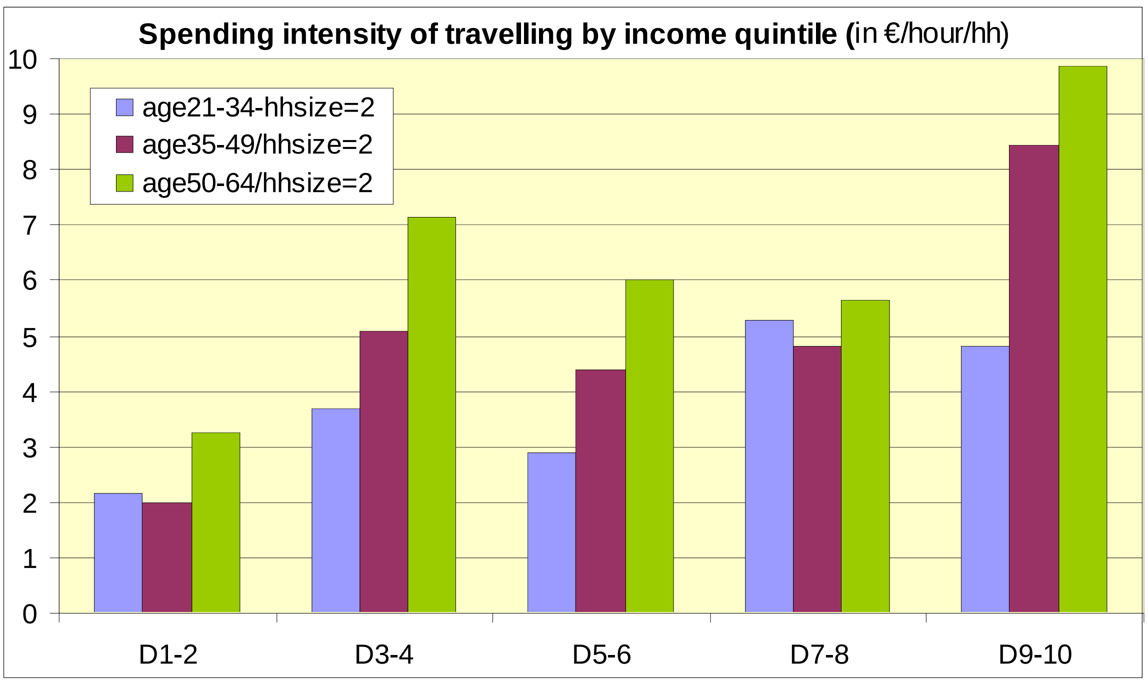


Figure 3. *Expenditure intensity (€/travelled hour) per capita in two person households*

The within decile difference between consecutive age categories is partly also attributable to travel time effects. Yet, apart from that there seems to be a remaining part hinting at larger willingness to pay per hour of travel with rising age. Probably at higher ages the need for other large purchases reduces and thereby allows households to spend more on comfort, status, or whatever less tangible characteristic of various transport modes.

6.2 Travel time allocation and mode choice

The micro-data set on time use has also been used to analyse propensities to travel in relation to characteristics of the respondent and the household. Other than is the case with the expenditure data, time use data and income are personalised rendering a more precise analysis possible. The analysis is based on assumptions derived from the theory of household production and consumption (see e.g. Gronau, 1977; Winston, 1982). It means that households, in order to be able to actually consume (enjoy) something, will often need to produce a ready-to-consume product or service by combining time, skills, purchased consumables and durable goods. They have a certain leeway in choosing the mix of these inputs. In a number of cases it is also possible to totally outsource the production of a ready-to-consume product (e.g. restaurant meal or take-away service). In the background household members have to make preceding choices and fine tuning decisions with respect to the amount of time to be devoted to paid labour and the balancing of paid and unpaid labour between involved household members. Figure 5 summarises the structure of the process. A selection of usual factors influencing the decision on the mix of production factors is mentioned in the oval area. In addition the typical requirement levels of a household (and its members) and the physical and social infrastructure impact on the process (including the assessment of the requirement level). In formal terms one can now state that the production of the required (demanded) mobility services is a function of the endowments and limitations that enable the actual supply of mobility (the factors at the left hand side of figure 4 and the environment features). Given the similarities with conventional production theory a Cobb-Douglas function can be chosen as initial functional form, e.g. $\mathrm{T} = \alpha . \prod_i \{F_i^{\beta_i}\}$, where T denotes time use for a certain function, F_i are the relevant influence factors, and β_i denote the parameters[3] of the influence factors F_i. By taking the logarithms at both sides a fairly straightforward function is obtained, which can be easily estimated thanks to the linearity in the parameters[4].

Apart from the usual characteristics such as income, working time, gender, age, education level, household size, degree of urbanisation, some constructed 'typecasting' variables were included. The large amount of detail on activities enables the definition of types of respondents in terms of inclination to a certain type of activities. In this case the following types of free time patterns were identified a 'sports type', a 'cultural type', a 'hobby type', a 'societal active type' and a 'low profile type'. The first four types imply that the involved respondents scored fairly high to high frequency ratings on activity participation in the relevant category. The low profiled type does neither rate fairly high nor high in any of these other categories. Later on in the analysis results hinted at a slight above average amount of working hours for the non-profiled, whereas otherwise this type of person is slightly more sedate (home bound) than the others.

The category 'societal active type' is rather small and therefore not further taken into account in the regression analysis. The sports type and cultural type correlate clearly with above average overall travel time, also after controlling for other variables. The non-

[3] . Since substitution between time use categories can occur there can be no a priori upper or lower limit on the sum over all parameters βi . Only if a kind of 'complete' model, also involving alternative time uses would be estimated, a valid interval such as $0 < \sum i\ \beta i < 1$ may be possible.

[4] . Admittedly the above considerations and consequent choice of functional form do not account for synchronization behaviour within families. This would complicate the formal analysis and is probably more important for timing than for budget allocation decisions. A promising approach can be found in Zhang et al (2005).

profiled group and to a lesser extent the hobby group rate below average in terms of travel time, also after controlling for other variables. For all the types binomial discrete choice models have been estimated using other personal and household characteristics to explain the probability to belong to a certain type of free time pattern (see also section 6.3; table 2) The degree of urbanisation is a significant explanatory variable for all groups. This ties in with earlier studies pointing at the relevance of the *bi-directional* interaction between living environment and personal characteristics in the context of propensities to travel (e.g. Schwanen and Mokhtarian, op. cit; van Wee et al, op. cit.). Thanks to the discrete choice functions the evolution of the occurrence of the different profiles can be endogenised in the scenario.

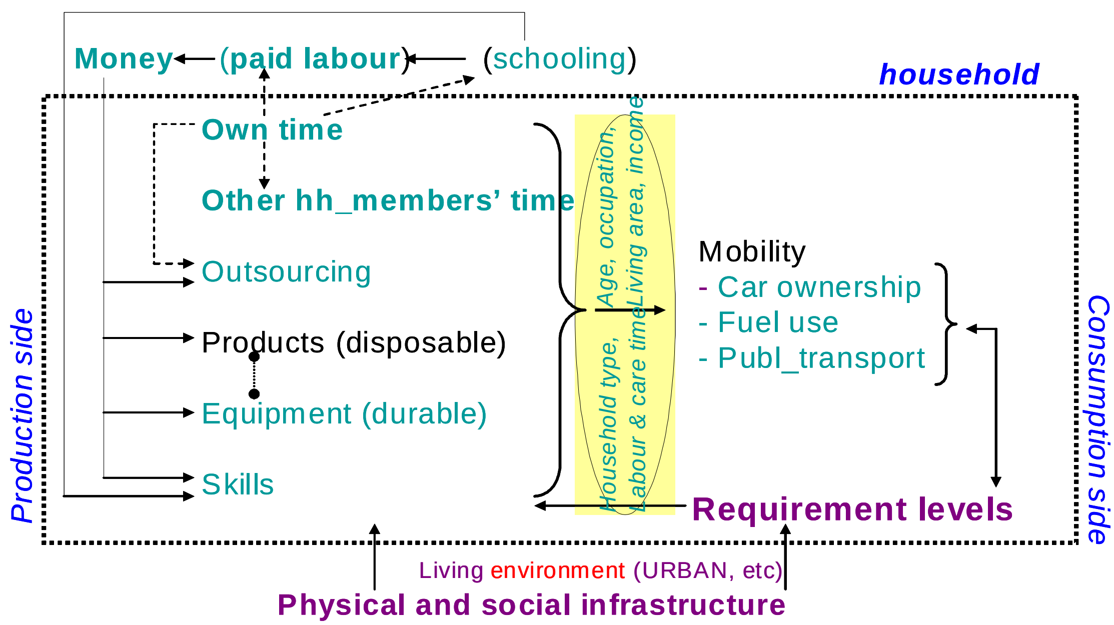


Figure 4. *Matching production and consumption of ready-to-consume products - example of mobility*

Estimates have been made for total travel time, total travel time by age group (under 21; 21-64; 65^{+}), commuting, commuting by age group, commuting by car, free time, free time by age group, and free time by age group and car. Variables that almost invariably rate high in significance tests are: age, gender, working time, own net wage rate, number of household members, (co)ownership of a summerhouse, (inner)urban residence dummy, and the low-profile free time pattern dummy. In addition, fairly often significant variables are: sub-urban residence dummy, countryside residence dummy, and the number of cars owned. Occasionally also the various free time activity type dummies (cultural, sports), education level and the net wage rate of the partner appear to be significant. Figure 5 contains an overview of the change in average travel time for total travel time due to consecutive *single* variable deviations. The alternative values for the simulated impact of a single variable represent outcomes of various estimated models.

Legend to figure 5:

kop_typ = low free time profile (work oriented/sedate)
Dcouside = dummy for countryside residence (1=yes; 0=no)
Durbfrin = dummy for residence in the urban fringe (1=yes; 0=no)
Durbcore = dummy for (inner) city residence (1=yes; 0=no)
Dsp = gender dummy (1=male; 0=female)
part time = half of the average daily full time working hours
wage rate+15% = increase of the own (hourly) wage rate by 15%

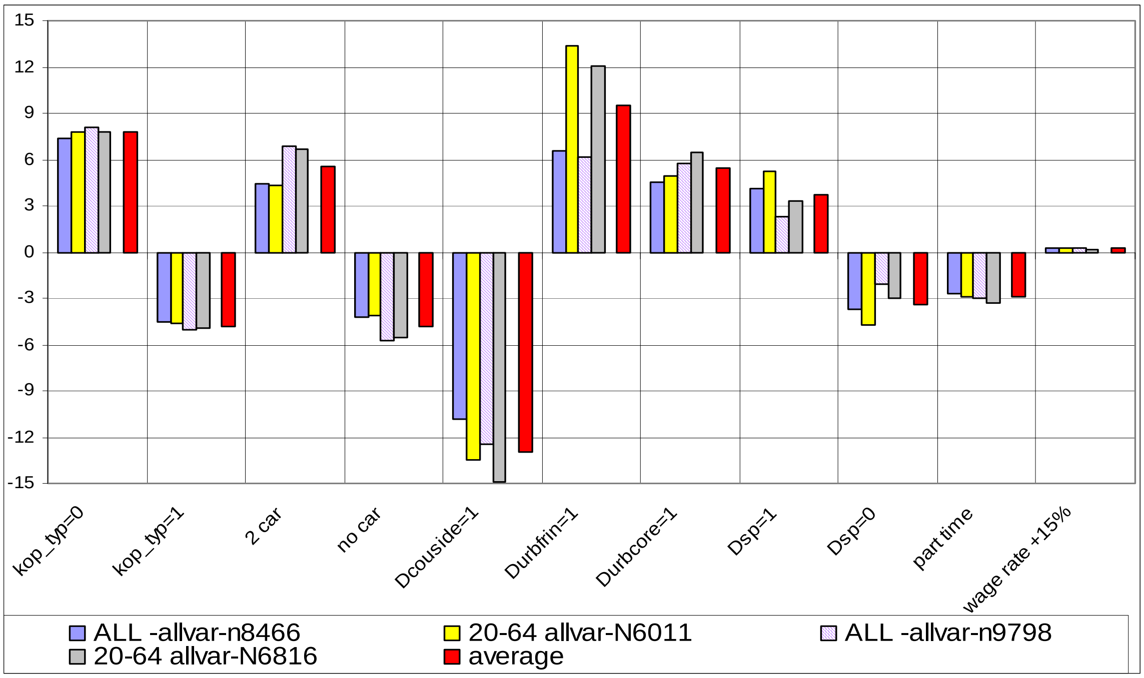


Figure 5. *Impacts of deviations in selected variables on the total travel time (in minutes per day)*

The most important determinants of commuting time (not shown here) are only partly the same as those for total travel time. The commuting time budget of the average employable adult is 35 minutes per day, covering all seven days. The average total travel time per day is about 70 minutes, including both weekend and work days[5]. Residential location (Durbcore, Durbfrin, Dcouside) has a clear and substantial effect in both cases. The next most influential variable is the amount of working time. In figure 5 the effect of a part time (50%) job is shown in comparison to a full time job. The effect on commuting time is larger than for total travel time implying that (significant) working time reduction leads not only to reduced mobility, but also to a reorientation of mobility. Gender shows opposite effects for commuting as compared to total travel. This probably relates to the

[5] . Respondents with significant restrictions on their mobility capability were excluded from the analysis. The travel budgets include walking. The results are weighed for the actual population composition. The budget figures differ somewhat from the 1998/1999 survey results carried out for the Ministry of Transport and Communication.

fact that women commute less by car than men (see next point on car ownership), while overall men travel more than women, except for teenagers. Car ownership has rather limited influence on commuting time, but gets more important when total transport time is considered. As regards the impact on total travel time car availability means also more transport performance (pkm/year). This is different in the case of commuting, in which case the efficiency of travel seems to be important, hence a better availability of cars tends to lead to reduced travel time (with an approximately stable transport performance). The travel time reduces only modestly as not everybody, who could switch, would benefit from a switch. The typecasting variable kop_typ, indicating a somewhat sedate lifestyle, indicates that this type of person uses slightly more time for commuting, but overall needs less travel time. The average amount of working time for this type is slightly higher than for other types.

6.3 The interaction effect between urbanisation and lifestyles

From a sustainability point of view it is important to identify factors, in as far as addressable by policy, that reduce the need for travel and/or reduce car use. Car ownership is an obvious factor. Working time, especially if it would be extended to include also flexibility and self-determination (e.g. through teleworking as was indicated in the interviews), is also a relevant factor, though a tricky one. Generic modifications in working time can have significant ramifications for the economy, both in terms of labour productivity and in terms of household budgets. However, undeniably the time budget does just as well belong to the household endowments as the money budget does. It is perfectly in line with micro-economic theory that beyond a certain level of material wealth the value of non-working time increases sufficiently as to make people more interested in work time reduction.

The discussion in section 6.2 demonstrated that the living environment, represented by the degree of urbanisation, affects mobility substantially. Last but not least the personal inclination on how to spend free time or more general 'lifestyles' affect the level of mobility as well. Both urbanisation and lifestyle can be influenced by policies. However, there are some intriguing linkages between lifestyles, here represented by the free time profiles, and the degree of urbanisation. The consequence is that the recipes are not as straightforward as they sometimes are believed to be. That is to say, an urban environment does not necessarily produce the most sustainable transport performance per inhabitant. This is illustrated in figure 6 below, in which the travel time is translated into annual kilometres[6] per person, distinguished by mode and for three area types (places of residence). Indeed city dwellers are travelling less by car, but are more than compensating that with substantial more travelling in most other modes. The figures do include business travel. If ferry, airplane and truck (+tractor in the countryside) would be left out the travel performance in the different areas would be converging, with sub/semi urban having the lowest travel performance.

[6] . This is done by applying average speeds per mode per travel purpose (derived from LVM, 1999), with slight adjustments for cities (speed of motorised road vehicles ↓) and countryside (speed of motorised road vehicles ↑).

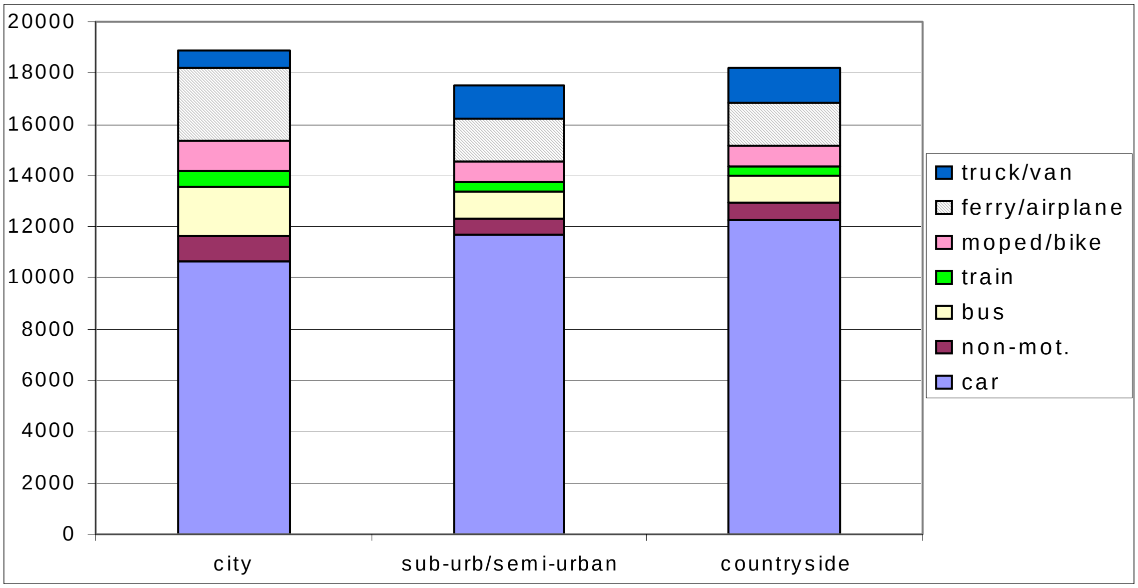


Figure 6. *Transport performance in person kilometres per year by area type and mode*

The emissions per passenger kilometre vary substantially over modes. Therefore the transport performance by area type not necessarily represents the concomitant emission levels. Furthermore, it is debatable to what extent business travel and cross-border travel should be attributed to the area type or for that matter to the inhabitant of that type of area. Table 1 shows (1) the relative emission levels per average traveller per day by place of residence of the traveller[7] and (2) the eco-efficiency of travelling by place of origin of the traveller in terms of emissions per passenger kilometre. The emissions caused by air travel and travels on (international) ferries are not included. From figure 6 can be inferred that inclusion of the latter kind of trips would add more to the emissions per traveller from cities than those originating from other places.

When both business and international travel are excluded the eco-efficiency of the urban citizen with respect to passenger transport seems to be on the whole worse than the sub/semi-urban citizen and often also the countryside resident. Inclusion of all forms of business travel tilts the picture in favour of cities. However, if the indicators were to include also international ferry and airline travel the environmental performance distinguished by place of residence would converge. Residents of (larger) cities report more international ferry and airline trips, probably both for push and pull reasons. That means both the easy accessibility *and* the inclination of urban residents cause this larger amount of trips. Furthermore, especially larger cities count more business activities with international relations, causing their employees to engage in more international travel, whereas these employees live either in the same city or in adjacent urban fringe. With these considerations we return again to the issue of interaction between urban characteristics and the characteristics of the residents. It seems that urban environments have various characteristics that stimulate people to adopt more urban (that is

[7] . Travellers from any origin will have travel performance in all areas, albeit in different relative quantities.

active/contact rich/outgoing/mobile) lifestyles (see table 2[8]). Vice versa people that do not favour urban environments are probably underrepresented in the urban population.

Table 1. *Emissions per traveller by place of residence (origin) excluding/including business trips (trips by ferry and aeroplane not included)*

	City (=100)	Sub/semi urban	countryside
CO_2 emissions/car traveller	100	95/102	96/103
NO_x emissions/traveller	100	85/92	92/99
N_2O emissions/traveller	100	98/106	103/111
Particles emissions/traveller	100	94/101	100/108
NO_x emissions/pkm	100	87/92	90/96
N_2O emissions/pkm	100	99/107	100/108
Particles emissions/pkm	100	95/102	98/104

Table 2. *Share of the population representing a certain type of free time profile*

	sedate	hobbies	culture	sports	societal
City	55 %	26 %	21 %	11 %	6 %
Suburban/semi-urban	66 %	22 %	9 %	9 %	6 %
Countryside	69 %	18 %	7 %	6 %	9 %

In addition to interaction effects between urban lifestyles and augmented mobility patterns, cities can also be considered in terms of their spatial-economic functioning. The larger a city is, the larger will be the surrounding area with which it interacts. This results in a tendency that a larger share of the employees in larger cities is engaged in activities that involve more long distance travelling. In other words the observed differences in people's travel performance are to some extent also the product of the spatial-economic organisation of a country[9]. Finland shows a tendency of continued reduction of the countryside population and a steady increase of the population of a small number of cities (or city regions), whereas other areas with medium densities and stand-alone medium-sized towns have by and large stable populations. The question arises to what extent centralisation is beneficial for the national economy and for sustainability and what is the leeway regarding these objectives when trying to manipulate the balance between the Helsinki metropolitan area and the other (principal) centres.

[8] . Accounting for age structure differences between the areas would correct the differences to some extent, but by and large the same pattern remains.

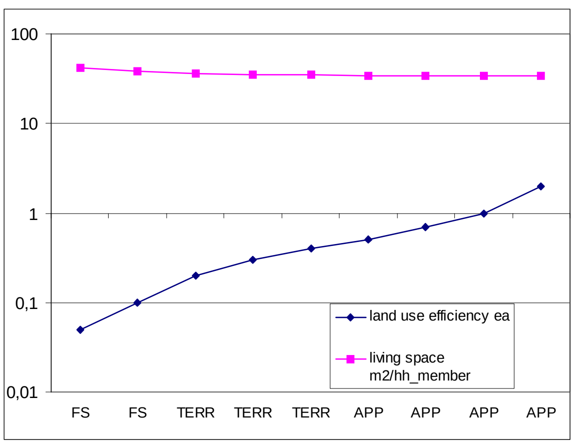
[9] . The spatial-economic organisation is of even greater significance for goods transport. Location of material intensive industries is not any more closely tied to the geographical distribution of the population, and hence a good part of logistics is not closely tied to the urban hierarchy in a country.

7. Other impacts of the physical living environment

7.1 Infrastructure efficiency

The previous chapter illustrated that urbanisation may not lead to a more sustainable mobility patterns. The living environment of a household is not only affecting a household's sustainability performance through mobility, but also through the infrastructures for energy, water, and sewer have important impacts. Higher spatial density usually reduces the amount of energy and material needed per citizen. This is illustrated with two graphs in figures 7a and 7b, based on data from Finland.

However, also in this case some counter-trends and –effects may occur. Firstly, it is now possible to construct low energy houses, as for example terraced or semi-detached homes, with the same or even better energy performance standards as apartment buildings have. For example, apartment buildings often require more generic spaces and facilities (stair-houses, galleries, elevators and elevator shafts, etc.) compared to other types of residential buildings (detached, semi-detached and terraced houses). It is often also more costly to adapt a multi-story apartment building to - for example - energy system innovations such as solar collectors, in comparison to other types of residential buildings.



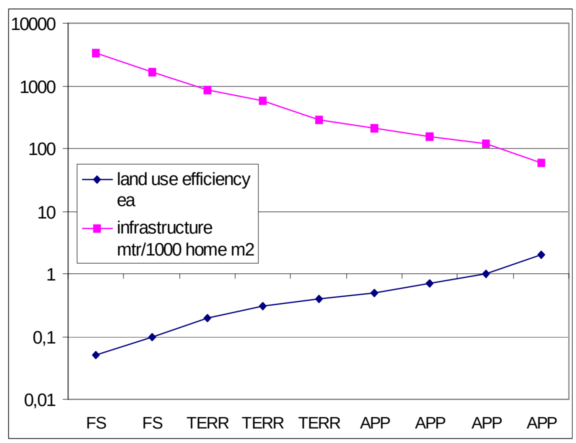


Figure 7a and7b. *Land use efficiency and living space per household member and land use efficiency and infrastructure endowment per 1000 m^2 floor space*

Due to the higher land value it is recommendable to build with higher densities in a city, however this gets more challenging in terms of neighbourhood lay-out if a larger number of single family houses is to be integrated into an urban building project. This would improve the infrastructure efficiency of such a neighbourhood in comparison to the alternative further away from the (inner) city. And even if the design can be realised, the previous chapters pointed at the issue that a part of the potential buyers may be only interested in a more spacious house in the real - more spacious - urban fringe. A way out of these problems might be to impose overall sustainability performance standards for new and thoroughly renovated neighbourhoods. This allows more flexibility regarding the various elements (transport, energy, etc.) to municipalities and planners, but strives to ensure that overall the sustainability targets are achieved. From the climate mitigation literature is well known that it usually pays off to allow flexibility in lieu of very precise prescriptions, e.g. Parry and Williams (1999).

7.2 Urbanisation and material lifestyles

A last item is the question whether different living environments significantly induce the choice of particular lifestyles. In this case it is especially important to check whether otherwise similar households tend to be more consumption oriented (i.e. trying to earn enough for an ambitious level of consumption requirements) than households living in other - less urban- environments. In Perrels (2003) it is illustrated that people in Finland move to cities notably for reasons of expected higher incomes[10], which results in higher purchasing power despite the higher cost of living in cities.

Preliminary findings indicate that there may be some systematic differences in consumption behaviour between cities, semi-urban areas and the countryside attributable to the consumer supply infrastructure. For example, according to regression analysis the propensity to save[11] is to some extent sensitive for the degree of urbanisation, implying that the propensity to save diminishes when the living environment becomes more urban. As regards expenditures by category the budget shares allocated to restaurants, leisure, personal care, tourism, and financial services tend to go up as the living environment becomes more urban. Conversely, the budget share for food purchases in shops is negatively correlated to urbanisation.

Also the time use analysis indicates that people living in cities tend to spend more time on shopping and on culture & entertainment compared to people living in other types of areas, at least for the years 1999 and 2000. The correlation between the occurrence of various types of free time profiles and urbanisation (see section 6.2) alludes to the same tendency. Even though the preliminary results seem to confirm the picture that an urban environment has some stimulating effect on private consumption, the additions in consumption seem to concentrate in services, which often have lower environmental impact per euro spent than the average consumption basket. However, at the same time it concerns mostly services that presuppose travel, which may imply that the total environmental impact of the supplied and consumed service could still be considerable.

8. Conclusions and directions for further research

The findings reported here are based on ongoing research, therefore the proviso should be added that – notably at more detailed levels – findings and hence conclusions can still be subject to modifications.

Urbanity and Mobility

Counter to the usual expectations it turns out that urban dwellers at least in Finland not necessarily reduce travel performance compared to others despite the – potentially – shorter distances to services and work. On the other hand urban dwellers do have an

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[10] .The expectation is based either on a change to a job with better remuneration or indirectly by first raising the education level.

[11] . Only non-compulsory savings, i.e. part of the disposable income not used for consumer expenditures.

environmentally more favourable modal split, especially when the higher share of travels by ferry and aeroplane are set aside.

Owing to their facilities, atmosphere and spatial-economic role urban environments do incite people to adopt more mobile lifestyles and/or do attract people with mobile lifestyles, resulting in an overall transport performance which exceeds those of other area types. It also means that in terms of eco-efficiency of travelling, city life *in practice* does not result in an evidently environmentally more benign travel performance, even though the potential for higher eco-efficiency may be technically present (thanks to public transport and proximity of services).

In a dynamic setting, i.e. in significantly expanding cities such as the Helsinki metropolitan area, it is important to know to what extent people, who move from the central city to a suburb or semi-urban area, are imposing their urban mobility patterns on those new areas or conversely are adapting to less mobile lifestyles.

Observing that countryside – that is low density – areas in Finland seem to result in second to largest transport performance per person, the study results up to now suggest that reasonable densities but probably not too large urban units enable the most favourable conditions for environmentally sustainable passenger transport. Further checking of this is needed by means of more precise distinctions of living environments and settlement structures.

Urbanity and Consumption

Cities tend to provide facilities and an atmosphere which stimulates engagement in activities that augment private consumption, as it shows in the time use and expenditure statistics of its inhabitants. The increments in consumption incited by cities tend to be concentrated in services, but with an increase of mobility as a significant side-effect.

The concept of the '*means of consumption*', introduced by Ritter and in this paper argued to be a logical consequence of the ongoing quest for overall productivity increases, seems to provide also a fertile platform for assessing consumption and sustainability. Hence the concept deserves thorough operationalisation for the purpose of impact assessment.

Methodology

Time use and expenditure micro-datasets can be used in a complementary way in order to improve the description of consumer behaviour in simulation models. Yet, improvement in the possibilities of accurate joint use of variables from both datasets would greatly enhance the analytical capabilities.

The use of information from purpose designed in-depth household interviews *in conjunction with* micro-simulation models deserves further exploration. Apart from concrete data exchange the combined use seems also beneficial in terms of providing orientation and reflection concerning the 'questions' actually analysed.

The results indicate that eco-efficiency, although very important, is an insufficient indicator to serve as the prime policy indicator. Favourable eco-efficiency can obviously be achieved even though the total rate of exhaustion of natural resources remains high.

References

Arnfalk, P. (2004), *Sustainability impacts of proliferating ICT on transport and of ICT in transport*, presentation in STELLA FG4 meeting in Brussels, 25-27 March, 2004.

Faist, M, S. Kytzia, and P. Baccini (2001), The impact of household food consumption on resource and energy management, *International Journal of Environment and Pollution*, Vol.15, pp.183-199.

Ferrer-i-Carbonell, A. and J.C.J.M. van den Bergh (2004), A Micro-Econometric Analysis of Determinants of Unsustainable Consumption in the Netherlands, *Environmental & Resource Economics*, Vol.27, No.4, pp.367-389.

Gronau, R. (1977), Leisure, Home Production and Work, the theory of the allocation of time revisited, *Journal of Political Economy*, pp.1099-1123.

Heinonen, S. and P. Lahti (2002), Sustainable, Competitive or Good Cities – Bake a Cake or Make a Fake? *Futura,* Vol. 2, pp. 109-121.

Heiskanen, E. – M. Halme – M. Jalas – A. Kärnä – R. Lovio (2001), *Dematerialization: the potential of ICT and services,* Ministry of the Environment, Finnish Environment series no. 533, Helsinki.

Himanen, V., M. Lee-Gosselin and A. Perrels (2004), Impacts of Transport on Sustainability: Towards an Integrated Transatlantic Evidence base, *Transport Reviews*, Vol. 24, No.6 pp.691-705.

Høyer, K.G., and E. Holden (2003), Household Consumption and Ecological Footprints in Norway – Does Urban Form matter?, *Journal of Consumer Policy*, Vol. 26, pp.327-349.

Jalas, M. (2002), A Time use Perspective on the materials intensity of consumption. *Ecological Economics*, 41 (1), s. 109-123.

Jalas, M. (2003), The Everyday Life-context of the Increasing Energy Demands: Time-use Survey Data in Decomposition Analysis, *Journal of Industrial Ecology*.

Jeeninga, H.(1998), *Domestic appliances and life style. Consequences for domestic electricity consumption in 2010* (Summary of Dutch report), ECN Policy Studies, Petten, the Netherlands.

Kletzan, D. – A. Köppl – K. Kratena – M. Wügler (2002), *Economic Modelling of Sustainable Structures in Private Consumption*, WIFO, Vienna.

Lahti, P. – S. Heinonen – K. Koski – H. Tolsa (1997), *Kestävä kehitys aluerakenteessa. Kansainvälisiä näkemyksiä, suomalainen sovellus (Sustainable development in spatial structures: international views – Finnish application).* Suomen ympäristö 109. Ympäristöministeriö, Alueidenkäytön osasto. Oy Edita Ab. Helsinki.

Linder, S.B. (1970), *The Harried Leisure Class*, Columbia University Press.

Ministry of Transport and Communication (Liikenne- ja viestintäministeriö LVM) (1999), *Passenger Transport Survey 1998-1999* (in Finnish), Helsinki, 1999.

Moll, H. and K.J. Noorman (2002), Towards Sustainable Development at City Level: Evaluating and Changing the Household Metabolism in Five European Cities, in Hertwich E., (ed.), *Life-cycle Approaches to Sustainable Consumption – workshop proceedings*, IIASA Interim Report IR 02-073, Laxenburg, pp. 153-170.

Munksgaard, J., M. Wier, M. Lenzen, C. Dey (2002), Indicators for the environmental pressure of consumption, in Hertwich E., (ed.), *Life-cycle Approaches to Sustainable Consumption – workshop proceedings*, IIASA Interim Report IR 02-073, Laxenburg, pp. 171-192.

Mäenpää, I. – Juutinen, A. (2002), Materials flows in Finland, Resource use in a small open economy, *Journal of Industrial Ecology* 5:3, s. 33 – 48.

Parry, I.W.H. and R.C. Williams, A second best evaluation of eight policy instruments to reduce carbon emissions, *Resource and Energy Economics*, Vol.21, pp.347-373, 1999.

Pendyala, R.M. and K.G. Goulias (2002), Time use and activity perspectives in travel behaviour research, *Transportation* Vol. 29 No.1, pp.1-4.

Perrels, A. (2004), *The basic service quality level of transport infrastructure in peripheral areas*, VATT discussion paper 335.

Perrels, A., K. Ahlqvist, E. Heiskanen, P. Lahti (2004), *Kestävän kulutuksen potentiaalia etsimässä (Searching for the sustainable consumption potential)*, VATT discussion paper 323.

Perrels, A. and R. Sullström (2005), *Modelling household consumption and consequent production requirements – with special reference to nutrient flows,* VATT report (forthcoming).

Ritter, G. (2001), *Explorations in the Sociology of Consumption*, Sage Publications.

Ruuskanen, O.P. (2004), *The Econometric Analysis of Time Use in Finnish Households* (dissertation), Helsinki School of Economics.

Schwanen, T. (2004), The determinants of shopping duration on workdays in the Netherlands, *Journal of Transport Geography*, Vol.12. No.1, pp.35-48.

Schwanen, T. and P. Mokhtarian (2005), What effects commute mode choice: neighbourhood physical structure or preferences towards neighbourhoods?, in: Perrels, A., Himanen, V. & Lee-Gosselin, M. (eds.) 2005. *Special issue of Journal of Transport Geography,* Vol.13. No. 1. (forthcoming).

Shove, E. and H. Wilhite (1999), Energy policy: what it forgot and what it yet might recognise, ECEEE Summer Study 1999 proceedings – Panel I – paper 16, European Council for an Energy Efficient Economy, ADEME editions, Paris.

Steg, L. & Gifford, R. (2005), Sustainable transportation and quality of life, in: Perrels, A., Himanen, V. & Lee-Gosselin, M. (eds.) 2005. *Special issue of Journal of Transport Geography,* Vol.13. No. 1. (forthcoming).

Van den Broek A. and K. Breedveld (eds.) (2004), *Trends in Time – The Use and Organisation of Time in the Netherlands*, SCP, The Hague.

Vringer, K., K., Blok (1995), 'The direct and indirect energy requirements of households in the Netherlands', *Energy Policy* **23**-10, pp. 893-910.

Weber C. and A. Perrels (2000), Modelling lifestyle effects on energy demand and related emissions, *Energy Policy*, **28**-8, pp. 549-566.

Winston, G.C. (1982), *The Timing of Economic Activities*, Cambridge University Press.

Zhang, J., H.P. Timmermans, A. Borgers (2005), A model of household task allocation and time use, *Transportation Research Part B*, Vol.39. pp.81-95.

Re-Searching towards a culture of sustainability: a transdisciplinary and cultural comparative perspective for Europe

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Introduction

In the past 10 years or so, social reality changed dramatically, more than ever expected. Nowadays, some social scientists pointed out, that modern societies will change even more radical in the near future than in the past. There is a quite spectrum of driving factors that accelerate theses changes. For modern societies, like Germany, four cultural mega-trends could be seen as crucial: Globalisation, Information and Communication Technology, structural change of work and leisure, and the brake-through of the knowledge-based society. These cultural mega-trends are not only overlapping the existing basic trends in modern "lifestyle-societies" (functional differentiation, pluralisation of life forms, individualization of lifestyles), but will also speed-up the further modernization process of society at the whole.
In terms of non-sustainable consumption patterns these developments have radical effects and could lead to several new paradoxies, which are not anticipated in existing policy strategies towards SCP yet, on the one hand. On the other hand, existing research on SCP mostly lacks the theoretical foundation to analyse the socio-ecological transformation in modern societies and to generate strategic options. Experiences from Germany and other European Countries show, that research on SCP is to much descriptive, less apply-orientated, still mono-disciplinary and less integrated, more empirical than analytical, more quantitative than qualitative, more implementation based than explorative. Research on SCP needs therefore a radical "constructive" shift towards an perspective, that give answer to the question "what are the social, economical, technical and cultural potentials and pathways towards a sustainable society"? This will be not only a normative question, it implies a new paradigm of research and politics.

<u>Outline of the paper/presentation</u>
The outline of the paper/presentation will focus on the following aspects:

- SCP as a challenge for politics and research
- "Culture" as the forgotten dimension of sustainability: from implementation to exploration
- "Culture of Sustainability" as integrative concept for politics and research towards SCP
- Innovation and the Modernization of Society: Socio-ecological transformation as an operational framework towards trans-disciplinary and cultural comparative research in Europe

Policy making and Research on SCP: the need for multi-dimensionality (an integrated approach)

The temporal orientations of ecological modernization and sustainable consumption

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Introduction

Ecological modernization and eco-efficiency have been successful catchwords of the environmental debate for two decades. More recently, the topic of sustainable consumption has been added on the agenda to highlight the non-sustainability of continuous economic growth and the levels of consumption in the wealthy nations. The notion of sustainable consumption has served as a necessary counterpart or add-on device in conjunction with the enthusiastic and lofty expectations of radical eco-innovation and improved eco-efficiency. However, the concept of sustainable consumption is ambiguous and the ability of this notion to create new insights for research and policy is questioned. On the one hand, it risks being reduced to mere productionistic insights, which do not address consumption per se (Princen, 1999), and, on the other hand, the calls to understand and acknowledge consumption as composing of particular social and cultural practices remain largely unanswered (Dolan, 2002). Furthermore, Hobson (2002) argues that a rationalising discourse of sustainable consumption makes the policy initiatives impotent in the task of changing patterns and levels of consumption.

These fears are reflected in the claims that ecological modernization is chiefly interested in improving the efficiency of production and accelerating the processes of industrialization and, as a result, not capable of addressing issues of consumption (Carolan, 2004). However, others see ecological modernization theory as potent also in the sphere of consumption. Authors such as Spaargaren and van Vlit (2000), Cohen and Murphy (2001) and Mol and Spaargaren (2004) address sustainable consumption as a part of the theory of ecological modernization. Cohen and Murphy recognise the neo-liberal, individualistic ontology of the contemporary discussion on consumption, and argue that the prevailing disciplines around sustainable consumption are economics and engineering. Furthermore, they maintain that the policies of ecological modernization of consumption have fallen short and essentially address production and products, but not the demand for consumer goods. They call upon other disciplines such anthropology to provide a more in-depth and interpretive understanding of consumption. Such a change is radical. Most importantly, individuals and particular consumption practices as the targets of critical writings dissolve and what comes into the fore, is the considerations of the limits and the structuring of individual choices, the social nature of needs, and the shared practices of consumption.

I argue that such an approach implies a break and a confrontation within the discussion of ecological modernization. Hence, the question should not merely be how one should expand the thought of ecological modernization and apply these theories on consumption (cf. Cohen and Murphy, 2001). Such ‘easy’ solutions deceive the aims of the discussion and do not grant the notion of sustainable consumption an autonomous status as a counterpart of the efficiency discourse. Hasty attempts of positioning sustainable consumption within the discussion of ecological modernization thus undermine clarity of the debate. Rather, what is needed is careful attention to the different premises of discussing consumption as separate from production.

In this paper I demonstrate a discontinuity between the production-oriented eco-efficiency discourse and the interpretive approach on consumption by focusing on their temporal orientations. Just as ecological modernization praises and builds on a neo-liberal ideology and market-based solutions to the environmental problems, it also embraces a utilitarian and orthodox economic theory of consumption and rational, individual decision-makers. This utilitarian thought brings along a specific temporal orientation, which treats time as an abstract commodity.

Sustainable consumption, on the other hand, has been suggested to imply quite a different notion of time. It embraces slower pace of life, wealth-in-time instead of material growth, intrinsic meanings of human action and social justice. The meanings and practices of consumption are to be understood and appreciated instead of the engineering look at distance. Consumption and time then appear as meaningful in a specific cultural context.

While some of the critique on ecological modernization has been labelled as unfeasible pleas for demodernization (see the debate between Carolan 2004 and Mol and Spaargaren, 2004), there are other possible strands of critique. To select a more collective ontology and treat consumption as culture implies a rejection of some of the tenets of modernization, but not to attempt undoing modernization. Rather, just ecological modernization seeks to accelerate the process of modernization, a cultural orientation on consumption may articulate a difference against eco-modernization by emphasising the changing and increasingly symbolic nature of consumption in affluent societies.

Consumption in ecological modernization

Ecological modernization as a neo-liberal thought

Ecological modernization is a strain of thought that has at least two distinct straits, which relate directly to consumption. On the one hand, the concept refers to a macro-level change in the industrial societies in which economic growth becomes increasingly decoupled from the use of natural resources (Jänecke et al., 1989). The phenomenon is known and environmental Kutznets-curve implying that the environmental load of mature economies starts first to decline in relative terms but later also in absolute terms. The decoupling is attributed to both the technological development and to the structural changes in the economy and in consumption.[12] Hence, increases in consumption are not only compatible with but possibly even a prerequisite for sustainable development. Or to state it less provocatively, sustainable consumption need not address volume of consumption provided that the structure of consumption alters towards less resource-intensive patterns.

The other important strait of ecological modernization addresses innovation. Innovation and an 'engineering-take' contain the promise of win-win situations, which is a central tenet of ecological modernization, and while eco-efficiency discussion originally may have been a business-oriented concept, there seem to be no practical reasons why not to address the efficiency of consumption as well. Indeed, it is argued that in order to achieve radical changes in the environmentally detrimental patterns of production and consumption we need to fundamentally question the ways we derive and strive for utility while consuming. In lieu of prescribing environmentally less harmful patterns of consumption, the discussion has promoted a focus on the end-services of consumption (e.g. Mont 2002; Heiskanen and Jalas, 2003; Behrendt et al. 2003). In the popularising literature on eco-efficiency, it is often repeated that consumers do not want the products, but the results these service-producing-machines yield (e.g. von Weitzäcker et al. 1997). These thoughts resemble the words of the household economists in the late 1960's who theorised consumption as a question of rational time allocation (Becker, 1965), and indeed, as I will highlight when discussing time and temporality, it is crucial to note that such an approach essentially treats all consumption as work and production.

In has been repeatedly stated that one fundamental assumption behind these suggestions is the dominance of individuals who are guided by instrumental rationality and seek to maximise their own utility (Doland, 2002; Hobson, 2002, Mol and Spaargaren 2004). What results is that the responsibility over the change towards sustainability is placed, unfairly and unrealistically as the critics argue, on individual consumers. Within such a discourse, the cure for the environmental problems appears to be an increase of environmental information, which would feed a value change and 'environmental citizenship' (Hobson, 2002).

Eco-innovation in socially embedded technological systems

Mere efficiency engineering is a naïve solution to the environmental problems of production and consumption, and hardly promoted as such. The sociological approaches

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[12] The reasoning for the U-shape of the curve and for the causality from economic growth to environmental improvements is versatile and it builds upon the theories and hypotheses of ecological transition, restructuring and modernisation. On the one hand, the transition of agrarian economies in to industrial economies is thought to be continued towards more high technology products and followed by another transition from an industrial economy to a service economy (e.g. Bell 1976; Labson and Crompton 1993; Baldwin 1995; Grossman 1995) or to an information society, in which knowledge becomes an ever more important factor of production (e.g. Shapiro and Varian 1999; Windrum and Tomlinson 1999). Technological development and the accumulation of knowledge that leads to greater efficiency in using environmental resources may be another reason for the U-shape (Johnson 1997). It is also suggested that as societies accumulate wealth, they can afford and will start to value a clean environment (e.g. Baldwin 1995). Further causes of ecological transition that are mentioned are the worsened state of the local environment and the consequent change in preferences (de Bryun 2000) and the relocation of polluting industries to less developed countries (de Bryun 2000, Baldwin 1995).

to consumption and technology have been used to pinpoint that successful policies on consumption must acknowledge the context of prescribed changes and also utilise the knowledge of disciplines other than economics and engineering (Heiskanen and Pantzar, 1997; Dolan, 2002). For example Heiskanen and Pantzar, after painting a picture of a revolution in service efficiency, take a step back, draw on science and technology studies and evolutionary economics, and argue for a much more complex picture in which technologies develop along certain inscribed paths and needs arise in use.

Science and technology studies regard technological development as an evolutionary and political process in which the title of the best design is always contested and that lock-in effects result 'inefficient' systems. The 'best', or the 'most efficient', design does not win automatically. Hence, the language of these disciplines emphasises the constraints and discusses technology as lock-in effects, path-dependency, trajectories (Geels, 2002), dominant designs (Rosenkopf and Tushman, 1994), co-determination (Shove and Southerton, 2000) and integrated systems-of-provision (Fine and Leopold, 1993). However, I argue that even such elaborate and historically-informed ways of contextualising eco-efficiency potentials is an incomplete answer to the pleas of taking a more interpretive approach on consumption when discussing sustainability. Albeit these theories recognise the social embeddedness and the historic contingency of economic and technical systems, they do not do away with economics being the dominant paradigm. As for consumption, science and technology studies seem to discuss choices as constrained but not as constructed.

Sustainable consumption as contentment

Sustainable consumption appeared on the environmental agenda in The Rio summit in 1992 as consumption in the wealthy industrial societies was recognised as source of environmental problems. However, many agree that what has emerged as consumption-oriented policies are mere extensions of production policies. Products are addressed and innovations in end-consumption are prescribed, but consumption and demand remain untouched (Cohen and Murphy, 2001; Princen, 1999). Thomas Princen poses a crucial question: what is sustainable consumption if it is not efficient production. One can further refine the question: what is sustainable consumption if it is not efficient household production.

Some answers are starting to emerge. Writers within ecological economics maintain the distinction between needs and wants (Jackson and Marks, 1999; Reisch, 2003). Sustainable consumption could thus be represented as efficient provisioning for a *limited set of needs*. However, attempts to confine the market activity to serve a set of basic needs seem far-fetched, and a weak pair or counter-discourse for the efficiency movement. To say the least, there are other proposals, which warrant further investigation.

Sustainable consumption can alternatively be represented as a value change towards lifestyles of lower environmental impacts. For example, Reisch (2001) calls for strategies of sufficiency-motivated 'new models of wealth'. For her, sufficiency implies a lifestyle change, which is based on behavioural changes and social innovations. Yet, as such, sufficiency is an individualistic concept; it is guided by need-reflection and motivated by insight and self-commitment. The origin of an altered course is within the individual; what remains to be answered is how do values and attitudes change and how do needs arise and continuously make sense to the involved individuals.

Consumption psychology seems to offer some leads out of the all-encompassing rationality of individuals and the consequent need to call for a value change. Jalas (2002; 2005) has argued that it is crucial to conceptualise consumption as a temporal process and seek to understand how consumption becomes intrinsically meaningful and how wealth-in-time becomes a feasible option against increasing cycles of (over)work and (over)consumption (Sanne, 1999). In deed, also Reisch (2003) points towards need to allow for the intrinsic value or process benefits of consumption. Common to all of these approaches is to emphasise the multiple psychological dimensions of consumption. Consumption is argued to entail intrinsically meaningful flow-states, which are the seeds on contentment.

However, these attempts also point towards a different theoretical orientation. In quest of trying to understand and appreciate consumption many authors have called upon anthropology and cultural studies (Cohen and Murphy, 2001). With such theoretical resources, the understanding need not be confined to the constraints and path-dependent features of contemporary technological systems. Neither is it necessary to locate the prerequisites of intrinsically meaningful or ecologically responsible action inside the heads of the individuals. Rather, anthropology and cultural studies raise in the front the shared, context-specific rationalities of consumption and claim that (only) in such specific contexts consumption makes sense, appeals and appears rational to the involved individuals (e.g. Warde 2003, see also Schatzki, 2001). In the same vein, Hobson (2002) suggest that sustainable consumption, or in broader terms, sustainable living could be interpreted as social justice, and thus raises the question of how and why consumption appears as justified. In short, the focus of debates on sustainable consumption might be on the social and cultural context flow-states and contentment.

What are the commonalities of these discrete attempts to conceptualise sustainable consumption. I argue that they all displace the notion rational consumer from the centre of environmental thought. A shift from the productionist theories of ecological modernization to the theories of consumption implies that each of the local, or internal, ways of reproducing meanings in consumption is an asset for the discussion rather than routinised irrational and inefficient behaviour to be fixed. In the same vein, excessive focus on efficiency improvements and innovations in consumption acts like a Trojan horse disguising an assumption of utility-maximising, rational individuals.

Temporal orientations of ecological modernization and sustainable consumption

There is long tradition for anthropologists (e.g. Sorokin and Merton 1937, Coser and Coser 1963), historians (e.g. Thompson 1967, Cross 1993) and economist (Becker 1965, Linder 1970) to focus on time and temporality as a social phenomenon. In the following I will use the topic of time and temporality to further explore the terrain of consumption as it is presented in ecological modernization and in the alternative formulations of sustainable consumption.

Ecological modernization: time as money

Time use, or rather the rational allocation of time, has been theorized in the field of household economics (Becker 1965). This economic orthodoxy represent humans as capable and willing maximizers of their own utility. All consumption activities are thus thought to be driven by a cognition of a goal and of the available means for striving towards it. Accordingly, time is a scarce resource, which is sold on the labour-market and carefully invested in the various free-time activities so that the marginal benefit of each unit of time is the same in all activities.

I argue that much of the ecological modernization discussion is premised on these assumptions. One indication relating to consumption is the claim that consumers are not interested in the products, but in the results that these service-producing machines yield (Weitzäcker et al. 1997). Eco-efficient services seek to replace private ownership of goods with leasing and renting schemes (Behrendt et al. 2003), but alongside the physical products the households outsource many other things. As one extreme, the popular discussion mentions so called result-oriented services (see Heiskanen and Jalas 2003), which deliver sole results, such as clean clothes, independent of the ways of provisioning. Consumption is thus represented as work, which is to be performed in the most efficient way and which is oriented by its results. The processes and the outcomes, the means and the ends, are clearly demarcated for sake of finding and arguing for innovation potential. Consequently, the doing of consumption carries no intrinsic meaning, utility exists only in the achieved results but not in the process itself.[13]

Academics have explored (the making of) the scarcity of time: Thompson (1967) argues that the notion of the value of time and the moral dissension with idleness is connected to industrialization and the birth of labour markets; Robinson and Godbey (1997) point towards scientific management and the way it has been adopted in everyday life; Stahel (1999) argues that the capitalist system is dependent on an instrumental and abstract concept of time. Furthermore, Linder (1970) compellingly predicts that productivity growth will only increase the efforts to economise time use in all spheres of human life in modern societies. In short, the abstract nature of time and the thought that time is money, is a capitalistic thought, which is connected to the assumption of rational individual agents and which is taken as granted and natural in much of the public discussion. As was argued above, it is also well inline with the premises of ecological modernization.

However, the abstract nature of time is also a contested ideology. In the same vein, it is not the only premise through which to approach sustainable consumption. In fact the detrimental, environmentally-relevant outcomes of time-famine and harriedness are

[13]Economists have also considered joint-production, affective experiences and ‘process benefits’ (see Pollack and Wachter 1975; Juster et al 1981; Dow and Juster 1985; Winston 1982; Gershuny and Haplin 1996).

rather obvious. Godbey (1996) claims that time-famine prompts the use of resource-intensive products and implies higher levels of municipal solid waste. Røpke (1999) and Binswanger (2001) address the issue of time-squeeze with a reverse causality claiming that time-saving technologies are essential constituents of increasing levels of consumption. Furthermore, the consumer society as a whole has been seen to depend on a deliberate or forced choice of work-and-spend (Schor 1991; Cross 1993; Aronowitz and DeFazio 1994; Sanne 2000) and on the choice of material wealth instead of wealth-in-time (Reisch 2001).

Sustainable consumption; time as made experiences
Sustainable consumption is frequently presented as slower pace of life, down-shifting and contentment. Anthropologists and sociologists of time contrast the temporal orientations of traditional societies and modern societies. While the modern societies are seen to increasingly depend on the above-mentioned abstract notion of time, in traditional societies time is experienced as cyclical and organised by the rhythms of nature and the agricultural practices (Adam, 1995; Levine, 1997). Some approaches to sustainable consumption, such as voluntary simplicity (Leonard-Barton, 1981) seem to be preoccupied with finding solutions for the current problems from the models of traditional societies. However, while such an inclination is denied by the eco-modernists (e.g Mol and Spargaren 2004), I suggest that there are no reasons not to try to understand also modern consumption as a set of cultural and social practices in which time is organised and regulated by collective structures.

In modern societies, the sources of collective structuring of time are partly different from traditional societies. It is out of the scope of this paper to engage in comparisons between so-called 'traditional' and 'modern' societies, but some observations of the structuring of time are necessary to support and advance my argument of interpreting sustainable consumption as meaningful time.

It has been claimed that the meanings and goals of consumption have become more difficult to interpret and more malleable to change (Firat and Dholakia 1998). Goods are tools only in a limited sense as they simultaneously constitute together with language our symbolic social reality (Dietmar 1992). In this reality, consumers may increasingly prefer to playfully engage in certain activities, be it for reasons of self-actualization, inter-personal communication or social cohesion. Substantial changes in consumption are parallel. On the one hand, the relative share of expenditure on such elementary items as nutrition has declined. On the other hand, there is a growing sector of advertisement and marketing, which is harnessed to influence demand and mould preferences (Røpke 1999). Furthermore, mass-media and modern communication technology link people in new ways and act as infrastructure for sharing ideas and nurturing the collective practices of consumption.

However, I want to stress that my argument neither requires a substantial 'cultural turn' in the economy (see Du Gay and Pryke, 2003) nor conceptualising modern societies as hyperreality in the words of Baudrillard. For example, Miller (2002) strongly argues that contemporary economies are not becoming in an exceptional way impregnated with culture. Rather, he claims that all economic activity is deeply cultural. As a consequence, to think of sustainable consumption in terms of culture, does not require that the contemporary economy is given labels such as 'The experience economy' (Pine and Gilmore, 1999).

The 'rational decisions of time allocation' are also conditioned by various regulating institutions (Sorokin and Merton 1937; Coser and Coser 1963; Cross 1993). While consumption culture reproduces meanings and gives rise to new practices, the regulation of time anchors and cements these practices. Working-time regulations regulate also consumption and in certain national contexts the shared understanding of Christmas practices regulate the whole of the twelfth month of the year. The important of such informal institutions is emphasised by the fact that the time-use statistics repeatedly report robust patterns of time use despite the technological changes and the deregulation of time.

Thus, and to say the least, it is conceivable that time and consumption can be experienced simply as fun or as duty without evoking much reflection and rational maximization behaviour. It is then also possible to conceive time as not a resource subject to continuous optimisation, but something which humans either experience as meaningful, necessary or fun as such or something, which does not permeate our cognition at all, but resides unquestioned behind social norms and cultural practices.

Implications and further questions; how to speak of consumption

In this paper I have demonstrated a discontinuity between prevailing thoughts of ecological modernization on the one hand and sustainable consumption on the other hand. Furthermore I have argued that the various versions of cultural theories, which highlight consumption practices, constitute a decisive theoretical resource for sustainable consumption as opposed to the efficiency discussion, which is oriented by orthodox economic theories and engineering. The notion of sustainable consumption requires analytical distance from the theory of ecological modernization, calls for a different ontology and implies different research approaches

The inherent contradiction between the notions of ecological modernization and sustainable consumption has implications both for policy and for research on the environmental problems. Allowing for the social origin of needs and the multitude of context-specific rationalities, which guide and govern consumption, undermines the criticism of over-consumption. Is any kind of consumption then legitimate and are the individuals free of moral obligations? If we accept that the rationalities of consumption are arbitrary, it follows that efficiency evaluations lack a ground as well. Must the discussion then altogether eschew eco-efficiency thinking? Or is there a way to incorporate situated, context-specific knowledge with the universal agenda of ecological modernization?

An answer must start by stating that environmental concerns and global inequalities are substantial and real enough. Therefore, calls for efficiency increases are legitimate. What is more, relativistic reading of consumption can be used to legitimate the resource intensive practices of the wealthy nations. In short, the nature and scale of environmental crises denounce the possibility of relativism. Furthermore, there is scope for such policies on consumption that understand everyday life and the logic of practices of consumption. The world is not perfect; there are information deficits and friction in the economy; there are path-dependencies and technological couplings, which may work against a voluntary and a cost-efficient change towards more sustainable patterns of consumption.

However, the policies of consumption must not undermine practices alongside attempting to decompose and engineer them. Practices, traditions and local knowledge are anchors in the process of spreading of capitalistic thought; practices are loci of resistance, they must be appreciated as a source of meanings and different ways of being. Practices are thus not to be left alone, but treated carefully as each of them contains a seed of sustainability.

How can such ideas be operationalised in empirical research? In a recent article, Halme and colleagues (2004) discuss sustainable home services. They criticize the dominance of eco-efficiency thinking and point out a lack of attempts to take a holistic view of sustainability on consumption. In the article, they argue that services should not be considered as isolated technical provision of results. Rather, any new service evolves in, contributes to and impacts a specific social context. Hence, the criteria for sustainability include such aspects as comfort and empowerment as well as social contacts. In short, they consider the eco-efficiency innovations as psychological processes and as human interaction, which both seem to be absent in the world-view of rational individuals, but clearly implicated by the alternative approaches to sustainable consumption.

There is a rather thin line between trying to understand the context of consumption in order to devise successful new innovations and trying to find ways to support the rationalities evoked by the context. Where as for example Halme and colleagues target the former, also the latter warrants research. If there are some grounds to identify sustainable, low resource-intensive practices or otherwise sustainable practices, it is a task of research to elaborate on the emergency and reproduction of such practices. In a similar way, the notion of sustainable consumption calls for attention on the ways time and consumption practices are regulated in modern societies.

Finally, we can consider the discussion of ecological modernization and the critique it seems to be vulnerable against. Why is the discussion premised on such assumptions? Have the side-effects of such premises simple gone unnoticed, or are there more elaborate explanations? Dolan (2002) suggests that an individualistic view, to which the abstract nature of time hinges upon, is politically more feasible. I would like to suggest that the issue also touches the notion of basic needs. Many activists within ecological modernization would like to harness rationality to drive eco-innovation but not continued economic growth in the wealthy nations. The rational agent for them is also environmentally aware, even altruistic; thus rationality and innovation is not directed at the maximization of output and utility, but at the minimization of input and environmental harm of the current levels of well-being (or otherwise defined level of basic needs). The imputing of such a value change is handy for the ecological modernization debate, but at the same time it involves risks. In the absence of it, the embracing of rationality and innovation drives further economic growth and may impede sustainable development. Such an assumption should thus be made more visible instead of trying to deny it.

On a most practical level, the policy instruments of ecological modernization may need to be questioned. Sustainable consumption has been given the interpretation of downshifting and wealth-in-time instead of material wealth. Should, for example ecological tax reforms, which work towards a increased market-bias in provisioning for the human needs, be substituted by or coupled with programs of work-sharing?

Altogether, it seems that ecological modernization theory and sustainable consumption do not fit together simply by speaking of them in the same sentence. Rather, there is a danger that productionistic policies spill over to consumption and undermine policies of sustainable consumption. Reisch (2005, p.230) seems to share much of the questions posed by this article when stating that "New integrative policy fields, such as eco-social time policy, help to maintain a systems view and keep policies which work against each other to an acceptable level". I also contend that instead of trying to maintain a policy agenda in which sustainable production and consumption are inseparable, we would be better off to identify eco-efficiency of production and sustainability of consumption as separate fields of policy both informed by the escalating environmental impacts of human activity.

References

Aronowitz, S. and W. DeFazio. 1994. *The jobless Future*. Minneapolis: University of Minnesota Press.

Baldwin, R. 1995. Does sustainability require growth. In: Goldin, I. &. Winters, L. A (eds.): *The economics of sustainable development*, pp. 51-79. Cambridge University Press.

Bradford

Becker. G. 1965. A theory of the allocation of time. The Economic Journal 65: 493-517.

Behrendt, S., Jasch C., Koortman J., Hrauda, G., Pfitzner R. & Velte D. 2003. *Eco-service development. Reinventing supply and demand in the European Union.* Sheffield: Greenleaf Publishing.

Bell, D. 1976. *The Coming of Post-Industrial Society*. Harmondsworth: Penguin Books.

Binswanger, M. 2001. Technological Progress and Sustainable Development: What About the Rebound Effect? *Ecological Economics* 36: 119-132.

Carolan, M. 2004. Ecological Modernization: What about Consumption? *Society and Natural Resources* 17.

Cohen M. & Murphy J. 2001. (eds). *Exploring sustainable consumption.* Amsterdam: Pergamon.

Coser, L. and R. Coser. 1963. Time Perspective and Social Structure, reprinted in *The Sociology of Time* edited by John Hassard (1990). London: MacMillan, pp. 191-202.

Cross, G. 1993. *Time and money. The making of the consumer culture.* London: Routledge.

De Bruyn, S. 2000. *Economic Growth and the Environment*. Dordrecht: Kluwer Academic Publishers.

Dietmar, H. 1992. *The Social Psychology of Material Possessions. To Have Is To Be.* Hemel Hempstead, UK: Harvester Wheatsleaf.

Dolan, P. 2002. The sustainability of "Sustainable Consumption". *Journal of Macromarketing* 22(2): 170-181.

Dow, G. K. and F. T. Juster. 1985. Goods, Time, and Well-Being: The Joint Dependence Problem. In *Time, goods, and well-being,* edited by F.T. Juster and F.P. Stafford. Ann Arbor, US: The University of Michigan, pp. 397-414.

du Gay, P. & Pryke, M. (eds) 2002. *Cultural economy: cultural analysis and commercial life*. London: Sage.

Fine, B. & Leopold, E. 1993. The world of consumption. London: Routledge.

Firat, A. F. and N. Dholakia. 1998. *Consuming people. From Political Economy to Theaters of Consumption.* London: Routledge.

Geels, F. 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and case study. *Research Policy* 31:1257-1274.

Gershuny, J. and B. Haplin. 1996. Time Use, Quality of Life, and Process Benefits. In *In pursuit of the quality of life* edited by A. Offer. Oxford: Oxford University Press.

Godbey, G. 1996. No Time to Waste: Time Use and the Generation of Residential Solid Waste. Yale Working Papers on Solid Waste Policy # 4. Available at http://www.yale.edu/pswp/orderfrm.htm

Grossman, G. 1995. Pollution and growth: what do we know. In: Goldin I. & Winters L. A. (eds.): *The economics of sustainable development*. pp. 19-46. Cambridge University Press.

Halme, M., Jasch, C. & Scharp, M. 2004. Sustainable homeservices? Towards household services that enhance ecological, social and economic sustainability. *Ecological Economics* 51: 125-138.

Heiskanen, E. & Jalas, M. 2003. Can services lead to radical eco-efficiency improvements? − A review of the debate and evidence. *Corporate Social Responsibility and Environmental Management* 10: 186-198.

Heiskanen, E. & Pantzar, M., 1997. Towards sustainable consumption: Two new perspectives. *Journal of Consumer policy* 20, 409-442.

Hobson, K. 2002. Competing discourses of sustainable consumption: does the rationalization of lifestyles make sense*? Environmental Politics* 11 (2): 95-120.

Jackson, T. & Marks, N. 1999. Consumption, sustainable welfare and human needs- with reference to UK expenditure patterns 1954-1994. *Ecological Economics* 28 (3): 421-442.

Jalas, M. 2002. A time use perspective on the materials intensity of consumption. *Ecological Economics* 41: 109-123.

Jalas, M. 2005. Sustainability in everyday life – a matter of time. In: Reisch, L. & Röpke, I. (eds) *The Ecological Economics Of Consumption*. Edward Elgar.

Jänicke, M., Mönch, H., Ranneberg, U. & Simonis, U. E. (1989). Structural change and environmental impact: empirical evidence of thirty-one countries in East and West*. Environmental Monitoring and Assessment* 12: 99-114.

Johnson, B. 1997. Institutional learning and clean growth. In: Tylecote, A. & van der Straaten, J. (eds.): *Environment, technology and economic growth.* Cheltenham: Edward Elgar Publishing ltd.

Juster, F. T., P. N. Courant and G. K. Dow. 1981. The Theory and Measurement of Well-Being: A Suggested Framework for Accounting and Analysis. In *Social Accounting Systems: essays on the state of the art* edited by F.T. Juster and K.C. Land. New York: Academic Press, pp. 23-94.

Labson, B. S. & Crompton, P. L. 1993. Common trends in Economic Activity and Metals Demand: Cointegration and the intensity of Use Debate*. Journal of Environmental Economics and Management* 25: 147-161.

Leonard-Barton, D. 1981. Voluntary Simplicity Lifestyles and energy conservation. *Journal of Consumer Research* 8, 242-252

Levine, R. 1997. *A geography of time*. New York: Basic Books.

Linder, S. B. 1970. *The harried leisure class.* New York and London: Columbia University Press.

Miller, D. 2002. The Unintended Political Economy. In: du Gay, P. & Pryke, M. (eds) *Cultural economy: cultural analysis and commercial life*. London: Sage.

Mol, A. P. J. & Spaargaren, G. 2004. Ecological Modernization and Consumption: A Reply. *Society and Natural Resources* 17: 261-265.

Mont, O. 2002. Clarifying the concept of product-service system. *Journal of Cleaner Production* 10(3): 237-254.

Pine, J. & Gilmore, J. 1999. *The experience economy: work is theatre and every business a stage*. Boston (Mass.): Harvard Business School Press.

Pollack R. A. and M.L. Wachter. 1975. The Relevance of the Household Production Function and Its Implications for the Allocation of Time. *Journal of Political Economy* 83(2): 255-277.

Princen, T. 1999. Consumption and environment: some conceptual issues. *Ecological Economics* 31: 347-363.

Reisch, L. A. 2001. Time and Wealth. The role of time and temporalities for sustainable patterns of consumption. *Time & Society*, 10(2/3): 367-385.

Reisch, L. 2003. Consumption. In: E. Page & J. Proops (eds). *Environmental thought "Current Issues in Ecological Economies*. pp 217-243. Cheltenham, UK: Edward Elgar.

Robinson, J. & G. Godbey. 1997*. Time for life. The Surprising Ways Americans use Their Time*. University Park, PA: Pennsylvania State University Press.

Røpke, I. 1999. The dynamics of the willingness to consume. *Ecological Economics* 28: 399-420.

Rosenkopf L. & Tushman, M.L. 1994. The Co-evolution of Technology and Organization. Organization Science 8: 289-309.

Sanne, C. 2000. Dealing with environmental savings in a dynamic economy – how to stop chasing your tail in the pursuit of sustainability. *Energy Policy* 28: 487-497.

Schatzki, T. 2001. Introduction: practice theory. In: Schatzki, T., Knorr Cetina, K & von Savigny E. (eds) *The Practice Turn in Contemporary Theory*. pp. 1-14. London and New York; Routledge.

Schor, J. 1991. *The Overworked American.* New York: Basic Books.

Shapiro, C. & Varian, H. R. 1999. *Information rules. A strategic guide to the network economy.* Boston: Harvard Business School Press.

Shove, E. & Southerton, D. 2000. Defrosting the freezer: from novelty to convenience. *Journal of Material Culture* 5(3): 301-319.

Sorokin, P. and R. Merton. 1937. Social-time: A Methodological and Functional Analysis, reprinted in *The Sociology of Time* edited by John Hassard (1990). London: MacMillan, pp. 56-66.

Spaargaren, G. & van Vlit B. (2000). Lifestyles, Consumption and the Environment: The Ecological Modernization of Domestic Consumption. *Environmental Politics* 9 (1): 50-76.

Stahel, A.W. 1999. Time contradictions of capitalism. Online book: Capitalism Nature, Socialism (CNS) Part 10. Available at: http://members.cruzio.com/~cns/Occasional/paper10.html

Thomson, E.P. 1967. 'Time, Work-Discipline, and Industrial Capitalism', reprinted in *Essays in Social History* edited by M.W. Flinn and T.C. Smout (1974). Oxford: Clarendon Press, pp. 39-77.

von Weitzäcker, E., Lovins, A, Lovins, H., 1997. *Factor four – doubling wealth, halving resource use.* London: Earthscan publications.

Warde, A. 2003. *Consumption and theories of practice*. Draft CRIC Discussion paper. Centre for Research on Innovation and Competition. University of Manchester.

Winston, G.C. 1982. *The Timing of Economic Activities*. Cambridge University Press.

Sustainable consumption research exchanges (SCORE !)

An EU Funded Network Supporting UNEP's Ten Year Framework of Programs on Sustainable Consumption and Production

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Summary

Sustainable consumption and production (SCP) is key policy priority world-wide. The EU is – pending successful negotiations – likely to fund a research network in this field. The network will ensure that experts that understand **business development, (sustainable) solution design, consumer behaviour** and **effectiveness of (policy) instruments** work together in shaping them. Furthermore, this should be linked with **experiences of actors** (industry, consumer groups, ecolabelling organisations) in **real-life consumption areas.** Since in the EU a network with these characteristics is absent, we propose to set up a **Co-ordination action in the field of SCP, emphasizing on "user awareness" for sustainable consumption, involving key expertise covering all relevant steps of the value chain in the priority consumption domains Mobility, Agro-Food, and Energy/electronics.** These domains contribute to over 70% of the life cycle impacts of household consumption, are a priority in the EUs Enviromental Technologies Action Plan (ETAP), and give good examples of user awareness schemes (e.g. labeling). This paper is one of the first announcements of the network, describes its envisaged structure, and the possibilities for contributions.

1. Introduction: scientific and technological objectives in brief

Realizing sustainable consumption and production patterns are a key priority for policy makers world-wide. This has been emphasized among others by:

At EU level:

- the European Environmental Technologies Action Plan (ETAP)
- the EU's Integrated Product Policy, supported by a.o. the EuP, ROHS, WEEE and ELV directives;
- European ecolabel schemes and type III product declarations.

At global level:

- The statement adopted at the 2002 Johannesburg Summit on Sustainable Development, that a 10-year Framework of Programs should be organized in the field of Sustainable Consumption and Production (SCP).

In our view, sustainable consumption and production structures can only be realized if experts that understand **business development, (sustainable) solution design, consumer behaviour** and **effectiveness of (policy) instruments** work together in shaping these structures. Furthermore, developing SCP structures becomes a theoretical exercise if this is not linked to real-life consumption areas, calling for involvement of (preferably industrial rather than academic) experts in **well-chosen priority consumption domains**. However, in the European theatre a network with these characteristics that co-ordinates research and innovation in the field of SCP is absent. In order to fill this gap, a group of institutes in Europe has taken the initiative to set up a **Co-ordination action in the field of SCP, emphasizing on "user awareness" for sustainable consumption, involving key expertise covering all relevant steps of the value chain in priority consumption domains.** This CA was recently positively evaluated under the EU's 6th Framework Program and is currently in the contract negotiation stage. The project is likely to start early 2005 and has as duration of 30 months. The objectives of the CA are four-fold:

1. Generating and dissemination of best practice
2. Programming research (co-ordination of existing research and identification of priority research needs)
3. Forming a platform for practical and scientific input into relevant policy trajectories;
4. Building a structural network of European SCP researchers, breaking across:
   - Boundaries of scientific disciplines
   - Boundaries of academic research, applied research and innovation at business level;
   - Geographical boundaries.

2. Sustainable consumption research: State of the art

Sustainable consumption is a relatively new area of research. No major research programs in the field have been in place at EU level yet. In FP5, the issue of product-service (or integrated solution) development has got a lot of attention, but this did not focus on consumption per se. At world scale, the main effort in this field has been funded by the Japanese government in the form of the 3-year program 'Life cycle approaches to Sustainable Consumption'[1]. Additionally, UNEP has organized a number of workshops in the field. At national scale, a variety of expert groups in various EU countries have done research into the issue.

In terms of the state of the art and lessons learned, a number of issues stand out.

1. **Understanding (sustainable) consumption behaviour needs a system perspective.** Figure 2.1 gives an explanation, based on interim results of the Japanese SCP project. Consumers have needs in different domains, such as Housing, Food, Mobility and Leisure[2]. These needs are either covered via Business to Consumer (B2C) interactions, or (co-)delivered via governmental services (preceded by Business to Government interactions, or B2G). A key point is, indeed, that consumption is not an autonomously controllable driver for B2C,

[1] Executed by SNTT and AIST, one of the METI institutes, between 2002 and 2005. Incidentally, by involving the research communities in the US and Europe in this field, this Japanese project has done quite a good job in getting European researchers in this field connected.

[2] The figure shows functional domains since in this way fulfilling consumer needs can be easily linked to production sectors. Of course another way of would be describing human needs in terms of the hierarchies of e.g. Maslow (1943), Alderfer (1972), Max-Neef (1992), and Jackson (2004). See also Vlek et al. (1997)

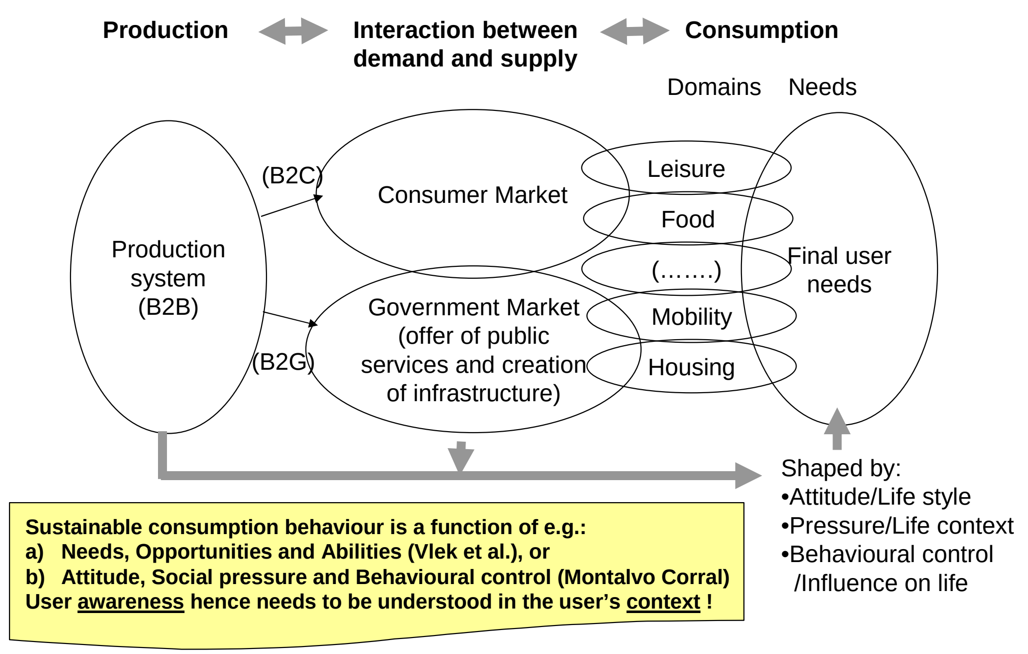
B2G and B2B processes. The production side of the economy in turn shapes the *context* in which consumption takes place – and hence becomes a driver in itself.

2. **Consumption is not only a function of individually controllable elements.** This is actually the consequence of 1). Many authors have pointed at the fact that individual *need or willingness* to change (consumption) behaviour, e.g. by a change in awareness, is not sufficient. The NOA-model (Vlek et al. 1997) states that such a change is a function of a *Need*, an *Opportunity* (availability of means) *Ability* (access to means). Montalvo Corral (2002) comes on the basis of extensive research to somewhat other determinants for willingness to change, i.e. the *personal attitude,* the *behavioural control* and the *societal pressure*[3] [4].
3. **Different levels of change in (production-) consumption systems need to be discerned.** In relation to the former two points, one can discern roughly three levels of change to sustainable consumption (see figure 2.2 and 2.3):
   a. *System optimization*. Example: introducing an energy label that supports enhancing the fuel-efficiency of a car. The typical sustainability improvement is 20-30%. There is no change in the structure of the production-consumption system. Incentives for change are rather 'soft', such as awareness raising approaches that mainly try to influence the *attitude* of the user (and indirectly the producer).
   b. *System re-design.* Example: the offer of an integrated mobility system where people use public transport where feasible and car sharing systems as a back-up. The typical sustainability gains are 50% or more. The structure of the production-consumption interactions changes. Awareness raising is complemented by the availability of an inherent sustainable solution for the mobility problem (albeit still shaped in an existing context and market framework). Not only the *attitude,* but also the *behavioural control* of the consumer is addressed.

[3] Of course all these authors discern sub-determinants. Part of the work of the CA will be to find a good descriptive model for sustainable consumption behaviour.

[4] A simple example: 40-50 years ago taking a weekly bath was the norm in Europe. Applying this (sustainable) habit now would probably put your job and social life in peril, and hence is not an option.

Figure 2.1: Sustainable Consumption



Adapted from: project Life Cycle Approaches to Sustainable Consumption, AIST, Japan

Figure 2.2: Levels of change

What	Sustainability gains	Approaches
1. Optimise systems	Marginal (<50%)	Awareness raising
2. Redesign systems	Factor 2 (50%)	Awareness raising + offers of (more) sustainable solutions
3. Innovate systems	Substantial (>>50%)	Awareness raising + offers of (inherent) sustainable solutions+ adapting context and framework conditions

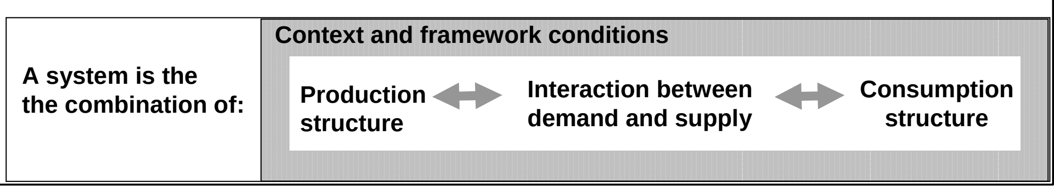


Figure 2.3: Levels of change, examples

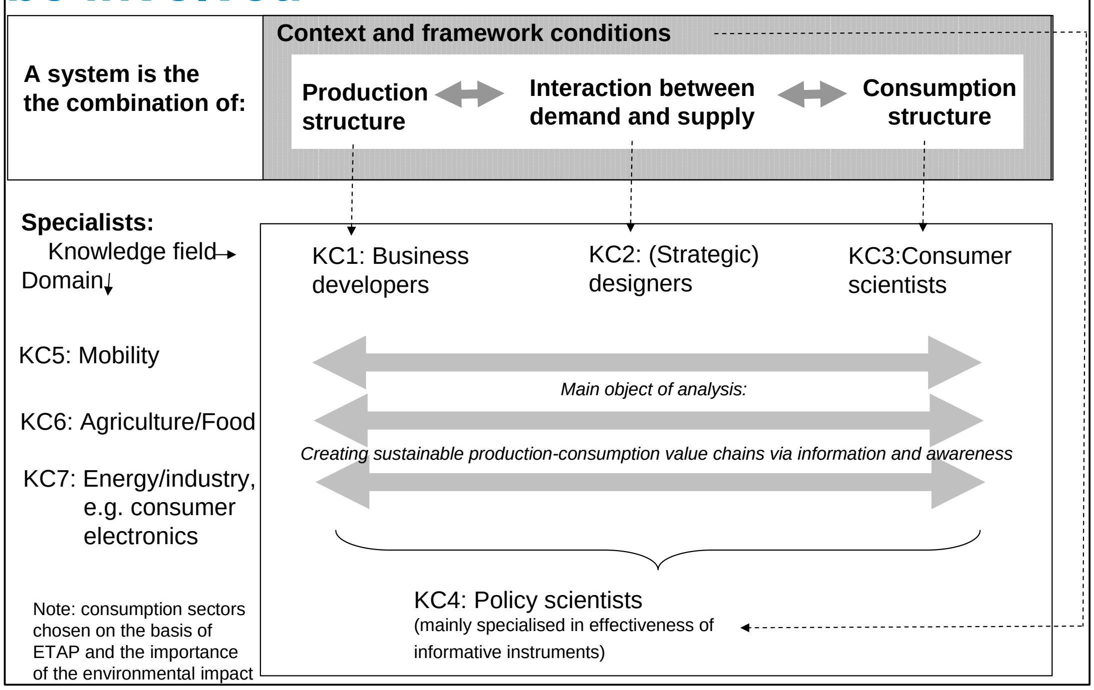
What	Approaches
1. Optimise systems	Awareness raising
2. Redesign systems	Awareness raising + offer of sustainable solutions
3. Innovate systems	Awareness raising + offer of sustainable solutions+ adapting context and framework

1. Car energy label

2. Car sharing system

3. Low transport-need environment (Floridosdorf, Vienna)

Figure 2.4: Knowledge communities to be involved



c. *System innovation.* Example: spatial planning and incentive systems that result in a context of life where an inherent low need for transport exists[5]. Awareness raising and the availability of inherent sustainable solutions are complemented by adapting the context of life and incentive systems. Not only the *attitude* and *behavioural control* is addressed, but also *social pressure* is put in place.

Given the above, we think that merely addressing informative instruments in the CA, without addressing the system context of consumption, is insufficient, if not naïve. Users will not change behaviour just because they are *aware* of how sustainable consumption can be realized. Though we will take User Awareness as a starting point, we will analyze it connection with the other elements that determine behaviour, i.e. control and pressure viz. ability and opportunity[6].

Implications: approach to the project

The former sections have the following implications for the approach to the project.

First, the project aims to give **priority consumption domains** a central role in the project. We choose for the domains **energy/electronics**, **agro-food,** and **mobility,** for three main reasons:

- Industry, agriculture and mobility are the main priorities in the EU's Environmental Technologies Action Plan (ETAP).
- Energy, food and mobility are most important final consumption domains from an environmental point of view (see table 3.1)[7].
- In all these domains (eco-)labeling and other awareness raising measures abound, allowing for fruitful evaluation of best practice.

[5] The example in Figure 1.3 is the quarter of Floridosdorf near Vienna, that had been designed to be (almost) car free and that has excellent public transport facilities. The housing rental contracts discourage car ownership as well. These push and pull factors (pressure to diminish car ownership and a life context stimulating the same) created a successful example of sustainable consumption (e.g. Hertwig, 2002)

[6] Indeed, the emphasis on user awareness as a driver for change to sustainable consumption patterns is in the mean time totally falsified by experiences in sustainable marketing. Marketers have learned that the *prime importance* for a consumer will always be functional performance, experiences, etc.. Stressing 'green' aspects of a product normally backfires and doesn't help sales. Stressing the regular benefits (experience, performance, price) does (Charter et al., 2002). And if additionally you can say your product is green, fine- but do not expect the customer to pay a high premium for that. The main driver for firms to 'green' their products seems not so much direct user awareness, but the desire to be ahead of problems, implement easy win-wins's, comply with regulations like EuP, ROHS and WEEE, and avoid risks of scandals,.etc. See e.g. GBG, 2004.

[7] Currently, under management of TNO, the ESTO network executes a study into priority setting of environmental impacts of products for the EU's Integrated Product Policy (the EIPRO Project; Tukker et al., 2004). This study has reviewed all major studies performed thus far, that inventoried the life-cycle impacts related to final consumption activities. The EIPRO project aims to develop the first EU-wide environmental input-output table. In order to avoid duplication of work, this CA will directly use the results of the EIPRO project and hence has no special Work Package into environmental priority setting of consumption domains or –activities – this information simply is available at the start of the CA.

Table 3.1: Life cycle environmental impacts per final consumption activity/domain (source: EIPRO and TOOLSUST projects)

Final consumption domain	**Approximate contribution to indirect and indirect energy use**[8]	**References**
Feeding	20%	ASBL/VITO (2003); Bio/O2(2003); Nijdam and Wilting (2003), Kok et al. (2003), Tukker et al. (2004)
Mobility (car use, transport for holidays, etc.)	20%	
In house energy use (house heating and lighting, personal care, clothes washing)	40%	
Other	20%	
Total	100%	

Second, the project takes a **systems view** to production and consumption and the role of creating user awareness as a vehicle to sustainability. This implies involvement of the following **knowledge communities** (see figure 2.4):

a) Content-oriented: Business development, (sustainable) system and solution design, consumer behaviour, policy instruments;
b) Domain-oriented: Mobility, agro-food and energy/electronics.

Each knowledge community is represented by at least one **project partner** (functioning as work package leader) and a number of **members**, representing EU-wide excellence in the field. Among the members will be also relevant **representative organizations** (e.g. consumer and trade organizations, ecolabelling institutions) .

Third, the need to have an effective interchange between **theory** and **practice** leads to the following main structure of the project[9]:

1. There will be a first preparatory phase where the **concepts** for understanding the relation between user awareness and sustainable consumption are clarified. This is mainly the (combined) task of the content-oriented knowledge communities that cover all elements of the value chain (see a) above)
2. After that, there will be a phase where the focus is more on the **empirical validation** of these concepts and their potential implementation. Here, industry- and consumer-oriented domain specialists will take the lead role (see b) above). In a CA, this validation cannot be done by experiments but must comprise of:
    a. Gathering *cases on sustainable consumption*
    b. Analysing the *success and failure factors*

[8] Direct energy use is energy used during the activity (e.g. gas used for cooking food). Indirect energy use is energy use in earlier life cycle stages (e.g. energy used for farming crops). These specific data are derived from the Toolsust study, but all other studies referred to confirm these priorities and these order of magnitude of environmental impact. Of course the cited studies give more detailed specifications of which final consumption activities lead to which environmental impact.

[9] On the surface, we present here a rather linear model of research (concept development followed by empirical validation). The experiences in many previous projects (e.g. HiCS, SusProNet, etc.) show that in practice this is often a circular process: concepts are developed in an initial stage; empirical information leads to an adaptation of concepts; which in turn calls for different empirical information, etc. In practice hence this project will have a continuous interaction between concept development and practice; we foresee, however, an initial stage where the content-oriented specialists will have a dominant role, and a second stage where the domain-oriented specialists will have a dominant role.

c. Determining when *user awareness* in combination with *informative (policy) instruments* were decisive for success
d. Analysing examples of how such *informative instruments* for user awareness can be most effectively implemented, both in the relation between industry and user, and in this relation plus government.

3. Finally, an **integration** of lessons learned from the concept and empirical validation phases will take place under management of the project co-ordinator with all WP leaders involved.
4. Frequent workshops and conferences will ensure involvement of a much wider community than the about 30 members and WP leaders. Generic activities include Management and Communication/Dissemination. Last but not least, a specific Work package will analyse how a structural EU SCP community can be set up after the end of EU funding.

Figure 3.1 and 3.2 reflect the approach and focus per workshop/conference.

Conclusions

Sustainable consumption and production is a priority for environmental policy makers world wide. The EU will support a network under its 6th Framework Program, for the period 2005 until 2007. The project is organized around a series of workshops and conferences that bring together experts from totally different disciplines, in order to discuss the development and implementation challenges related to SCP structures in the fields of mobility, agro-food, and energy/electronics. The project must result in (see figure 4.1):

1. Generating and disseminating best practice
2. Programming research
3. Input into policy
4. Exploitation and dissemination/Permanent network building.

More specifically, the project will generate an extensive case database on SCP, including the drivers and barriers to implementation, and related policy implications.

Figure 3.1: Structure of Activities

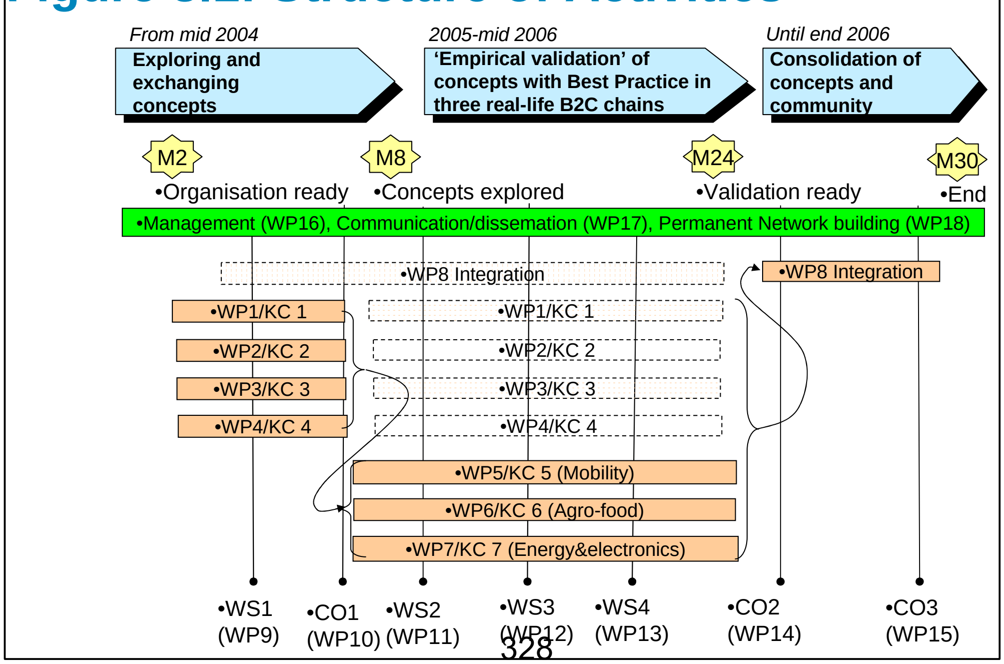


Figure 3.2: Focus per Event

Workshop 1	General platform for exchange of views how to realise sustainable consumption structures between the 33 Participants and Partners, from their own knowledge background.
Conference 1	Goals: •Launch the network in the EU arena •Provide a broad platform for conceptual exchange •Provide a broad platform for SC case presentation s
Workshop 2	WS2-4 are organised giving consumption domains centre stage. WS2 starts with discussing 5-10 SCP cases per domain from the 4 knowledge perspectives, analysing success- and failure factures, re-design potential, and danger of rebound effects
Workshop 3	WS3 abstracts the lessons of WS2 to a higher level, leading to concepts models and case typologies of successful implementation approaches for sustainable consumption in relation to user awareness
Workshop 4	WS4 focuses on the implementation tools for successful approaches (e.g. how to organise information management for user awareness)
Conference 2	Conference 2 validates the results of the project and forms a first outreach to policy, industry, certification organisations and other bodies relevant for implementation
Dissemination event	The dissemination event is meant to disseminate the full lessons of the project to all relevant extermal parties.

Figure 4.1: Key results to be generated

Main header	Result
1. Generating and disseminating best practice	• Describing best practice how to organize user awareness to reach sustainable consumption (3 sectors, 3 levels of change, interplay between 4 knowledge fields)* • Dissemination across EU-25 via workshops, conferences, reports
2. Programming research	• Exchange and (informal) co-ordination of research among participants, with a focus on EU-25 but with links world-wide (over 150 fte research capacity) • Developing input in the form of a structured overview of research needs in FP6/FP7 and UNEP's SCP program
3. Platform for input into policy	•Input of 1) and 2) into the following potentially relevant policy platforms: • EU's IPP and Resource policy: insight in the role of 'soft' informative instruments such as labelling, product declarations, etc. • EU's ETAP: insight in 'willingness to consumer behaviour change' in 3 relevant sectors • EU and UNEP SCP policy platforms
4. Permanent network building	• Building a structural 'Sustainable solution' community covering SCP in collaboration with existing structures in Advisory Board (GIN, Prepare)

*Example sectors:
1. Transport
2. Agro-food
3. Energy&electronics

Levels of change in consumption:
1. Via awareness
2. Via awareness+new solutions
3. Via awareness+new solutions+ framework changes

Knowledge fields:
1. Business development
2. Strategic solution design
3. Consumer behaviour
4. Policy instruments for innovation & information

As with any project, also this project is executed by a fixed team. The main partner and participants are listed in Table 4.1. However, a co-ordination action is by nature a networking activity, and the EU also takes a high value in the fact that such network activities lead to a lasting structure. Of course these are real challenges, since the projects like these have finite budgets (implying limitations in inviting participants during the project) and a finite time span (implying that after some time the network has to stand onits own feet, which creates complexities all too well known by the GIN co-coordinators). Howe exactly we will solve these issues is yet unknown, However, it is likely that we will proceed as follows:

a. the project foresees already a number of open events, in which non-project team members can participate and present research.
b. It is likely that we will create an agenda membership' for the different working groups that make up the project, which allows non-participants to follow progress closely and to comment on interim results.
c. It is likely that from an early moment in the project, we will seek co-operation with existing network structures such as GIN and ERSCP, in order to provide for a 'soft landing' provision for the challenge to create a structural home for the SCP community. Rather than creating another society in an already diluted field of environmental scientists, we thaink that we should use our funding to get a subject on its feet, but also to enforce suitable exising structures via this opportunity.

In this early stage, how the project will roll out exactly is of course still uncertain. Yet, a good opportunity is created to put the issue of SCP (and in relation: radical innovation for sustainability) high on the agenda in the EU and to strengthen networks dealing with this topic world wide.

Table 4.1: Participants in SCORE !

Partners/WP Leaders • TNO, Delft, Netherlands • The Centre For Sustainable Design, Farnham, UK • Polytechnico di Milano – Indaco, Milano, Italy • SIFO, Oslo, Norway • Riso, Roskilde, Denmark • Vito, Mol, Belgium • Econcept, Agency For Ecology And Design Advice, Köln, Germany • Energie De France, Clamart, France **Participants and Experts *** • Aarhus School Of Business, Aarhus, Denmark • Arc Systems Research – Seibersdorf, Austria • Erasmus University – Rotterdam, Netherlands • GRAT – Vienna, Austria • IIIEE/Lund University, Lund, Sweden INETI/Cendes, Lisbon, Portugal • Institut National De La Recherche Agronomique – Paris, France	• • IÖW, Ecological Economics Research Institute, Berlin, Germany • IWOe – Hochschule St. Gallen – St. Gallen, Switzerland • Les Ateliers, Paris, France • MERIT – Maastricht, Netherlands • NTNU, (Norwegian Technical University) – Trondheim, Norway • Motorola Gmbh, Taunusstein, Germany • Spirit Of Creation, London, Uk • Sheffield Hallam University – Sheffield, Uk • SDS/Dalt, Brussels, Belgium • Technical University Delft, Industrial Design Department, Delft, Netherlands • Technical University München, München, Germany • University Of Groningen – Groningen, Netherlands • University Of Tartu – Tartu, Estonia • Utzkapeh – Netherlands/Costa Rica* • Wuppertal Institute – Wuppertal, Germany

References

Charter, M. K. Peattie, J. Ottman and M. Polonsky (2002). 'Marketing and Sustainability'. Downloadable via www.cfsd.org.uk

Global Benchmarking Group (GBG, 2004). Sustainable Product Design Forum. Seminar Proceedings, 30&31 March 2004, Amsterdam, the Netherlands

Hetwich, E. (2002), Life-cycle approoaches to sustainable consumption.
Interim Report IR-02-073. Laxenburg: International Institute for Applied System Analysis

HomeServices (undated): Website project Home Services, www.sustainable-homeservices.com

Inaba, A. (2004). What is the Practical Way to Sustainable Cosumption ? In: K. Huback, A. Inaba and S. Stagl (eds.), Proceedings International Workshop on Driving Forces of and Barriers to Sustainable Consumption, University of Leeds, March 5-6, UK.

Kazazian, T., for WWF France (2002). Il y aura l'age des choses legeres. Design and developpement durable. (The age of light things is arriving. Design and sustainable development) Victoire-Editions, Paris, France

Labouze E, Monier V, Puyou J-B. (2003). Study on external environmental effects related to the life cycle of products and services. BIO Intelligence Service and O2 France for the European Commission Directorate General Environment (Sustainable Development and Policy support).

Lasalle, D. and T.A. Britton (2003). Priceless. Turning ordinary products into extraordinary expieriences. Harvard Business School Press, Boston, USA

Manzini, E. (2002). Sustainable Solutions. New business ideas and new ideas on business. Working Paper, INDCAO, CIR.IS, Politecnico di Milano, July

Maslow, A.H. (1954). Motivation and Personality. New York: Harper and Row.

Max-Neef, M. (1992). Development and Human Needs. In: P. Ekins and M. Max-Neef (eds.): Real-life economics: Understanding Wealth Creation. London, New York: Routledge, 91-108

Montalvo Corral, C, (2002). Environmental policy and technological innovation. Why do firms reject or adopt new technologies? Edward Elgar, Cheltenham, UK, Northampton, MA, USA

Nemry F, Thollier K, Jansen B, Theunis J. (2002). Identifying key products for the federal product & environment policy. Final report. Institut Wallon de développement économique et social et d'aménagement du territoire ASBL and Vlaamse Instelling voor Technologisch Onderzoek (VITO) for the Belgian Federal Services of Environment, Department on Product Policy.

Nijdam D S, Wilting H. (2003). Milieudruk consumptie in beeld [A view on environmental pressure on consumption] Bilthoven: RIVM. (RIVM rapport 7714040004).

Pine II, B. Joseph and James H. Gilmore (1999). The experience economy. Harvard Busines School Press, Boston, US

Rotmans, J., ed. 2001, Transitions and Transition Management, The Hague: Netherlands Ministry of Spatial Planning, Housing, and the Environment.

Munch Andersen, M. (2002). Organising Interfirm Learning: As the Market Begins to Turn Green. In: Th. de Bruijn and A. Tukker, Partnership and leadership, Building Allicances for a Sustainable Future, Kluwer Academic Publishers.

Rixt K, Falkena H-J, Benders R, Moll H C, Noorman K J. (2003). Household metabolism in European countries and cities - Comparing and evaluating the results of the cities Fredrikstad (Norway), Groningen (The Netherlands), Guildford (UK), and Stockholm (Sweden). Toolsust Deliverable No. 9. Groningen: Center for Energy and Environmental Studies, University of Groningen. (www.toolsust.org).

Sagal. J. (2004). How Much Money do We Need in The Affluent Society? In: K. Huback, A. Inaba and S. Stagl (eds.), Proceedings International Workshop on Driving Forces of and Barriers to Sustainable Consumption, University of Leeds, March 5-6, UK.

Tukker, A. (TNO), G Huppes (CML), M. Van Holderbeke (VITO), P. Nielsen (DTU) (2004), Environmental Impacts of Products. Report Step 2: Evaluation of existing studies and consequences for method development. Interim report of the European Science Technology Observatory (ESTO), available via TNO, Delft, Netherlands, or JRC/IPTS, Seville, Spain.

Vlek, C.A.J., A.J. Rooijers and E.M. Steg. (1999). Duurzamer Consumeren: Meer Kwaliteit van Leven met Minder Materiaal? (More Sustainable Consumption: More Quality of Life with less Material?). Research report for the Dutch Ministry of Environment. COV, Groningen University, Groningen, the Netherlands

UNEP, 2002.: Product Service Systems and Sustainability. Opportunities for Sustainable Solutions. UNEP-DTIE, Paris, France

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