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Red, Yellow, and Green: A psychological perspective on car purchase and implications for subsequent car use

Doctoral thesis

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ABSTRACT

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Research on consumer behaviors having high impact on natural resources and the environment is considered important for developing measures for a sustainable future. This thesis focuses on one of such consumer behaviors – purchases and use of new passenger cars.

The primary aim of the thesis is to examine the effects of socio-psychological factors in individuals' car type choice. The thesis also investigates possible rebound effects as well as psychological spillover effects from the purchase stage to the subsequent use stage. Following a review of economic models explaining car purchase and socio-psychological theories explaining pro-environmental behavior, a range of potential determinants of individuals' choice of cleaner cars are identified. To test the influence of these potential determinants, a pilot study was carried out in in 2011 using online survey. A larger quantitative data collection was then conducted in 2012 using similar online survey. For both data collections, Norwegian car owners who had recently purchased a new passenger car for private use were contacted.

The results show that normative and intentional processes and brand loyalty are significant determinants of choosing a more fuel-efficient car type after controlling for socio-demographic factors. At the same time, high levels of environmental concern and altruistic values are observed while perceived social pressure and intrinsic motives are low among car buyers. The results, in general, indicate manifold motivations of car buyers. Moreover, the results show some signs for direct rebound effects in terms of average household car ownership and frequency of car use among adopters of battery electric cars. Finally, the research also indicates the positive traces of psychological spillover effects from potential psychological determinants of car purchases on their respective pendants from car use. Based on the results, it is suggested to reevaluate the Norwegian government policy, and to design further solutions in order to best influence behavior change in the long-term.

NORSK SAMMENDRAG

Rødt, Gult, og Grønt:
Et psykologisk perspektiv på bilkjøp og implikasjoner for påfølgende bilbruk

Forskning på ulike typer forbrukeratferd som har stor innvirkning på miljø og bruk av naturressurser anses som et viktig grunnlag for å kunne utvikle tiltak for en bærekraftig fremtid. Denne avhandlingen fokuserer derfor på én type forbrukeratferd, nemlig anskaffelse og bruk av nye personbiler.

Hovedmålet med avhandlingen er å undersøke effekten av sosio-psykologiske faktorer som påvirker individers valg av biltype. Utover dette undersøker avhandlingen rebound-effekter og psykologiske spillover-effekter, fra anskaffelsesstadiet til det påfølgende bruksstadiet. Etter en gjennomgang av økonomiske modeller som forklarer bilkjøp, og av sosio-psykologiske teorier som er relevante for å forstå miljøvennlig atferd, er et utvalg av potensielle determinanter som har betydning for individers valg av mer miljøvennlige biler identifisert. For å teste innflytelsen av de potensielle determinantene ble en pilotstudie utført i 2011 ved hjelp av internettbaserte spørreundersøkelser. En større kvantitativ datainnsamling ble deretter gjennomført i 2012 med lignende metoder. Begge datainnsamlingene er basert på informasjon innhentet fra norske bileiere som nylig hadde kjøpt en ny personbil til privat bruk.

Etter kontroll for sosio-demografiske faktorer viser resultatene at normative og intensjonelle prosesser samt merkelojalitet er signifikante determinanter for å velge en mer drivstoffbesparende biltype. Blant bilkjøperne er det også observert høye nivåer av miljøbevissthet og altruistiske verdier, og lave nivåer av ytre sosialt press og indre motiver. Generelt indikerer resultatene mangfoldige motivasjoner blant norske bilkjøpere. Forøvrig viser resultatene noen tegn til direkte rebound-effekter med hensyn til gjennomsnittlig antall biler per husholdning og hyppighet av bilbruk blant elbileiere. Til slutt antyder resultatene også positive spor av psykologiske spillover-effekter fra potensielle psykologiske determinanter som påvirker individers bilkjøp på sine respektive anheng som har innflytelse på individers bilbruk. På grunnlag av disse resultatene, er det forslått å revurdere den norske regjeringens politikk, og å utforme ytterlige løsninger for å best mulig kunne påvirke atferdsendringer på lengre sikt.

LIST OF PUBLICATIONS

The following published papers are included in the thesis. The author would like to thank peers and reviewers for the comments during the publication process.

Paper I

Nayum, A., Klöckner, C. A., & Prugsamatz, S. (2013). Influences of car type class and carbon dioxide emission levels on purchases of new cars: A retrospective analysis of car purchases in Norway. *Transportation Research Part A: Policy and Practice*, *48*(A), 96-108.

Paper II

Nayum, A., Klöckner, C. A., & Mehmetoglu, M. (2016). Comparison of socio-psychological characteristics of conventional and battery electric car buyers. *Travel Behaviour and Society*, *3*, 8-20.

Paper III

Nayum, A., & Klöckner, C. A. (2014). A comprehensive socio-psychological approach to car type choice. *Journal of Environmental Psychology*, *40*, 401-411.

Paper IV

Klöckner, C. A., Nayum, A., & Mehmetoglu, M. (2013). Positive and negative spillover effects from electric car purchase to car use. *Transportation Research Part D: Transport and Environment*, *21*, 32-38.

TABLE OF CONTENTS

SYNOPSIS

Considering the importance for developing measures for a sustainable future, assessment of direct and indirect environmental impacts of products have previously been carried out using various sophisticated tools and indicators (e.g., Finnveden & Moberg, 2005; Ness, Urbel-Piirsalu, Anderberg, & Olsson, 2007). Consistent findings indicate that transport is a major contributor to consumption-related environmental impacts (Hertwich, 2005a; Tukker & Jansen, 2006). Among measures to reduce environmental impacts from transport, increasing the amount of cleaner cars in the total car fleet is identified as one of the most significant pathways (de Haan, Peters, & Scholz, 2007; Hickman, Ashiru, & Banister, 2010; Metz et al., 2007; Peters, 2009; Turcksin, Mairesse, & Macharis, 2013).

The goal of this thesis is thus to investigate the effects of various socio-psychological factors in consumers' choice of car type and use. The primary focus is to integrate determinants identified by choice modelling studies (Dargay, 2001, 2002; Whelan, 2007) with determinants put forward by various socio-psychological theories (e.g., Ajzen, 1985, 1991; Aarts, Verplanken, & Knippenberg, 1998; Schwartz, 1977; Schwartz & Howard, 1981; Stern, 2000; Stern et al., 1999; Triandis, 1977, 1979) to understand purchase or adoption of cleaner cars (e.g., more fuel-efficient cars and/or battery electric cars). As the initial purchase decision typically affects the post-purchase behavior, the thesis also examines possible rebound effects (Berkhout, Muskens, & Velthuijsen, 2000; Hertwich, 2005b) at the post-purchase stage, as well as possible psychological spillover effects (Thøgersen, 1999a; Thøgersen & Ölander, 2003) from the purchase stage to the subsequent use stage.

By reviewing economic models on car purchase, and socio-psychological theories and research papers in pro-environmental behaviors, two self-administrated questionnaires were developed. The first questionnaire focused on purchase of new passenger cars, and the second questionnaire addressed car use. The psychometric properties of the psychological measures included in the questionnaires were examined through a pilot study using an online survey in 2011.

The first study in this thesis reports the findings of the pilot study. Based on self-reports of 232 car owners who had purchased a new passenger car for private use, the study tests an integrative model for choice of car type class, which is obtained through a latent class cluster analysis approach based on the latest purchased car's features. The results show that the purchased car's Carbon dioxide (CO_2) emissions are strongly determined by the car type class. Being female and living in the suburbs strongly predict choosing a car with low CO_2

emissions. Additionally, the intention to purchase a more fuel-efficient and environmentally friendly car result in having a strong direct impact (i.e., not mediated by car type class) on choosing cars with less CO_2 emissions. The intention itself is strongly predicted by psychological factors from intentional and normative processes. While no significant effects of intention and household income on choice of car type class is observed, car buyers' education level, location of residence, brand loyalty (operationalized as repeated past purchase frequency), household size and perceived behavioral control over buying more fuel-efficient and environmentally friendly car indicate substantial influence on the choice of a certain car type class. Nevertheless, under the condition when psychological factors are controlled for, the impacts of sociodemographic factors on choice of car type class are small. The results seem thus to imply that instead of making car purchase decision within traditional car size class boundaries, individuals narrow down their choice within certain car type class through considering important car features. Once a car type class with valued car features is identified, their beliefs, attitudes, norms and intention affect whether they consider a car with less CO_2 emissions within that car type class.

Based on the results of the pilot study, the items in the two self-administrated questionnaires were revised to improve clarity, reliability and validity. A larger data collection was then carried out in 2012 using the improved questionnaires among conventional passenger car owners and an extra sample of battery electric car owners. Using the dataset from the questionnaire on the purchase of new passenger cars, the second study investigates socio-psychological profiles of five conventional car buyer groups and a group of battery electric car buyers. The groups of conventional car buyers are differentiated according to car type classes, which are obtained following a similar classification approach as used in the first paper. Results reveal that different socio-psychological profiles exist within conventional passenger car buyers, and between conventional passenger car buyers and battery electric car buyers. The apparent mismatch found between the high level of environmental consciousness and the low level of normative concerns among all car buyer groups suggest a possible crowding-out of consumers' intrinsic motivations (Frey & Oberholzer-Gee, 1997; Frey & Stutzer, 2006) by the current incentives provided by the Norwegian government.

The third study tests a more comprehensive version of the integrated car type choice model based on the results from previous two studies above. The same dataset, as analyzed in the second study, is used to examine impacts of various socio-psychological variables on purchase of a more fuel-efficient car. The results indicate that the intention to purchase a more

14

fuel-efficient and environmentally friendly car has the strongest positive impact on choosing a car from the more fuel-efficient car category, and all other intentional and normative variables have their impacts mediated through the intention. While the perceived importance of environmental attributes of the car has a very strong positive influence on the intention, the perceived importance of convenience and performance attributes negatively affect the intention. In addition, brand loyalty has a strong negative influence on purchasing a car within a more fuel-efficient car category. Finally, demographics and household characteristics turn out to have low-to-medium level of impact on the individuals' purchase of a more fuel-efficient car. The results thus provide policy makers with information that might be essential for influencing behavior change in the long-term.

The forth study yields an examination of rebound and spillover effects from battery electric car purchase to its use. In addition to the dataset used in the second study, the dataset from the questionnaire on car use, which was also collected in 2012, is analyzed. The psychological variables included in car use questionnaire are operationalized as close to their counterparts in car purchase questionnaire as possible. The results indicate possible signs of a direct rebound effect in terms of an increased number of cars per household and a higher car use frequency, but not in terms of expected annual mileage. In addition, potential psychological determinants show a high correlation between the purchase and use stages, hinting potential psychological spillover effects. However, motivations to reduce car use are generally lower among battery electric car owners compared to conventional passenger car owners. The results hence imply that strategies encouraging adoption of cleaner cars need to consider variables affecting post-purchase behavior in order to gain desired effect.

INTRODUCTION

As an important part of the production-consumption chain, individuals affect the natural resources and environment through their day-to-day choices of which goods and services to buy and how to use them. Despite the natural resource depletion and environmental pressure caused by each individual being small compared to those caused by production activities, one might argue that millions of individual consumers ultimately are the cause for those production activities (Peters & Hertwich, 2008). They are thus major contributors to the problems such as energy issues, global climate change, air pollution, water pollution, land use, and waste generation (OECD, 2002). Evidence has also confirmed this by identifying households as one of the largest sectors contributing to energy use and carbon emissions (Hertwich, 2005a; Vandenbergh et al., 2010). Therefore, individual consumer behavior constitutes an important target for interventions aiming at sustainable consumption (Holden & Norland, 2005).

Nevertheless, individual consumer behavior relates to a wide range of domains. Consequently, interventions aiming to realize sustainable consumption will only be effective if (i) the areas that are responsible for the largest proportion of consumption-related environmental impacts are prioritized (Spangenberg & Lorek, 2002; Tukker, Cohen, Hubacek, & Mont, 2010), and (ii) consumption patterns in the priority areas are subjected to a combined set of intervention measures (Abrahamse, Steg, Vlek, & Rothengatter, 2005, 2007; Jansson, 2009; Peters, 2009; Steg & Vlek, 2009).

In order to identify priority areas and products, environmental scientists have developed various sophisticated tools, methods, and indicators (Finnveden & Moberg, 2005; Ness et al., 2007). These methods deploy fundamentally different data-inventory methods, for example bottom-up life-cycle assessment versus top-down input-output analysis, and have used a range of measures to estimate impacts (Tukker et al., 2008). Investigators have also focused on different geographical areas, ranging from the local to the global and covering different pollutants and resources and various product clusters (EEA, 2005; Hertwich, 2005a; Tukker, 2006; Tukker et al., 2006; Weidema et al., 2005; Weinzettel et al., 2014).

Despite the methodological variations, the main findings of this body of work are clear and consistent (Tukker et al., 2008). Transport, food, and home building and demolition are responsible for the largest proportion of consumption-related environmental impacts. Specifically, energy, planes and cars have the highest emissions intensities (Hertwich, 2005a; Tukker & Jansen, 2006). These domains, in aggregate, account for 70% to 80% of the life

17

cycle environmental impacts of households' final consumption expenditure in industrialized countries (Holden, & Norland, 2005; Tukker et al., 2008).

Given that road transportation is the largest fossil energy consumption sector in the world (EEA, 2007; IEA, 2011), it is typically viewed as the most dominant contributor to CO_2 emissions that increase global warming (Pachauri & Reisinger, 2007). Within transport, cars (i.e., fuel, and purchase and operation of cars) are currently seen as the most dominant contributor to environmental impacts of the road transportation (Hertwich, 2005a; Tukker & Jansen, 2006). Furthermore, ever increasing private car ownership and passenger-kilometers by households further deteriorate problems such as dependency on fossil fuels (IEA, 2008), emissions of toxic chemicals (EPA, 2005), increased respiratory diseases (WHO, 2004), and traffic noise (EEA, 2000).

Given that the right purchase decision of a product is proposed to reduce, and even eliminate, the negative impacts in the post-purchase stage of the consumption cycle (Thøgersen, 1999b), the initial purchase decision about what type of car to choose could have a significant effect on efforts to decrease the negative impacts from road transportation (Kågeson, 2005; Scown et al., 2013; Thiel, Perujo, & Mercier, 2010). Consequently, increasing the amount of cleaner cars (i.e., cars equipped with improved internal combustion engine, cars with hybrid powertrain, and cars on alternative fuels and drive trains) in the total car fleet is identified as one of the most significant pathways to reduce the negative impacts from the road transportation (de Haan et al., 2007; Hickman et al., 2010; Metz et al., 2007; Peters, 2009; Turcksin et al., 2013).

Understanding Car Purchase

Identification of car purchase, more specifically purchase of cleaner cars, as a priority focus area, is an important step towards tackling current challenges our modern society faces from road transportation. To handle the challenges efficiently, however, a combined set of intervention measures needs to be designed and implemented (Abrahamse et al., 2005, 2007; Jansson, 2009; Peters, 2009; Steg & Vlek, 2009). For this purpose, we need to identify, examine and evaluate factors affecting individuals' uptake of cleaner cars.

Given that the purchase of a new car generally involves substantial costs, it is often suggested that individuals make their decision by carefully evaluating all available options and associated costs (Heffner, Kurani, & Turrentine, 2007a, 2007b). Therefore, individuals should be responsible for the sustainability of their consumption pattern (Norwegian Ministry

of Environment, 1994). Meanwhile, the argument for individual responsibility needs to be carefully balanced when "macro conditions exist which can be blamed for contributing to the problem or constraining the effectiveness of individual efforts" (Roberts & Bacon, 1997, p. 89). The macro conditions involve a wide range of factors such as economic conditions, government policies and regulations, technological developments and innovations, social and cultural changes, and population demographics, all of which often have significant influence on what we buy (Gatersleben & Vlek, 1998). Therefore, it seems that an individual's deliberation about what type of car to buy and what type of car not to buy is limited by the macro-level conditions. To put it in another way, car buyers are most of the time 'locked in' to unsustainable consumption patterns through macro-level conditions, such as the incentive structures, institutional barriers, and restricted choices (Jackson, 2005).

Changing the macro-level conditions in which individuals make their decisions, for instance through financial rewards, laws, or the provision of alternative fuel cars, hybrid cars and electric cars, could thereby most likely alter the pay-off structure, make alternative options more attractive, create better opportunities, and strengthen individuals' abilities to adopt such cars (Coad, de Haan, & Woersdorfer, 2009). Nevertheless, the empowerment of individual car buyers only makes it possible for consumers to take responsibility for the environmental and ethical consequences of their choices and behavior. "It is not sufficient to make them do it, or to explain why they do it" (Thøgersen, 2005, p. 159). In addition, introducing financial benefits and hence putting a price tag on the environment is a risky approach to address the problems society faces (Coad et al., 2009). They may 'crowd-out' consumers' intrinsic motivations (i.e., motivation to act coming from within the individual) to contribute voluntarily to the protection of natural resources and the environment (Frey & Oberholzer-Gee, 1997; Frey & Jegen, 2001; Steinhorst, Klöckner, & Matthies, 2015).

These arguments point toward the complexity and difficulty associated with negotiating any attempt at a transition toward a more environmentally friendly car fleet. They place an emphasis on the need for effective strategies to manage the social and institutional context (macro-level factors), as well as attempting to affect individual behavioral antecedents (micro-level factors) such as motivational factors (e.g., preferences, beliefs, attitudes, norms, and expectations) directly (Lane & Potter, 2007). Despite the diversity of viewpoints, some basic insights can be inferred, most notably perhaps with respect to the interdependence of micro-level and macro-level factors, which shape and re-shape conditions for car purchase (Lane & Potter, 2007). It is therefore apparent that the purchase and ownership of cleaner cars is indeed complex, and cannot be explained solely by macro-level factors such as financial

19

factors or government policy and incentives (Jansson, 2009; Peters, 2009; Ozaki & Sevastyanova, 2011; Turcksin et al., 2013). Therefore, to better understand consumers' motivations behind car purchase, there is a need to examine the effects of both macro-level conditions and micro-level or internal factors in detail.

Although the micro-level or internal factors such as motivational factors, abilities, opportunities, and habits or routines have been conceptualized to mediate the relationship between macro-level factors or external conditions and actual behavior (Black, Stern, & Elworth, 1985), those micro-level factors could only yield the desired outcome when the facilitating context (i.e., macro-level condition) is evident. Therefore, the existence of a facilitating context is viewed as crucial for consumers' car type choice. Accordingly, an overview of the Norwegian context, within which this research on consumer car purchases was carried out, is presented in the following section, together with its implication for methodological choices made in the research.

Context: Norwegian Passenger Car fleet and Government Policy

Passenger Cars in Norway

In the last 10 years, the Norwegian passenger car-fleet has changed significantly with regard to size, composition and average age of the cars. By the end of 2004, the number of passenger cars was about 1.98 million. With about 4.6 million inhabitants in 2004 (Statistics Norway, 2004), the number of passenger cars per 1000 inhabitants was 432. As shown in Table 1, about 87% of these were powered by gasoline.

Table 1: Norwegian passenger car fleet and its composition, end of year 2004 – 2014

End of year	Gasoline	%	Diesel	%	Electric	%	Other*	%	Total	Average age
2004	1720982	87.0 %	254828	12.9 %	1106	0.1 %	30	0.0 %	1977922	10.2
2005	1710987	84.3 %	315626	15.6 %	1243	0.1 %	37	0.0 %	2028909	10.2
2006	1693051	81.2 %	388572	18.6 %	1417	0.1 %	66	0.0 %	2084193	10.2
2007	1645622	76.4 %	506540	23.5 %	1457	0.1 %	111	0.0 %	2154837	10.2
2008	1596852	72.7 %	597391	27.2 %	1693	0.1 %	171	0.0 %	2197193	10.3
2009	1550434	69.1 %	690560	30.8 %	1776	0.1 %	178	0.0 %	2242948	10.4
2010	1500841	65.0 %	804384	34.9 %	2068	0.1 %	192	0.0 %	2307485	10.5
2011	1448232	61.0 %	922986	38.9 %	3909	0.2 %	238	0.0 %	2375365	10.5
2012	1408198	57.7 %	1025220	42.0 %	8031	0.3 %	410	0.0 %	2441859	10.5
2013	1368625	54.8 %	1110621	44.4 %	17770	0.7 %	2175	0.1 %	2499191	10.5
2014	1328380	52.0%	1186194	46.4%	38652	1.5%	1135	0.0%	2554361	10.5

* Other passenger car can be fuelled by gas, hydrogen, paraffin, and others.
Data Source: Statistics Norway (2010a, 2014a), own adaptations

Since 2004, the Norwegian passenger car-fleet has been growing at an annual average rate of 2.6%, which resulted in a total number of about 2.55 million passenger cars running on Norwegian roads by the end of 2014. While the proportion of gasoline-powered passenger cars has gradually decreased, dropping to about 54% in 2013, passenger cars with diesel motors have enjoyed a steady increase over the years. As illustrated in Figure 1, strong sales of diesel-powered passenger cars in 2007-2011, contributed to a record high of 44% of Norway's passenger car fleet being powered by diesel in 2013 and this accounted for 72-76% of the new registered passenger cars (Norwegian Road Federation, 2014). Meanwhile, the average age of passenger cars in Norway has increased gradually during the last 10 years.

Figure 1: New registered passenger cars 2004 - 2014, distributed on fuel type
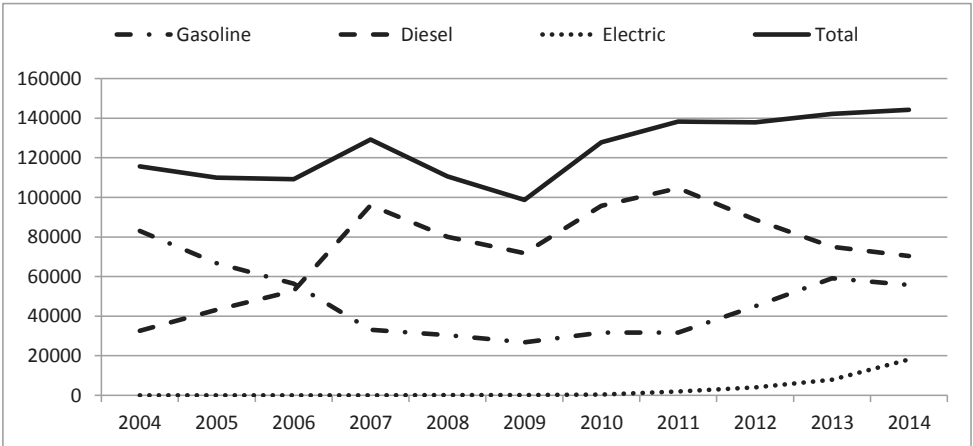
Data source: Norwegian Road Federation (2014), own adaptations

Although passenger cars powered by gasoline and diesel have dominated the Norwegian passenger car-fleet for years, the number of battery electric cars has been rising substantially in recent years, as presented in Table 1 and Figure 1. Specifically, Norway's battery electric car market share rose from 1.4% in 2011 to 2.9% in 2012 and reached 5.5% of new car sales in 2013 (Norwegian Road Federation, 2014). Among the top selling countries of battery electric cars in 2012, Norway was ranked 5th with a 7% market share of global sales (IEA, 2013). With 38,652 battery electric cars, and about 5.1 million inhabitants by the end of 2014 (Statistics Norway, 2014a, 2014b), the market penetration reached about 7 battery electric cars per 1000 inhabitants.

It is important to note that a large proportion of the newly registered passenger cars in Norway are owned by corporations and public organizations. As indicated in Figure 2, at least

40% of the new registered passenger cars in Norway in 2009-2013, were registered as the property of corporations and public organizations. The reason behind this increase compared to previous years can be found in the Norwegian government tax regulations that make it advantageous for corporations and public organizations to own/lease new cars. Although understanding the consumer behavior of corporations and public organizations is important regarding changes in size and composition of the passenger car-fleet, the scope of this thesis is limited exclusively to the area of private car buyers. The justification for this choice lies in the reasoning that organizational purchasing is carefully controlled by bureaucratic procedures (Stuart, Sarrell, Guinipero, & Kolchin, 1991), whereas for private consumers, there is no such constraint.

Figure 2: New registered passenger cars 2005 - 2014, distributed on ownership type
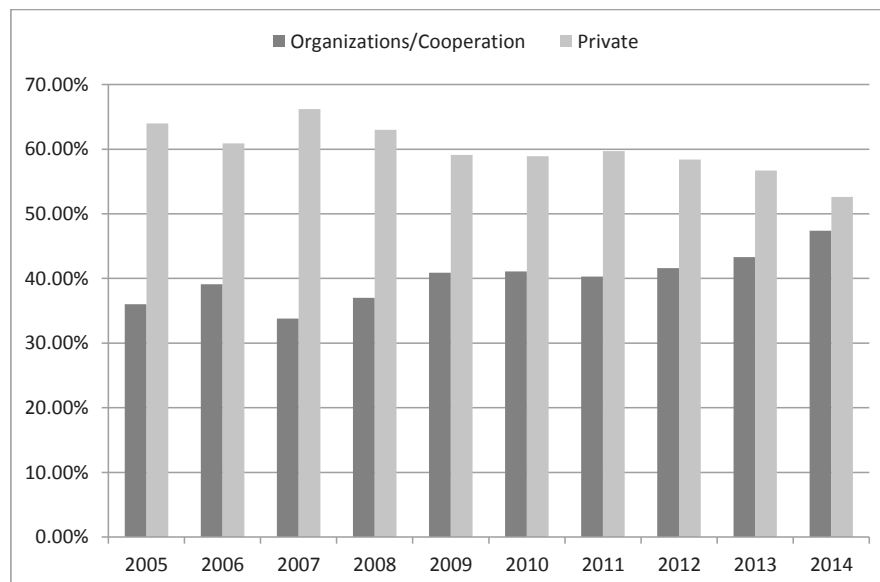
Data source: Norwegian Road Federation (2014), own adaptations

Tax Regulations and Incentives in Norway

The aforementioned changes in the Norwegian passenger car-fleet are closely associated with a number of strategies attempted by the Norwegian government, which aimed at encouraging new car buyers to purchase cars defined as more environmentally friendly than others. Much focus on this encouragement has been put on creating financial incentives for different types of cars in different time periods.

To purchase a new passenger car, one-off registration tax, which must be paid when the car is first registered in Norway, is the most relevant government regulation impacting consumer choice. Rather than economic efficiency, it was the revenue-raising considerations that have motivated the introduction of the current one-off registration tax. The tax was calculated based on the car's unladen weight, engine displacement, and power. These values were further differentiated into four categories with different tax rates (Norwegian Directorate of Customs and Excise, 2004). Consequently, the tax punishes heavy, big engine, and powerful cars. Due to a poorer power-to-weight ratio than the gasoline engine, average diesel engine cars tend to be heavier than their counterparts with similar power. This difference resulted in the continued domination of gasoline-engine cars in the Norwegian passenger car-fleet up until 2007 (see Table 1).

With an increasing focus on the threat of climate change, a major modification of the one-off registration tax was introduced from January 1, 2007 (Norwegian Directorate of Customs and Excise, 2007). The amount of CO_2 emitted per kilometer (km) driven replaced engine displacement while calculating the one-off tax. The tax rates levied per passenger car were thus calculated based on the car's unladen weight, power, and the amount of CO_2 emitted per kilometer (km) driven, and each of which was further differentiated into four categories where different tax rates were applied. Given that modern diesel engines produce less CO_2 emissions than gasoline engines, buyers of diesel-powered passenger cars were rewarded, i.e. they paid less one-off registration tax than buyers of gasoline engine cars. As a result, a drastic increase of diesel-fueled passenger cars in the Norwegian new car registrations was observed in 2007, as portrayed in Figure 1.

Further changes regarding CO_2 emissions were implemented from January 2009 (Norwegian Directorate of Customs and Excise, 2009). While a deduction of NOK 500 per g/km for cars with CO_2 emissions below 120 g/km was introduced as the incentive for environmentally friendly cars, an additional (NOK 500 per g/km) high rate for cars with CO_2 emissions above 250 g/km was applied. The changes in regulations resulted in a relatively low percentage of gasoline-powered passenger cars in the Norwegian new car registration between 2007 and 2011, as illustrated in Figure 1.

A more recent government attempt to influence car buyers concerns the tax rates for Nitrogen oxide (NOx such as mono-nitrogen oxides NO and NO2 [nitric oxide and nitrogen dioxide]) emissions, with a greater tax rate reduction for cars with CO_2 emissions below 50 g/km (Norwegian Directorate of Customs and Excise, 2012). From 1 January 2012, NOx emissions were introduced as another component in calculating one-off registration tax in

order to tackle local air pollution. Meanwhile, an extra high deduction rate (NOK 850 per g/km) for cars with CO_2 emissions below 50 g/km was implemented. These changes in the one-off registration tax have led to a significant drop of diesel-powered passenger cars in the Norwegian new car registrations from 2012.

Although gasoline-powered passenger cars were increasingly purchased in response to the changes in the regulation, a visible increase of battery electric cars in new passenger car registration was evident. This is because of a range of financial and non-financial benefits offered for battery electric car buyers. Battery electric cars are not just exempt from of one-off registration tax and VAT (Norwegian Directorate of Customs and Excise, 2013), but also do not pay road tolls. They have free access to bus lanes, municipal parking areas, and public charging stations that are already made available in large cities and will be built along main national roadways (Norwegian EV Association, n.d.).

Due to this incentive structure, the market for battery electric cars is developing exceedingly rapidly in Norway. Between 2011 and 2012, battery electric car sales grew by 120%, and battery electric cars constituted 3% of new cars sold in Norway each month (Norwegian Road Federation, 2014). For three months at the end of 2013, battery electric car models, such as the Tesla S and Nissan Leaf, were the best-selling models among all cars sold in Norway, beating popular conventional fuel cars such as the Volkswagen Golf (Norwegian Road Federation, 2014). According to the current legislation, tax advantages and related benefits for buyers of environmentally friendly cars, such as alternative fuel and/or battery electric cars, will last until 2017 or until the 50,000 zero emission vehicles in Norway target is reached (Norwegian Ministry of Transport and Communications, 2013). However, more recent political debate casts doubt on whether various benefits should be continued given that there are presently more than 50.000 battery electric cars running on Norwegian roads in 2015.

To summarize, tax regulations and incentives implemented in Norway make the country one of the few OECD countries to apply the highest tax rates for (very) high-emission cars while applying negative tax rates (i.e., provide subsidies) for cars with low CO_2 emissions per km driven (Braathen, 2012). Notwithstanding the important role of the government's attempts at shaping the composition of the Norwegian passenger car-fleet, a recent report form the Norwegian Institute of Transport Economics (Figenbaum, Eskeland, Leonardsen, & Hagman, 2013), concluded that the market driven sales of low-emission cars and technologies together with current incentive structure are too slow to achieve the government's 85 g/km target by 2020. Therefore, further management of consumer demand appears essential.

To manage consumer demand (e.g., to increase the amount of more fuel-efficient and environmentally friendly cars), however, requires not only the technological development (e.g., hybrid powertrains, rechargeable battery packs and electric motors, fuel-cell technology, and clean diesel) and government incentives (e.g., progressive one-off registration tax rates, incentives for low-emission cars, tax exemption for battery electric cars and other operating benefits), but also a closer understanding of micro-level factors or internal variables that are proposed to affect individuals' purchase decision to a large extent (Stern, 2000).

Micro-level Variables Identified by Traditional Economic Approach to Car Purchase

Traditionally, research investigating factors affecting consumers' car purchase and ownership have been primarily carried out by economists and market researchers. In consumer research literature, the role of economic and demographic factors on the purchase and ownership of cars have been presented by studies based on economic models such as aggregated models, cohort models, and disaggregated microeconomic models (see de Jong et al., 2004).

Using aggregated data at national or local levels, some economists and market researchers have proposed methodologies to forecast car ownership (Mogridge, 1983, 1989; Tanner, 1978). The projections are often based on econometrically estimated models that explain car ownership as a function of per-capita income or gross domestic product (Dargay & Gately, 1999; Whelan, 2001). In contrast, others propose alternative types of models that involve the use of disaggregated data (Karlaftis & Golias, 2002; Mannering, Winston, & Starkey, 2002), which are information held at the level of the individual or, since car ownership is typically viewed as a characteristic of the entire household, the household level.

By using the number and types of cars households own as dependent variables, choice modelling studies have revealed that the purchase price and fuel cost, relative preferences among car attributes (e.g., vehicle size, body type, top speed, fuel availability), socio-demographics (e.g., gender, age), income, household characteristics (e.g., size of the household, number of adults and children in the household) and residential location affect individuals' purchase decisions (Ahn, Jeong, & Kim, 2008; Brownstone, Bunch, Golob, & Ren, 1996; Brownstone, Bunch,, & Train, 2000; Caulfield, Farrell, & McMahon, 2010; Dagsvik, Wennemo, Wetterwald, & Aaberge, 2002; Dargay, 2001, 2002; Ewing & Sarigöllü, 1998, 2000; Greene, 1998; Mourato, Saynor, & Hart, 2004; Potoglou & Kanaroglou, 2007, 2008; Tompkins et al., 1998; Whelan, 2007). Among these factors, the most critical ones for adoption of cleaner cars are found to be price characteristics (Ahn et al., 2008; Caulfield et al., 2010; Dagsvik et al., 2002; Ewing & Sarigöllü, 1998; Potoglou & Kanaroglou, 2007),

followed by evaluation of car's performance and convenience attributes (Brownstone et al., 1996; Dagsvik et al., 2002; Ewing & Sarigöllü, 1998; Greene, 1998; Potoglou & Kanaroglou, 2007). Environmental benefits of cleaner cars, however, are frequently found to be of minor importance compared to other car attributes (Caulfield et al., 2010; Ewing & Sarigöllü, 2000; Potoglou & Kanaroglou, 2007).

The traditional economic models aiming to forecast car makers' market shares provide forecast mainly for the discrete choice of a car type that is usually defined by make and model, which result in categories corresponding to car size classes or car segment levels such as fastback, three door or five door compact cars, sedan, estate cars, SUVs, multi-van. (Peters, Mueller, de Haan, & Scholz, 2008). Though average energy efficiency depends on weight and car size class, a large variation in engine size, fuel type, drive system, gear type exist through and within all car segments in today's car market. As a result, average CO_2 emissions substantially differ not only between car size classes but also within car models. For example, an analysis conducted by de Haan, Mueller, & Scholz (2009) revealed that there is an average difference of 94 g CO_2/km between the most and the least efficient versions of the same car models with high sales numbers in Europe.

Given the variation in the afore-mentioned important car features between as well as within car size classes, the traditional economic models of car type choice cannot fully capture the car choice of individuals, who have now various possibilities of changing to more fuel-efficient and less CO_2 emitting cars. Subsequently, attempts were made to improve the discrete choice models of car purchase and ownership. One such attempt is made by Mueller and de Haan (2009), who introduced categories of CO_2 emissions, curb weight and rated power for eight car size classes in their agent-based micro-simulation to forecast car choice. The incorporation of relevant car features with car size classes and forecasting individuals' car choice, therefore, are considered a more realistic approach than car choice predicted by rather aggregated way on a car size class (Peters et al., 2008).

With regard to car purchase, individuals are thus believed to evaluate the material and social resources available to their households as most economic models have suggested (Dargay, 2001, 2002; Karlaftis & Golias, 2002; Mannering et al., 2002; Whelan, 2007). While economic variables of the household (e.g., household income and savings) are indicative of personal capabilities allowing or not allowing the purchase decision (Klein & Lansing, 1955), other demographics (e.g., age, occupation) and household characteristics (e.g., number of adults and children) create conditions for or against the purchase of a certain type of car

(Peters, 2009). Eventually, individuals are to narrow down their focus on a fraction of cars available in the market based on their judgement about the material and social resources.

Meanwhile, car manufacturers today offer cars in almost all car size classes that overlap in important car features such as engine size, weight, and volume. Additionally, within a traditional car size class a substantial difference exits in terms of those important car features. As a consequence, the narrowing down of a certain type of car is not as straightforward as it appears to be (Mueller & de Haan, 2009). This opens up the question of whether individuals narrow down their focus on a traditional car size class first and later incorporate important car features or whether they simultaneously consider important car features across traditional car size class boundaries.

Moreover, although socio-demographics and household characteristics are suggested to be indicative of personal capabilities and resources and thus relevant for performing a particular action (e.g., purchasing a new car) that requires certain capabilities and resources (Stern, 2000), they are not sufficient predictors of behavior. Empirical research evidences have indicated that individuals' values, beliefs, attitudes and norms also play an important role in purchase of cleaner cars (Choo & Mokhtarian, 2004; Coad et al., 2009; Jansson, 2009; Kahn, 2007; Ozaki & Sevastyanova, 2011; Peters, Gutscher , & Scholz, 2011; Turrentine & Kurani, 2007). This warrants investigation of psychological factors in relation to individuals' car purchase behavior together with the determinants put forward by the economic approach.

Psychological Factors Affecting Car Purchase

The previous argument that macro-level and micro-level (or individual) factors together determine individuals' car purchase behavior well-reflects the fact that "behavior is a function of the organism and its environment" (Stern, 2000, p. 415). In other words, all human behavior, including purchase of cars, results from an interactive function of internal variables and contextual factors (Guagnano, Stern, & Dietz, 1995).

Since cars have the highest emissions intensities (Hertwich, 2005a; Tukker & Jansen, 2006), the purchase and use of them have significant impact on natural environment or the ecosystem (Gärling & Steg, 2007). Subsequently, most of the research in this arena draws their assumptions about relationship between internal factors and purchase or adoption of cleaner cars from general research on environmentally significant behavior (Jansson, 2009; Lane & Potter, 2007; Ozaki & Sevastyanova, 2011; Peters et al., 2011). The most frequently used theoretical frameworks to explain the relationship between internal or attitudinal factors and environmentally relevant behavior are expectancy-value theories such as the theory of

planned behavior (Ajzen, 1985, 1991), and normative theories such as the norm activation theory (Schwartz, 1977; Schwartz & Howard, 1981) and the value-belief-norm theory (Stern, 2000; Stern et al., 1999), which differ in their core assumptions about direct psychological determinants of behavior (Bamberg & Möser, 2007).

The theory of planned behavior (Ajzen, 1985, 1991) states that a behavioral intention, which is "a person's subjective probability that he will perform some behavior" (Fishbein & Azjen, 1975, p. 288), is the immediate antecedent and key determinant of actual behavior (Ajzen, 1985, 1991). In the meantime, behavioral intention is formed by an expectancy-value assessment process, i.e. the persons' attitudes toward the specific behavior (i.e., a person's beliefs about the probability of consequences of the behavior and his or her assessment of these consequences), subjective norms (i.e., a person's belief about important others would approve or disapprove he or she should perform the behavior), and perceived behavioral control (i.e., a person's beliefs about the presence of factors that may facilitate or impede performance of the behavior) (Ajzen, 1991). As the attitude towards an act includes the evaluation of a certain outcome as well as the estimation of the likelihood of this outcome (Ajzen, 1991), it has been purported that salient information or factual knowledge about an issue is a necessary precondition for any attitude (Kaiser, Wölfing, & Fuhrer, 1999; Stutzman & Green, 1982). It is however suggested that "depending on the individual and the situation, these factors might have very different effects on behavioral intention" (Miller, 2005, p. 127). Ajzen (1991, 2002) further suggests that together with compatible intentions, perceived behavioral control directly predicts actual behavioral achievement.

Applying the theory of planned behavior, an individual's intention to purchase a cleaner car (e.g., fuel-efficient car and/or alternative fuel car) is therefore influenced by the following: how he or she evaluates ownership and use of such a car (i.e., attitude); how he or she thinks other important people would approve or disapprove of the purchase (i.e., subjective norm); and how he or she perceives whether he or she is capable of purchasing and using such a car (i.e., perceived behavioral control) (Lane & Potter, 2007). Subsequently, a favorable intention leads to the actual purchase when his or her perceived behavioral control is strong enough. Furthermore, he or she needs to have an adequate degree of actual control to execute intention-related behavior when the opportunity emerges (Ajzen, 2002; Lane & Potter, 2007).

While the theory of planned behavior views "the individual mainly as a utility maximizing actor" (Bamberg & Schmidt, 2003, p. 267), other conceptual frameworks including the norm activation theory (Schwartz, 1977; Schwartz & Howard, 1981) and the

value-belief-norm theory (Stern, 2000; Stern et al., 1999) emphasize explicit altruistic or moral motives of human behavior. Schwartz argued that some behavior is meant "to benefit another as an expression of internal values, without regard for the network of social and material reinforcements" (Schwartz, 1977, p. 222). In other words, individuals choose their actions not only because they intend to and/or are expected to, but because they feel morally obliged to do so (Thøgersen, 1996). Therefore, the driving force of pro-social and altruistic behaviors are personal or moral norms, which are feelings of strong moral obligation that people experienced with regard to their core value system (Schwartz, 1977; Schwartz & Howard, 1981; Stern, 2000; Stern et al. 1999).

According to the norm activation theory, a person's moral or personal norm towards buying a cleaner car is activated by behavior specific beliefs such as awareness of need (i.e., realization that action is required to prevent a problematic outcome), awareness of consequences (i.e., recognition of a causal relationship between one's actions and the problematic outcome), ascription of responsibility (i.e., the responsibility attribution to oneself as one causes these consequences), perceived behavioral control (i.e., the recognition of the own ability to perform the helping action), and perceived social norm (i.e., the consideration of social implications) (Schwartz & Howard, 1981). Stern and his colleagues (Stern, 2000; Stern et al., 1999) suggest that these behavior-specific beliefs are influenced by ecological worldview such as respect to natural limits, the importance of preserving the balance, and integrity of nature, which in turn is correlated positively with Schwartz' (1992, 1994) self-transcendence value orientations and negatively with self-enhancement value orientations.

Though expectancy-value theories (e.g., Ajzen, 1985, 1991) and normative theories (e.g., Schwartz, 1977; Schwartz & Howard, 1981; Stern, 2000; Stern et al., 1999) address normative constructs from different viewpoints, a more detailed explanation of normative constructs and relationships between them are provided by Cialdini and his colleagues (Cialdini, Kallgren, & Reno, 1991; Cialdini & Trost, 1998; Kallgren, Reno, Cialdini, 2000). They differentiated injunctive norms (i.e., suggesting the valued social standards) and descriptive norms (i.e., information about how others act in similar situation), and suggest that what other people do in a given situation (i.e., descriptive norms) can inform us about socially accepted or valued behavior in a given situation. The normal or socially valued behavior in any given situation reflects the expectations of important others for our behavior (e.g., the subjective social norms in Ajzen' [1985, 1991] theory of planned behavior). They further suggest that the extent to which the valued social standards (i.e., injunctive norms) actually

29

guide one's behavior depends on the degree of internalization of the standards. Once an injunctive nom has been internalized, "it becomes integrated into one's self-concept and future normative behavior represents conforming to one's own expectations of self" (Cialdini & Trost, 1998, p. 160) or as Schwartz (1977) puts it, a personal norm. More recently, Thøgersen (2006) proposed an extended taxonomy of norms, which outlines a continuum of increasing levels of internalization and integration of the afore-mentioned normative constructs. Additionally, Thøgersen (2006) further differentiated two types of personal norms: introjected norms, which are enforced by anticipated guilt or pride, and resulted from subjective social norms that are superficially internalized without much reflection on one's own personal values and goals; and integrated norms, which are based on conscious reflection on and evaluation of behavior outcomes. The motivation is not the anticipated guilt or pride but purely one's own value system and goals as specified in normative theories (Thøgersen, 2006).

It could be argued that altruistic or moral motives are the opposite of the utility maximization of individuals, and therefore the theory of planned behavior and the normative theories are incompatible. However, it can be debated that a performer of a pro-social or pro-environmental behavior may take the interests of others to be means of the promotion of his or her self-interest, directly or indirectly (Feinberg, 1996; Gert, 1967). Personal norms can therefore be interpreted in terms of utility maximization if utility can for example also be the good feeling one gets from acting in accordance with ones' values. Moreover, the suggestion that perceived social norms (e.g., the subjective social norms in Ajzen' [1985, 1991] theory of planned behavior) also directly contribute to formation of one's personal or moral norms (Schwartz, 1977) indicate internalization of social standards "provide the content of her/his personal moral norms" (Bamberg & Möser, 2007, p. 16). These arguments can in turn point to a possibility of integration of these two theoretical approaches for understating the underlying psychological processes of pro-environmental behavior (Abrahamse, Steg, Gifford, & Vlek, 2009; Bamberg & Möser, 2007; Harland, Staats, & Wilke, 1999; Oreg & Katz-Gerro, 2006).

Through the application of constructs from the theory of planned behavior, the normative theories and/or the combination of them, empirical research investigating individuals' purchase of cleaner cars reveal that concerns about environment, environmental knowledge, values and norms of the community or group, positive attitudes toward new technology, social norms, and personal or moral norm, relate to purchase/ownership of cars in varying degrees (Choo & Mokhtarian, 2004; Coad et al., 2009; Heffner et al., 2007a, 2007b; Flamm, 2009; Jansson, 2009; Kahn, 2007; Ozaki & Sevastyanova, 2011; Peters et al., 2011;

Turrentine & Kurani, 2007). Nevertheless, it is observed that the explanatory value of those general and behavior specific predispositions and beliefs (Stern, 2000) are limited, and very often they are not translated into changes in purchasing behavior (O'Garra, Mourato, & Pearson, 2005; Ricci, Bellaby, & Flynn, 2008; van Rijnsoever, Farla, & Dijst, 2009).

The discrepancy between environmental attitudes and purchase behavior (i.e., the attitude-behavior gap) found in empirical research indicates that attitudes and behavior towards cleaner cars are not merely determined by environmental consideration. In reality, purchase or adoption of cleaner cars and attitudes toward such cars are the result of complex trade-off involving contextual forces (e.g., economic factors, government regulations), personal capabilities, relative preferences among car attributes (e.g., performance, convenience, and environmental attributes), psychological factors, and past purchase behavior (Lane & Potter, 2007; Turcksin et al., 2013).

Past Car Purchase and Brand Loyalty

In addition to the analytical-rational system that processes information, the existence of an intuitive-experiential system in human mental processing and decision-making is widely acknowledged (Epstein, 1973, 1994; Tversky & Kahneman, 1974; Payne, 1976; Ostrom, 1998). Since humans have finite abilities to absorb and process information during any given unit of time (Bettman, 1979), the two systems are suggested to interact constantly to produce behavior (Epstein, 1973, 1994). As a general rule, the intuitive-experiential system creates an automatic association between a new event and other events or experiences within a similar schema. Instantaneously, a process of finding a rational explanation for experientially driven behavior occurs. In cases where a conscious behavior is repeated often enough within consistent settings, it begins to continue more efficiently and with less cognitive deliberation as control of the behavior moves into the intuitive-experiential system, in which cues in the environment activate an automatic response (Epstein, 1973, 1994).

Accordingly, in particular kinds of situations where people face complex problems or incomplete information (Payne, 1976), individuals are suggested to rely on their previous experiences or past behavior (as a cue) that tend to provide them good outcomes (Aarts et al., 1998). As behaviors are repeated in the same set of circumstances, there is an incremental increase in the link between the signs in the environment and the response (Wood & Neal, 2007). When this link grows strong enough with consistent satisfying behavioral outcome, the more often the response will be "instigated without the mediation of attitudes or intentions" (Anable, 2005, p. 68). In other words, frequent repetition of behavior in the same set of

circumstances that is rewarded, results in habitualization of the behavior (Klöckner & Matthies, 2012; Thøgersen & Ölander, 2006). The degree of habitualization is theoretically related to characteristics of the behavior itself (Klöckner, 2013). It is found that frequently performed behaviors in a stable context with satisfying outcome gain (habit) strength and are more easily habitualized than behaviors executed occasionally and in varying contexts (Ouellette & Wood, 1998).

Arguably purchase of new cars occurs less frequently and therefore the influence of past behavior or habit can be trivial as compared to influences from cognitive, emotional, and social factors (Ouellette & Wood, 1998). On the other hand, car purchase behavior is a complex problem, and it is hard for individuals to get perfect market information to perform full cognitive deliberation. Evidence indicate that rather than extensive searching for information, individuals rely on their own experiences from past car purchases (Kiel & Layton, 1981; Newman & Staelin, 1972). Moreover, in situations where an individual has no clear intention with respect to some desired act (e.g., purchase of a car with low CO_2 emissions), frequency of the past purchase is believed to have independent effect (Bagozzi & Yi, 1989).

Empirical evidences in marketing research indicate that brand loyalty, which is observed in terms of repetitive same-brand or same-brand-set purchasing (Jacoby & Chestnut, 1978; Oliver, 1999), has significant influences on car purchase (Ewing, 2000; Mannering & Winston, 1985, 1991; Sambandam & Lord, 1995). Even though habits, which are generally understood as context-cued automatic responses (Verplanken & Wood, 2006), are structurally different from brand loyalty, the function in the decision-making process appears to be comparable to a certain degree. It can be debated that the degree of loyalty to certain brand may serve a similar function as the strength of link (or habit strength) between the cue in the environment and the response. Like habit strength, brand loyalty can therefore provide a shortcut or simplify the decision-making process in car purchase behavior. It is, however, observed that some individuals switch from one specific make or brand to another, at times, whereas others remain loyal to the previously purchased make and display consistent choice of brand (Ewing, 2000; Sambandam & Lord, 1995).

An Integrated Perspective to Car Purchase

The views presented above provide the basis for understanding purchase of cleaner cars and its determinants. They portray the importance of economic, political, socio-demographic, and psychological factors in the decision-making process, as well as evaluation of car attributes

and past purchase behavior. It is clear that people's motivations behind adoption of cleaner cars are multi-faceted, and a wide range of determinants come into play.

Despite the traditional economic approach to car purchase, application of socio-psychological models, and repeated action or past purchase all being well supported by empirical evidence, none of these approaches on its own adequately represents the multi-dimensionality of purchase or adoption of cleaner cars. Each approach seems to over- and under estimate the importance of characteristic aspects. In most cases, simpler models have been more frequently applied and tested in empirical studies. However, the simpler models have limited ability to explain or predict different kinds of behavior. In contrast, sophisticated and complex models could provide enhanced explanatory power for behaviors in a wide range of situations. Although the difficulty of designing and testing such conceptually complex models has been a major concern for the application of such models in empirical studies, the methodological advances in statistical analysis in recent years have provided possibilities to explore and test complex relations using a combination of statistical data and qualitative causal assumptions based on theoretical frameworks.

In recent years there have been various attempts to combine different approaches and theoretical frameworks in order to understand how the multiple reasons relate to and interact with each other, interact, and ultimately lead to pro-environmental action (Bamberg & Möser, 2007; Klöckner & Blöbaum, 2010; Oreg & Katz-Gerro, 2006). One such complex model is proposed by Bamberg and Möser (2007). Suggesting "pro-environmental behavior is best viewed as a mixture of self-interest and pro-social motives" (Bamberg & Möser, 2007, p. 16), they proposed a structural model combing the assumption of the theory of planned behavior and the norm activation theory.

In line with the theory of planned behavior, their hypothesized model postulates that behavioral intention predicts pro-environmental behavior. However, together with attitude and perceived behavioral control, the moral or personal norm not the social norm is suggested to directly predict behavioral intention. The impact of social norm on behavioral intention is mediated by direct predictors of behavioral intention, which reflects the view of Schwartz and Howard (1981) that perceived social norm also directly contribute to the formation of an individual's personal or moral norms. Consistent with the norm activation theory, problem awareness, internal attribution, and feeling of guilt are important cognitive and affective precondition for forming personal or moral norms (Bamberg & Möser, 2007).

The model is subsequently confirmed by a meta-analysis based on information from a total of 57 samples reported in 46 studies that investigated a range of pro-environmental

behaviors. Though all hypothesized relations between psychological variables are significant and on average 52% of variance of the behavioral intention is explained by model constructs, intention predicts only on average 27% of variance of behavior (Bamberg & Möser, 2007). This implies the integration of self-interest and altruistic motives alone cannot fully capture the processes contributing to the actual behavior performance. A recent application of Bamberg and Möser's (2007) integrative model to purchase of more fuel-efficient cars also reveals that a combination of altruistic and self-interest motives falls short to explain substantial variance in purchase behavior (Peters et al., 2011).

Notwithstanding the importance of deliberate decision-making of individuals, whether it is originated from self-interest or altruistic motives or a mixture of both, it is widely accepted that frequently or repeatedly performed behaviors often circumvent cognitive processes (Ouellette & Wood, 1998; Triandis 1977, 1979; Verplanken & Aarts, 1999; Verplanken, Aarts, Knippenberg, & Moonen, 1998). Moreover, objective and subjective characteristics of situations or context of the behavior facilitate or inhibit performance pro-environmental behaviors (Stern, 2000). Though the argument that a simple model with the most important determinants should be applied to explain behavior is strong (Lindenberg & Steg, 2007), a further integration of variables, which are found to have a large impact on behavior in various frameworks and approaches, are suggested to provide a more comprehensive understating of behavior, and to be a more promising approach (Matthies, 2003; Wall, Devine-Wright, & Mill, 2007). Klöckner and Blöbaum (2010) therefore attempted to integrate the determinants proposed by various socio-psychological theories to explain pro-environmental behavior, and developed a comprehensive action determination model.

According to the comprehensive action determination model (Klöckner & Blöbaum, 2010), individual behavior is influenced by four possible sources: habitual processes or past behavior, intentional processes (e.g., attitudes, intentions), situational influences (i.e., objective constrains such as personal capability, and subjective constraints such as perceived power to perform the behavior) and normative processes (e.g., social norms, personal norms, awareness of need, awareness of consequences, ascription of responsibility, ecological world view, and value orientations). While the habitual processes mirror the impact of frequently performed or habitualized behavior, and the intentional processes reflect the results of expectancy-value assessments on behavior in question, the situational influences explain objective constrains (e.g., personal capabilities) and perceived constraints (e.g., perceived behavioral control) of performing a given behavior. Furthermore, the normative processes

provide the effect of moral or altruistic motivations in the decision-making process (Klöckner & Blöbaum, 2010).

The model postulates that the first three sources have a direct impact upon behavior. The effect of normative processes on individual behavior, however, is assumed to be mediated by intentional and habitual processes. It further contends that habitual and situational processes interfere with intentional processes and moderate the impact of intentions on behavior. Additionally, situational influences are suggested to affect the other three sources. Finally, the change or stabilization of personal norms and habits are affected by the behavior itself (Klöckner & Blöbaum, 2010).

More specifically, the model assumes that the individual behavior is directly determined by habit strength, intentions to perform the behavior, and perceived behavioral control that is the reflection of objective situational constrains such as opportunities and capabilities. Intentions are generated by referring to attitudes, social norms, personal norms, and perceived behavioral control. In line with the normative theories, personal norms are influenced by personal value orientations, ecological worldviews, awareness of need, awareness of consequences, and ascription of responsibility (Schwartz & Howard, 1981; Stern, 2000). Meanwhile, it is suggested that personal norms are formed by internalizing social norms into a consistent personal value system. However, the personal norms are not always active. In order to activate the personal norm, an acting person also needs to perceive some amount of behavior control (Klöckner & Blöbaum, 2010).

Klöckner (2013) later performed a meta-analysis to test the comprehensive model based on a pool of 56 different data sets, which were reported in published studies about a variety of environmentally relevant behaviors. All suggested relation between psychological variables are significant, and on average 55% of variance of the behavioral intention is explained by model constructs. Intentions to act, habits and perceived behavioral control directly predicted on average 36% of variance of behavior, which is 9% more explained variance in behavior compared to the model proposed by Bamberg and Möser (2007). This implies the comprehensive action determination model has more potential in explaining environmentally relevant behavior, and represents a general integrated framework for understanding of how the multiple determinants relate to each other, interact, and ultimately lead to the behavior.

Therefore the comprehensive action determination model could provide a base for integration of various determinants proven to influence purchase and adoption of cleaner cars reviewed earlier. The variables identified in choice modelling studies of car purchase

35

described early, namely sociodemographic and household characteristics that are often regarded as indictors of personal capabilities (Stern, 2000), could be considered as objective situational constraints or facilitators. As suggested earlier, these variables can create conditions for or against purchase of certain type of car (Peters, 2009), and they can also exert their impact on behavior through the formation of perceived power to perform the behavior (i.e., perceived behavioral control).

Meanwhile, evaluations of car attributes, which are also found to exert strong effect on car purchase in choice modelling studies, can form attitudes towards certain aspects of cleaner cars that could be an important predictor of behavioral intention. Although past actions and experiences tend to inform attitudes and personal norms and therefor formed intentions are also the result of feedback from past behavior or habit (Lane & Potter, 2007), evidence from marketing research indicates that frequency of past car purchase behavior (i.e., brand loyalty) could have a unique influence on decision-making of some car buyers (Ewing, 2000; Mannering & Winston, 1985, 1991; Sambandam & Lord, 1995). In this context, brand loyalty can serve a similar function as habit strength, which tends to have a direct influence on behavior not mediated by behavioral intentions.

The psychological factors, such as values, environmental concern, environmental knowledge, behavior specific beliefs, social and personal norms, and purchase intention that are found to affect purchase and adoption of cleaner cars in empirical research (Choo & Mokhtarian, 2004; Coad et al., 2009; Heffner et al., 2007a, 2007b; Flamm, 2009; Jansson, 2009; Kahn, 2007; Ozaki & Sevastyanova, 2011; Peters et al., 2011; Turrentine & Kurani, 2007), reflect the self-interest and pro-social motives of car buyers. The previously described argument (i.e., that pro-social or pro-environmental motives can also be viewed as a building block of one's self-interest) (Feinberg, 1996; Gert, 1967) indicates that altruistic or normative processes involving purchase and adoption of cleaner cars provide the moral dimension in expectancy-value assessment of the behavior. However, the subjective expectancy-value judgement has limited power or will not be initiated when contextual or situational forces are strongly positive or negative (Stern, 2000). Moreover, a minimum amount of affective and cognitive deliberation may be required when one can rely on his or her past purchase decision and personal experience with purchased cars (Kiel & Layton, 1981; Newman & Staelin, 1972).

To summarize, a facilitating macro condition is crucial for increasing the amount of cleaner cars in the car fleet. Although top-down government policy and regulations have been the major drive of the composition of the car fleet, at the end it is the individuals who will decide what car to buy or not to buy. Therefore, identification of the important personal

sphere variables, understanding how they interact and lead to purchase/adoption of cleaner cars will provide base for better design and implementation of effective intervention strategies. Given the complexity of car purchase behavior, simplified views, which either emphasize pure calculative or altruistic or experiential nature of human behavior, appear to perform notoriously poor. A plausible integration of them, however, will provide a more comprehensive understanding of the behavior, and thus offer primary and distal targets for interventions.

Rebound or Spillover Effects of Car Purchase

Although reduction of energy intensity per passenger kilometer via introduction and promotion of cleaner cars is suggested as a major pathway to reduce greenhouse gas emissions in the transport sector (de Haan et al., 2007; Hickman et al., 2010; Metz et al., 2007; Peters, 2009; Turcksin et al., 2013), scientists agree that adoption of products with energy-efficient technology may also result in take-back effects or rebound effects (Berkhout et al., 2000; Hertwich, 2005b; Khazzoom, 1980). Generally, three different levels of effects might be produced as results of adopting energy-efficient product or service: a first-order direct effect, a second-order indirect effect, and a third-level effect on the macro level (Berkhout et al., 2000).

The most common understanding of first-order direct effect refers to that "if a product or service becomes more efficient (regarding energy use or the use of some other resource), it will also become cheaper, which might give rise to increased demand" (de Haan, Mueller, & Peters, 2006, p. 593). For example, cars with emergent technologies (i.e., cars equipped with improved internal combustion engine, hybrid cars, and alternative fuel cars) can lower operating cost, and thus become cheaper to own and use. Subsequently, more people will demand and purchase such cars. Since such cars are cleaner or more environmentally friendly than traditional cars with internal combustion engine, the increasing amount of them in the car fleet will decrease the negative impacts associated with car use – the desired first-order direct effect.

However, with increasing energy-efficiency and resulting lower operation cost, people who purchase cleaner cars might drive more often and/or drive longer. In addition, with reduced cost doubled with incentives from the government, purchase and ownership of such cleaner cars become attractive. As a result, people might consider adding another car to their households' car fleet and/or change to larger cars that are energy efficient. As a result of these

direct rebound effects, the environmental benefits from the energy-efficient cars can be lower than initially estimated or even negative (Hertwich, 2005b).

Meanwhile, as a result of the reduced price of the product or service due to increased energy efficacy, purchasing power or available income of people will increase, which will lead to more expenditure on other products or services (i.e., a second-order indirect effect) (Berkhout et al., 2000). For example, the cheaper running cost and preferable incentives from the government may save people substantial amount of disposable income. Consequently, people may use their saved money for an increased amount of car trips, which may have been carried out by walking, cycling, taking public transportation, or other alternatives. It may also be possible that with the saved disposable income, people may take long distance air travel more frequently for their holidays. These indirect rebound effects can thus take back overall positive effects of purchasing cleaner cars. On the other hand, with the saved income other individuals may make investments in other products or services (e.g., rehabilitating and adding insulation to their house) that are more efficient and therefore further cut their environmental impact (i.e., spillover effect). Obviously, whether the effects of this second-order effect are negative or opposed desired directions is far from clear-cut (Hertwich, 2005b).

Furthermore, the first and second-order effects may subsequently lead to changes in production and sales patterns of the industry sector (i.e., a structure or macro level effect), which has consequences for energy demand (Berkhout et al., 2000). For example, the increasing demand for cleaner cars from the consumers' side may cause car industry to invest in cleaner car technology and subsequently produce more of such cars. The increased industrial activity may require more energy, thereby putting pressure on energy and material resources. In contrast, stimulated research and design activity due to consumer demand for cleaner cars may result in innovations and technological breakthroughs, and more sustainable products or cars could be made available. Consequently, the changes on the macro level can bring possibilities to cut negative environmental impacts of car traffic further (Hertwich, 2005b). Nevertheless, the third-level effect on the macro level is hard to quantify and confirm, and investigations on adopting energy-efficient products or services have mainly focused on first and second-order effects (de Haan et al., 2006; Hertwich, 2005b; Walnum, Aall, & Løkke, 2014).

In addition to economic understanding of effects associated with adoption of cleaner cars, it has been suggested that those effects have origins from socio-psychological reasons as well (de Haan et al., 2006; Girod & de Haan, 2009; Peters, Sonnberger, Dütschke, & Deuschle, 2012; Walnum et al., 2014; Wörsdorfer, 2010). Coad et al. (2009) suggest that

monetary factors or 'extrinsic motivations' alone could not guide decision-making of individuals. People have 'intrinsic motivations' such as goals, values, preferences, concerns and norms, which will define and redefine behavioral outcome (Jackson, 2005). For instance, cleaner cars or cars with increased energy efficiency can positively affect people's attitudes and preferences toward purchasing and using such cars, which lead to increased demand. The increased demand and ownership of cleaner cars therefore may bring desired first-order direct effect as described earlier. The theory of planned behavior (Ajzen, 1985, 1991) and the normative theories (Schwartz, 1977; Schwartz & Howard, 1981; Stern, 2000; Stern et al., 1999) describe in previous section give accounts for how the attitudinal factors lead to changes in behavior.

On the other hand, possible increase in car size and average household car ownership, and increased annual mileages, which are first-order direct rebound effect, may also occur as results of the changes in people's attitudes and preferences. It is possible that efficiency improvement of cars may decrease socio-psychological or moral costs of owning larger cars or more cars, and allow the owner using such cars more often (de Haan et al., 2006; Walnum et al., 2014). For example, a person, who initially feels strong moral obligations to reduce his or her car driving as much as possible, might feel less strong moral obligations after purchasing a cleaner car (Girod & de Haan, 2009). Likewise, individuals who refrained from owning SUVs due to neighborhood pressure or norms of a peer group might have been tempted to buy an SUV when the hybrid power train entered the market.

Moreover, it might also be possible that people who bought cleaner cars use socio-psychological denial mechanisms (Soland, 2013; Stoll-Kleemann, O'Riordan, & Jaeger, 2001) to overcome cognitive dissonance resulting from acting differently in relevant behavioral domains (Festinger, 1957). For instance, individuals, who have purchased cleaner cars, may regard themselves as having already done their share of responsible behavior, and assume further responsibility should lie in the hands others and policy makers. Consequently, they may deny the need to dispose the other car in their household and/or the need for reduction of their car use. These socio-psychological rebound effects may become a strong public resentment toward strict travel demand management programs, which is inevitable if private car use and ownership keep increasing.

Notwithstanding the arguments for existence of first and second-order rebound effects, a broad range of behavioral scientists has argued that a change in a particular behavior and/or attitude, which is produced by a targeted effort, may spillover into related areas (i.e., second-order indirect positive effect), and therefore become more general (Frey, 1993; Hertwich,

39

2005b; Jensen, 1992; Weigel, 1983). Empirical evidence also indicates that an individual's performance of pro-environmental behavior in one domain increases his or her propensity to engage in pro-environmental behavior in another relevant domain (Thøgersen, 1999a).

Several theories have shed light on the spillover phenomenon. One such theory is Bem's (1972) self-perception theory, which postulates that people use their own behavior as cue to their internal dispositions, in much the same way as they infer another individual's attitudes from observing his or her behavior. In line with this assumption, performing the specific behavior in question may activate a general disposition (e.g., pro-environmental values and beliefs) held by the actor, which may therefore be more likely to influence other relevant behaviors (Cornelissen, Pandelaere, Warlop, & Dewitte, 2008). For example, if an individual buys a cleaner car, this action may lead him or her to think of him- or herself as the kind of person who cares for the environment. He or she may therefore be left more positively predisposed to car use reduction.

Festinger's (1957) cognitive dissonance theory also provides explanations for the occurrence of spillover effects between behavioral domains. The theory suggests that, at least under some circumstances, people feel it is inconsistent to behave in an environmentally responsible way in one domain while refraining from doing so in another domain. Inconsistency violates a key element of a person's self-concept, questioning that person's competence, morality, or reliability (Dickerson, Thibodeau, Aronson, & Miller, 1992), and subsequently causes an unpleasant affect called cognitive dissonance, which is suggested to encourage spillover between behaviors of comparable difficulty (Thøgersen & Crompton, 2009). For instance, a person, who feels a strong moral obligation to reduce his or her car use but has not managed to cut a substantial amount of his or her car trips due to day-to-day activities, may have guilt feelings. As a result, he or she may replace his or her less fuel-efficient car with a cleaner car as a means to relive the discomfort that this creates (Bratt, 1999).

These arguments imply behavioral change strategies in promoting cleaner cars should manage and monitor not only the direct determinants of the target behavior but also its rebound and spillover effects on the subsequent post-purchase stage (Thøgersen, 1999a). Although effects triggered by cost savings are well documented in the past literature about car purchase (de Haan et al., 2007; Greene, Kahn, & Gibson, 1999; Small & Van Dender, 2007), empirical attempts to capture socio-psychological rebound or spillover effects associated with adoption of cleaner cars are rare. An empirical investigation based on relevant socio-psychological theory therefore appears necessary to confirm or refute the above contentions

about socio-psychological rebound or spillover effects. The empirical evidence then can be used to evaluate, improve and/or design the current measures, and to ensure the target of reducing negative impacts of road traffic.

AIMS

The aim of this thesis is to investigate the effects of various socio-psychological factors in individuals' choice of a more fuel-efficient car type and the behavior effects resulting from adoption of such cars. The primary focus is to integrate determinants identified by choice modelling studies with determinants put forward by various socio-psychological theories in order to understand purchase and adoption of cleaner or more fuel-efficient cars under the facilitating macro conditions. As the initial purchase decision typically affects the post-purchase behavior, the thesis also attempts to examine possible direct rebound effects at the post-purchase stage, as well as possible socio-psychological spillover effects from the purchase stage to the subsequent use stage.

Four studies included in this thesis investigated and evaluated potential determinants of purchasing cleaner cars and socio-psychological mechanisms associated with rebound or spillover effects resulting from adoption of such cars. Although this thesis focuses on purchase/adoption of cleaner cars with emergent technologies, an attempt of investigating the relations between potential psychological determinants of purchasing cleaner cars (i.e., battery electric cars) and potential psychological determinants of reducing car use among adopters and non-adopters of such cars may provide useful insights regarding occurrence of socio-psychological rebound or spillover effects.

In the first study, the aim was to carry out a pilot study where the feasibility of a full scale study and the applicability of an integrative model for choice of car type class were explored. Based on the argument that individuals simultaneously consider important car features (e.g., engine size, fuel type, drive system) across traditional car size class boundaries, the integrative model postulated that socio-demographics, intention (which mediates the effects of norms, attitudes, and ecological world view), perceived behavioral control, and brand loyalty directly predict the purchased car's CO_2 emissions and it's car type class membership, which is identified using important car features as indicators and thus predicts the purchased car's CO_2 emissions.

The second study aimed to explore socio-psychological profiles of conventional car buyer groups (which were identified using the purchased conventional car's important features as indicators) and a group of battery electric car buyers by analyzing a dataset from a larger survey. The results of the second study provided further bases for improvement and extension of integrative model for choice of car type.

In the third study, which can be viewed as an extension of the first study and the second study, an extended version of the integrative model for choice of car type was used to examine the importance of potential determinants of individuals' car type choice using the same dataset analyzed in previous study. Similar to the model tested in Study I, the model also postulated that demographic and household characteristics, intention to purchase more fuel-efficient car, perceived behavioral control over purchasing such cars, and brand loyalty predict purchase of a more fuel-efficient car type. The intention is, however, not only predicted by perceived behavioral control, attitudes toward purchasing more fuel-efficient car, social and personal norms, but also by perceived importance of car attributes (i.e., the relative importance of car attributes). Moreover, awareness of need and awareness of consequences are included as direct determinants of personal norm, and environmental knowledge on car ownership/use is assumed to affect attitudes toward purchasing more fuel-efficient car.

Finally, the fourth study analyzed and discussed if the adoption of battery electric cars would result in direct rebound effects and psychological spillover effects compared to non-adopters. Two datasets from the larger survey were analyzed. The potential direct rebound effects focused on increase in car ownership and use, and psychological spillover effects highlighted possible impacts of the potential psychological determinants of a car purchase on their respective pendants from car use. Moreover, the studies also derived practical implications for policy measures and intervention strategies aiming to facilitate promotion of cleaner cars.

METHODS

This section reviews the methods for investigating the overall aim of this thesis. Since the focus of this thesis is to integrate and evaluate potential determinants of cleaner car purchase/adoption that have been identified in the existing literature, a quantitative method was preferred. More specially, a cross-sectional retrospective design was chosen to explore and evaluate the impacts of various determinants. Taking into account advantages and disadvantages of various data collection methods, an online survey[1] preceded with a postal invitation letter was considered to yield a representative sample at reasonable costs. A pilot data collection was carried out among a small proportion of the target population, which was set to be individuals who purchased a new passenger car for private use recently, and a large scale survey was conducted later.

Population, Samples, and Data Collection Procedures

For the pilot data collection, names and addresses of private passenger car owners, who bought a new passenger car in December 2010, were requested from the Norwegian Public Roads Administration's national database. From a total number of 5,238 obtained addresses, a random sample of 2,000 was selected and contacted through a postal invitation letter (between April and May 2011) to participate in online surveys about car purchase/ownership and car use.

The invitation letter (see Appendix I) described the aim of the study, the study population, information about anonymity and confidentiality rules, and contact information to the researchers. Internet addresses to the online surveys, a personalized login ID, and instructions for filling out the online surveys were included in the invitation letter as well. In order to safeguard against the possibility that other persons in the household might respond to the online surveys, it was specified in the invitation letter and on the first page of the respective online survey that the survey on car purchase/ownership should be filled out only by the person who was mainly responsible for the purchase of the most recent car, and that the survey on car use should be filled out only by the person who drives the car in question most frequently.

The invitation letter also spelled out the possibility of participating in a lottery for two iPads if both of the online surveys were fully completed before the deadline (i.e., 28.05.2011).

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[1] Given that about 90% of the Norwegian households had access to both a computer and the Internet in 2010 (Statistics Norway, 2010b), online survey was considered to cover substantial part of the target population.

No reminder letters were sent. The usable response rate for the pilot survey on car purchase/ownership was 11.60%, and 8.90% for the pilot survey on car use (see Table 2). Since there was little information available about characteristics of the selected random sample (i.e., no demographics and other characteristics of the target population could be obtained beforehand) and data were anonymized[2], conducting a non-response bias analysis was not possible. Subsequently, the samples resulting from the pilot data collection were compared against the characteristics of general Norwegian population. The comparison revealed that males and individuals who had higher education and higher income were overrepresented in the sample (Statistics Norway, 2010c, 2012a).

For the larger scale survey, the Norwegian Public Roads Administration was contacted again in February 2012. Names and addresses of 13,783 private passenger car owners, who bought a new passenger car in November and December 2011, were obtained. In addition, names and addresses of 1,409 private battery electric car owners, who bought their battery electric car in 2011, were also obtained. This oversampling was based on the concern that the number of private battery electric car owners in any given month in 2011 was too small to

Table 2: Population, sample, and response rates

	Pilot data collection (2011)	Main data collection (2012)	
	passenger car owners	conventional passenger car owners	battery electric car owners
Sample	(2000)	(12000)	(1362)
Survey on car purchase			
Total attempts	333	1743	447
Attempts with completed responses	208	1329	345
Attempts with incomplete responses	125	414	102
Responses with unique login IDs[1]	288	1645	417
Response rate	14.4%	13.7%	30.6%
Usable responses[2]	232	1421	372
Usable response rate	11.6%	11.9%	27.3%
Survey on car use			
Total attempts	192	1296	342
Attempts with completed responses	176	1256	303
Attempts with incomplete responses	16	40	39
Responses with unique login IDs[1]	180	1279	324
Response rate	9.0%	10.7%	23.8%
Usable responses[2]	178	1249	313
Usable response rate	8.9%	10.4%	23.0%

1 Based on the unique login ID, duplicated responses were identified and removed.
2 Responses with more than 50% missing data were removed.

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[2] The codes to identify respondents from non-respondents were deleted to ensure anonymity of the respondents.

make a substantial group in the total sample. After screening for duplications and incomplete addresses, addresses to 12,000 conventional passenger car owners and 1,362 private battery electric car owners were retained. Slightly different versions of the invitation letters (see Appendix II and Appendix III), which were a modified version of the invitation letter that was used during the pilot study, were then sent via post to those addresses between April and May 2012. No reminder letters were sent this time as well.

Since the incentive (i.e., lottery for iPads) used in the pilot data collection was considered effective (i.e., resulting in satisfactory response rates for an online survey), the same method of increasing the response rate was used again in this data collection. Consequently, two iPads were rewarded to conventional passenger car owners, and another iPad was rewarded to a battery electric car owner, who completed both surveys on car purchase/ownership and car use before 28 May 2012.

While the response rates from the conventional passenger car owners (see Table 2) were within the range to be expected for an online survey with long questionnaires (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004), the response rates from battery electric car owners (see Table 2) were comparatively high. Once again, due to lack of information regarding the selected sample and data anonymization, a non-response bias analysis was not possible. However, the regional distribution of the respondent who purchased conventional passenger car represented the regional distribution of the Norwegian population well (Statistics Norway, 2012b), and the regional distribution of participants who purchased battery electric car matched the distribution of battery electric car sales in Norway (Kvisle, 2012). A comparison of the samples with the general Norwegian population (Statistics Norway, 2012a, 2013) revealed that individuals who had higher education and higher income were overrepresented.

Questionnaires and Operationalization of the Components

By an extensive literature review in the field, a questionnaire on car purchase/ownership (see Appendix IV) and a questionnaire on car use (see Appendix V) were developed and administrated online using SelectSurvey.NET – NTNU. The questionnaires were first developed in English and later translated into Norwegian by Anna Carlsson and Silje Storsveen. The Norwegian versions of the questionnaires were proofread, and adjustments were made to increase the legibility and the structure of the questions. After analyzing the pilot study data, both questionnaires were modified, and slightly different versions of the questionnaires were deployed for the larger data collection in 2012 (see update notes in

Appendix IV and Appendix V). The following sections describe operationalization of the questions and measures in the questionnaires.

Questionnaire on Car Purchase/Ownership

The questionnaire on car purchase/ownership included several major parts described below.

<u>Information on car ownership and the latest purchased car</u>

This part focused on passenger car ownership, purchase history, and detailed information about up to three cars that the person or his/her household currently owned. More specifically, respondents first were asked how many cars his/her household currently owned, how many cars (both new and used) he/she had purchased, and how many persons in his/her household had a driver's license. Next, respondents were asked to name the make of the last up to nine passenger cars, both new and used cars that had been purchased, in chronological order beginning with the most recently purchased passenger car. The brand loyalty was then calculated in using the function[3] below:

$$Brand\ loyalty = \frac{M-1}{T-1}$$
$M = number\ of\ times\ the\ same\ make\ has\ been\ bought$
$T = number\ of\ cars\ (up\ to\ nine, new\ and\ used\ cars) has\ been\ bought$

Detailed information about the latest purchased passenger car (e.g., make, model-variant, model year, fuel type, main driver of the car, its annual driving distance) was then asked. This enabled the process of crosschecking self-reported car information with an online database (www.bilnorge.no) providing specification of cars available in the Norwegian car market. Moreover, the detailed information about the latest purchased passenger car was used as indicators in latent class cluster analysis to differentiate car type classes among passenger cars. If there were more than one passenger car in the household, similar details were also requested for up to two more cars. This section ended with a question asking the respondent's annual driving distance irrespective of which car was driven.

<u>Psychological Measures</u>

A range of items and measures, both well-established measures and newly formulated items with specific regard to car purchase, were used to tap the psychological variables described in the introduction. The formulated measures, which consisted of minimum three items per construct, were developed according to Fishbein and Ajzen's (2010) general

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[3] The function was later modified (i.e., (M-0.99999) / (T-0.99)) to avoid creating system-missing values when only one car had been bought.

recommendations and previous studies on pro-environmental behavior (Fielding, McDonald, & Louis, 2008; Hunecke, Haustein, Grischkat, & Böhler, 2007; Jansson, Marell, & Nordlund, 2009, 2010; Kaiser, 2006; Klöckner & Blöbaum, 2010; Klöckner & Matthies, 2004; Klöckner, Matthies, & Hunecke, 2003; Matthies, Klöckner, & Preißner, 2006; Peters et al., 2011; Thøgersen, 2006).

Relative importance of car attributes

28 different car attributes (e.g., speed, energy label, anti-lock braking system, transmission, color), which were adopted from van Rijnsoever et al.'s (2009) study on consumer car preferences in the car-purchasing process, were included to measure relative preferences among car attributes. These items were randomly presented, and the respondents were asked to rate how important each of them were when they made the latest car purchase decision, on a 7-point ordinal scale ranging from 'not important at all' (= 1) to 'extremely important' (= 7).

Norms

To capture the potential prosocial and pro-environmental reasons for purchasing cleaner cars, constructs from Thøgersen's (2006) extended taxonomy of norms were incorporated to investigate the role of norms in individuals' car type choice. Accordingly, various statements were formulated, for example, "Many of the people that are important to me own environmentally friendly cars"; "I believe that many of the people that are important to me expected me to buy an environmentally friendly car"; "I would sometimes have a bad conscience if I did not own an environmentally friendly car"; and "My values told me that it was/would be the right thing to buy an environmentally friendly car", to operationalize descriptive norms, subjective social norms, introjected norms, and integrated norms respectively. Respondents were asked to indicate their agreement on these statements on a 7-point ordinal scale ranging from 'strongly disagree' (= 1) to 'strongly agree' (= 7).

Antecedents of personal norms: awareness of need, awareness of consequences and ascription of responsibility

Various statements were formulated to measure these direct antecedents of moral norms in order to facilitate an assessment of the extent to which these considerations enter individuals' car choice decision-making. The following examples illustrate how they were operationalized: "There is an urgent need for something to be done about the environmental pollution caused by people owning big cars"; "My own decision on what type of car I was going to buy has a relevant impact upon the environment", and "I feel personally responsible for the problems

resulting from the type of car I own". A 7-point ordinal scale ranging from 'strongly disagree' (= 1) to 'strongly agree' (= 7) was provided for the responses.

Perceived behavioral control, attitudes, and intention

Statements such as such as "It was mostly up to me whether I would buy a fuel efficient and environmentally friendly car" and "When I bought my new car, I wanted to buy a fuel efficient and environmentally friendly car" were formulated to operationalize the perceived behavioral control and the behavioral intention. The same response options as for the normative beliefs described above were provided. The attitudes toward purchasing a fuel-efficient and more environmentally friendly car were assessed using 7-point scales, ranging from 'very bad/harmful/unfavorable/foolish/unsatisfying/unpleasant' to 'very good/beneficial/favorable/wise/satisfying/pleasant'.

Ecological world view and value orientations

The New Environmental Paradigm (NEP) scale (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000) was used to tap a general set of core beliefs, or in other words an ecological world view. Once again a 7-point ordinal scale ('strongly disagree' to 'strongly agree') was used. A brief inventory of values (Stern, Dietz, & Guagnano, 1998) was deployed to capture overarching value-orientations such as self-transcendence, self-enhancement, openness to change, and conservation-tradition. These value orientations were assessed by a 7-point scale ranging from 'opposed to my values' (= -1) to 'extremely important' (= 5), as guiding principles in one's life.

Environmental knowledge

A test of factual knowledge about the relationship between car ownership/use and environmental issues was included on the questionnaire. The test consisted of 15 items that focused particularly on knowledge of issues relating to the use of the car. The items were not measured on a dichotomous, but on a five-point scale: 'absolutely true', 'probably true', 'probably not true', 'absolutely not true', and 'don't know'.

Socio-demographic and household characteristics

Finally, several socio-demographic (e.g., gender, age, civil status, employment, and education level) and household characteristics (e.g., number of household members, household income, household location, and residential area density) of the respondents were asked at the end of the questionnaire.

Questionnaire on Car Use

In order to explore potential rebound and spillover effects associated with purchase/adoption of cleaner cars, a questionnaire on car use was developed in parallel with the questionnaire on car purchase/ownership. The following describes its major parts.

Car use behavior

In order to measure typical car use behavior of respondents, questions about the frequency (i.e., percentage) of car use for seven specific trips[4] (i.e., travel to work/study, trips to hospital/physician, shopping trips for household, trips to take/bring children to/from kindergarten, trips to visit family or friends, leisure trips, and weekend away/holidays) were presented. Next, the total distance driven in the previous year and the total distance that is expected to be driven for the current year were requested.

Psychological Measures

Various statements (minimum three statements per construct) were formulated, according to Fishbein and Ajzen's (2010) general recommendations and previous studies on mobility behavior (Hunecke et al., 2007; Klöckner & Blöbaum, 2010; Klöckner & Matthies, 2004; Klöckner et al., 2003; Matthies et al., 2006), to tap norms, antecedents of personal norms, perceived behavioral control and intention toward car use reduction. These statements were constructed as parallel as possible to the similar statements used in the questionnaire on car purchase/ownership, but to reflect to car use reduction. Respondents were asked to indicate their agreement on these statements on a 7-point ordinal scale ranging from 'strongly disagree' (= 1) to 'strongly agree' (= 7).

Attitudes were also measured in a similar way as in the questionnaire on car purchase/ownership. Respondents were asked to indicate how it would be for them to reduce car use on 7-point scales, from 'very bad/harmful/unfavorable/foolish/unsatisfying/unpleasant' to 'very good/beneficial/favorable/wise/satisfying/pleasant'. Moreover, the ecological world view, value orientations, and environmental knowledge about car ownership/use were also included in the questionnaire. The same measures described previously were used. However,

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[4] In the main data collection in 2012, the frequency of car use for the seven specific trips was further differentiated into general car use frequency and electric car use frequency for battery electric car owners (see update notes in Appendix V).

these measures were only presented if the person was not the same person filling out the questionnaire on car purchase/ownership[5].

<u>Socio-demographic and household characteristics</u>

Finally, the same background measures on the questionnaire on car purchase/ownership were included on the questionnaire on car use. However, these measures were also only presented to those who were not the same person as the one who filled out the car purchase/ownership questionnaire.

Data Analyses Strategy

Since each of the studies included in this thesis has its specific goals, different approaches were used to analyze the collected data.

Study I

To uncover the underlying structure of psychological measures formulated in the questionnaire about car purchase, exploratory factor analyses applying maximum likelihood estimation were performed on the data collected in 2011. The reliability of the underlying latent constructs was assessed using Cronbach's alpha. The analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 19.

A latent class cluster analysis was conducted to identify car type classes using the latest purchased car's features, such as engine size, engine power, body type of car (categorical), drive system (categorical), fuel type (categorical), and make (categorical). Compared with more traditional approaches, for example hierarchical or k-means cluster analysis that "group cases together that are 'near' to each other according to an ad hoc definition of 'distance'" (Raggi, Mary, Santini, & Paloma, 2013, p. 7), latent class cluster analysis is "a model-based approach that offers a probability-based classification through a posterior probability of membership" (Costa et al., 2013, p. 4). The Akaike information criterion (AIC), Bayesian information criterion (BIC), and bootstrapped - 2 Log-likelihood (2LL) difference tests were used to assess the cluster solutions obtained by the analysis. The contribution of each predictor variable to the cluster solution was examined by the Wald statistic, and p-value (Haughton, Legrand, & Woolford, 2009; Vermunt & Magidson, 2002). The analysis was conducted using LatentGOLD 4.5 (Vermunt & Magidson, 2010).

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[5] In the pilot data collection in 2011, 5% respondents, who filled out the survey on car use, indicated they were not the same person who had filled out the survey on car purchase/ownership. In the main data collection in 2012, 6% respondents indicated they were not the same who filled out the survey on car purchase/ownership.

A path analysis was then conducted to test the integrative model for choice of car type class. Due to small sample size, the psychological variables were not modelled as latent variables but mean scores of these variables were used instead. Mplus (version 6) (Muthén & Muthén, 2010) was used to conduct the path analysis. Absolute goodness-of-fit indices such as the chi-square goodness-of-fit index and the standardized root-mean-square residual (SRMR), and relative goodness-of-fit indices such as the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the root mean square error of approximation (RMSEA) were used to evaluate the goodness-of-fit of the model. Traditionally, a CFI and a TLI close to 0.95, a RMSEA close to 0.06, and a SRMR close to 0.08 have been an agreed cut-off criteria, indicating a relatively good fit between the hypothesized model and the observed behavior (Hu & Bentler, 1999).

Study II

The data collected in 2012 from the survey on car purchase/ownership was analyzed to describe and compare socio-psychological profiles of car buyer groups. Once again, a latent class cluster analysis was performed among purchased conventional passenger cars to identify car type classes, from which groups of conventional passenger car buyers were differentiated. The analysis was conducted using LatentGOLD 4.5 (Vermunt & Magidson, 2010). Engine size, engine power, price, gear box type (categorical), drive wheel (categorical), fuel type (categorical), and body type (categorical) of the latest purchased conventional passenger cars were used as clustering predictors. The Bayesian information criterion (BIC), bootstrapped - 2 Log-likelihood (2LL) difference tests, Wald statistic and p-value for the contribution of each predictor variable were used to assess the cluster solutions.

Next, a series of analysis of variances (ANOVA) using post-hoc Bonferroni tests and Games-Howell-tests were performed to compare the groups of conventional passenger car buyers and another group of battery electric car buyers on continuous socio-demographic variables. In case where variance homogeneity was violated, the robust Welch/Brown-Forsythe-test was used. The analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 21.

A partial least squares path modelling (PLS-PM) approach was then conducted using XLSTAT software (Addinsoft, 2012) to examine the main psychological discriminators between the groups of car buyers controlling for respondent's age, gender, and income and education level. Constructs from the theory of planned behavior and the value-belief-norm

theory, together with relative importance of car attributes[6], were included in the analyses. There were several reasons to use the partial least squares path modelling to conduct the analyses. First, it produces robust estimators that do not depend on a specific distributional hypothesis (Jöreskog & Wold, 1982). Moreover, it efficiently manages data with large number of variables and presents a very flexible alternative method to multi-block analysis (Tenenhaus & Hanafi, 2010). It is also known to be robust to multicollinearity (Haenlein & Kaplan, 2004) and suitable for complex models with a large number of indicators or latent variables, or both (Chin, 2010).

The measurement models of the latent psychological variables were examined prior to the partial least squares path modelling. The reliability of the measurement models was assessed at both construct level (i.e., using Dillon-Goldstein's rho), and indicator level (i.e., examining the factor loadings). For the reliability at the construct level, a Dillon-Goldstein's rho (DG rho) value of 0.7 or higher is required (Hair, Ringle, & Sarstedt, 2011). The validity of measurement models was examined in relation to the convergent and discriminant validity of the latent psychological variables. An average variance extracted value larger than 0.5 is considered satisfactory as convergent validity. Discriminant validity could be stated if the average variance extracted value of a latent psychological variable is larger than the variable's highest squared correlation with any other variable (Fornell & Larcker, 1981).

Once the validity and reliability of the measurement model were verified, each of the latent psychological variables was regressed on the groups of car buyers (dummy coded). The analysis was controlled for gender, age, household income and education level of car buyers. The significant difference between unstandardized regression coefficients from groups to a latent psychological variable and their 95% confidence intervals, were used to reveal group differences on latent psychological variables.

More specifically, the intercepts represent the mean values of the latent psychological variables for the reference group. The unstandardized regression coefficient of each group (dummy coded) on a latent psychological variable indicate the mean difference between the reference group and the respective group. A positive b shows that the reference group had a lower mean on the latent psychological variables and vice versa. The p values shows if the difference was significant. Overlapping confidence intervals (i.e., 95% CI) between unstandardized regression coefficients for any two groups indicate a statistically non-significant mean difference on a latent psychological variable.

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[6] Exploratory factor analyses performed on 28 different car attributes revealed three factors, i.e. convenience attributes, performance attributes, and environmental attributes.

Study III

As an extension of the first study and the second study, an extended version of integrative model for choice of car type class was proposed and tested using the same data set analyzed in previous study (i.e., Study II). The integrative model was tested against the theory of planned behavior, a normative model, and combination of both through structural equation modelling approach using Mplus (version 7) (Muthén & Muthén, 2012).

Prior to the structural equation modelling analysis, a one-way between subjects analysis of variances (ANOVA) was performed to examine average fuel efficacy of the conventional passenger car type classes, which were identified in Study II. In case where variance homogeneity was violated, the robust Welch/Brown-Forsythe-test was used. Based on the results, an ordered categorical variable 'car type choice' was created with increasing fuel-efficiency, as battery electric cars were treated as the most fuel-efficient group. The variable 'car type choice' was then used as the behavioral outcome variable in the model.

The measurement model of the latent psychological variables[7] was tested using confirmatory factor analysis. For the environmental knowledge construct, Samejima's graded response model (Baker & Kim, 2004; Du Toit, 2003) was specified. The weighted least squares mean and variance adjusted (WLSMV) estimator was chosen because this procedure "provides for asymptotically unbiased, consistent and efficient parameter estimates and correct goodness of fit indices for variables that have a non-normal distribution" (van Dierendonck et al., 2008, p. 475).

After modification of the measurement model of the predictor variables based on the confirmatory factor analysis results, combined measurement and structural models were tested using the WLSMV estimation for the theory of planned behavior, a normative model, combination of both, and an integrative model. The ordered categorical variable 'car type choice' created in the previous step was used as final dependent variable in the models. The goodness-of-fit of both measurement and structural models were evaluated by applying the chi-square goodness-of-fit index, the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis Index (TLI). Recommendations by Hu and Bentler (1999) were followed.

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[7] Indicators of the latent psychological variables were all treated as ordered categorical due to non-normal distribution.

Study IV

Using the data from both of the surveys on car purchase/ownership and car use from 2012's data collection, the rebound and psychological spillover effects were explored. To examine possible rebound effects, the differences between conventional passenger car buyers and battery electric car buyers on the number of cars they or their household own, miles they drove in 2011 and anticipated to drive in 2012, and the percentage of trips they used the car for the seven specific trips were analyzed by means of several analyses of variances (ANOVA). In cases where variance homogeneity was violated, the robust Welch/Brown-Forsythe-test was used. The ANOVAs were conducted using Statistical Package for the Social Sciences (SPSS) version 19.

In a second series of analyses, in order to investigate possible psychological spillover effects (i.e., possible impacts of the potential predictors of car purchases on their respective pendants from car use) and to evaluate the effect of purchased car type on these relationships, a series of structural equation modelling comparisons was performed with the statistical tool Mplus (version 7) (Muthén & Muthén, 2012). For these comparisons, a range of psychological variables – constructs from the theory of planned behavior and the norm activation theory – from both surveys on car purchase/ownership and car use were examined. Prior to the structural equation modelling analyses, the discriminant validity and reliability of the measurements were examined using principal component analyses and Cronbach's alpha.

In each structural equation modelling analysis, a 'model A' was first specified that includes a regression from the latent variable specific to car purchase (e.g., attitudes toward purchasing a fuel-efficient and more environmentally friendly car) on its respective pendant specific to car use (e.g., attitudes toward reducing car use). The resulting regression weight indicates how similar the answering patterns are for the same construct compared between car purchase and use. The more positive the estimate, the stronger would be the sign for positive psychological spillover effect. The measurement model of the latent variable specific to car purchase and its respective pendant's measurement model were specified as close to the measurement invariance as possible. In addition, the purchased car type (dummy coded as 0 = conventional passenger car, 1 = battery electric car) is regressed on the latent variable specific to car use. The estimate here is then the mean difference in car use variable between conventional passenger car buyers and battery electric car buyers. A negative value indicates lower means for battery electric car buyers.

In the next step, a 'model B' was specified by including the interaction between the purchased car type and the latent variable specific to car purchase in the 'model A'. The aim was to examine if the relation between the corresponding variables for car purchase and use are different for battery electric buyers and conventional passenger car buyers. A negative estimate would indicate a weaker relation for battery electric car buyers. It was tested if the inclusion of the interaction in the model would increase the relative model fit.

A full information maximum likelihood (FIML) method was applied to handle missing data. In this approach, missing values are not imputed, and the model parameters were directly estimated from the available data using a maximum likelihood algorithm (Peyre, Leplège, & Coste, 2011). The goodness-of-fit of 'model A' was evaluated using recommendations by Hu and Bentler (1999). The chi-square goodness-of-fit index, the root mean squared error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis Index (TLI) were used. The Bayesian information criterion (BIC) for 'model B' and the relative improvement in model fit ΔBIC were used to evaluate if 'model B' fitted the data better than 'model A', and the interaction was only interpreted in these cases. A negative ΔBIC would indicate that including the interaction in 'model B' increased the model fit.

Ethical Considerations

The research was approved by the Norwegian Social Science Data Services, which sets strict rules about personal protection and privacy of potential participants of research in social science. All of the individuals contacted were informed about the confidentiality rules in the invitation letter. They were ensured that their privacy would be protected following regulations of the Norwegian Social Science Data Services. No separate consent was obtained, but participants were considered to have given their consent when they chose to fill out the online surveys. The collected data were subsequently anonymized.

RESULTS

Study I: Exploring the Determinates of Car Type Choice

Published in *Transportation Research Part A: Policy and Practice* in February 2013.

In the first paper, "Influences of car type class and carbon dioxide emission levels on purchases of new cars: A retrospective analysis of car purchases in Norway", we proposed a comprehensive analysis of the determinants of car purchases, including socio-demographics, psychological variables and brand loyalty. Additionally, an empirical study based on the pilot data collection was reported that attempts to address the question of whether decisions to purchase a new car are primarily based on car size class or made across the borders of car size classes.

Consequently, there were three purposes to Study I: (i) to test the feasibility of a full-scale study, and to validate the psychological constructs that are proposed in various socio-psychological theories as important in consumer decision-making; (ii) to test an approach of classifying car type classes using objective car features, such as engine size, engine power, body type of car, drive system, fuel type, and make; and (iii) to examine the applicability of an integrative model for choice of car type class, which is based on comprehensive action determination model (Klöckner & Blöbaum, 2010).

Data were gathered in April/May 2011 using an online survey on car purchase/ownership. From a sample of 232 respondents, 34 were excluded either due to 50% or more missing data for a multi-item predictor or being extreme univariate/multivariate outliers. The results of the exploratory factor analyses indicated that two descriptive norm items and another two subjective social norm items formed a distinct factor, which was later referred to as social norm. Only two out of four perceived behavioral control items reflected a common factor. For introjected norm, integrated norm, intention, attitude and ecological world view, unidimensionality could be confirmed. Except for perceived behavioral control, reliability of the underlying constructs was acceptable (ranging from 0.75 to 0.90).

The results of a latent class cluster analyses, which was used to differentiate car type classes, indicated that the model with four classes emerged as the one with the best relative model fit concerning the Bayesian information criterion (BIC). Although the bootstrapped - 2 Log-likelihood (2LL) difference tests indicated a significant improvement of the models with five and six classes as well ($p \leq .001$), the improvement was, however, larger for the step from three to four classes than for any other except the step from one to two classes. The Wald

statistic showed that all car features except make contributed significantly ($p < .05$) to the four-class solution. Accordingly four car type classes (Table 3) were retained, and used in the subsequent path analysis.

Table 3: Profiles of the four car type classes ($N = 198$)

	Class 1 (34.71 %)	Class 2 (22.54%)	Class 3 (20.31%)	Class 4 (22.44%)
Average engine size	1.95	1.49	1.60	2.21
Average Engine power	138.84	113.44	107.03	158.38
Fuel type (%)				
Petrol	0.08	54.57	1.29	9.15
Diesel	98.46	36.50	98.70	90.83
Other	1.45	8.92	0.01	0.01
Body type of car (%)				
3-door compact	1.13	9.51	4.88	0.02
5-door compact	13.65	65.34	30.44	7.24
Fastback	0.00	2.23	2.48	0.01
Station wagon	36.69	7.01	42.21	28.41
SUV	32.57	0.15	0.15	57.38
Other	12.95	15.75	19.83	6.94
Drive system (%)				
Front wheel	59.05	91.15	87.38	3.59
Back wheel	0.02	6.52	0.03	18.14
Four wheel	40.93	2.33	12.58	78.27
Most popular makes (%)				
	VW (20.1)	Toyota (24.5)	Peugeot (22.3)	Volvo (31.3)
	Ford (16.7)	VW (11.7)	VW (22.2)	BMW (17.9)
	Skoda (14.1)	Opel (9.0)	Ford (18.2)	Mitsubishi (13.3)
	Volvo (10.3)	Nissan (8.9)	Volvo (12.5)	Mercedes (11.2)
	Audi (8.4)	Ford (8.8)	Skoda (9.9)	Audi (9.2)

For categorical variables only the most relevant alternatives were named.

The car type Class 1 consisted of larger station wagons and SUVs, most of them were front-wheel drives but with a significant fraction of four-wheel drives. Almost all cars in Class 1 were diesel cars, and engine size and power of cars in Class 1 were larger than of cars in Class 2 and Class 3. Cars in Class 2 and Class 3 were characterized by smaller engines and less engine power, with most cars in those classes having front-wheel drives. The difference between Class 2 and Class 3 was that cars in Class 2 were five-door compact cars with a rather high probability of standard petrol engines, whereas the cars in Class 3 were more likely station wagons almost exclusively having diesel engines. Class 4 was the class consisting of the most powerful cars with the largest engines, most likely diesel and four-wheel drives. Most of these cars were SUVs and large station wagons.

The results of the path analysis showed a good fit of the adapted model ($\chi^2 = 73.05$, $df = 60$, $p = .120$; RMSEA = .033; CFI = .980; TLI = .946; SRMR = .025). CO_2 emissions of the purchased car would be significantly higher if the car was chosen from car type Class 1, and even higher if the car was chosen from car type Class 4 than from car type Class 3 (i.e., the

reference group). Males tend to purchase cars with higher CO_2 emissions than females. Individuals who live in the suburbs turned out to purchase cars with lower CO_2 emissions than others. Moreover, individuals who had stronger intentions to purchase more fuel-efficient and environmentally friendly car purchased cars with lower CO_2 emissions than others. Finally, individuals who had stronger brand loyalty seemed to purchase cars with higher CO_2 emissions, and individuals perceived higher behavioral control over purchasing more fuel-efficient and environmentally friendly car purchased cars with lower CO_2 emissions. Nevertheless, the impacts of brand loyalty and perceived behavioral control were not significant.

Having university level education and being older were positively and significantly contributed to purchasing a car from car type Class 1. Perceived higher behavioral control, on the other hand, had a negative and significant impact on purchasing a car from car type Class 1. Both intention and brand loyalty seemed to have a negative impact on purchasing a car from car type Class 1. However, their impacts were not statistically significant.

Purchasing a car from car type Class 2 was positively and significantly associated with living in the suburbs. Individuals who had larger households, however, were significantly less positive to make purchases from the car type Class 2. Likewise, individuals who had stronger brand loyalty seemed to be less positive to purchase a car from car type Class 2. On the other hand, intention seemed to have a positive influence on such a purchase. Yet, the impacts of brand loyalty and intention were not statistically significant.

Brand loyalty turned out to be the only significant predictor of making purchases from car type Class 4. Individuals with larger households seemed to prefer cars from this car type class as well. The impact of intention and perceived behavioral control were trivial for purchasing a car from car type Class 4.

All proposed relations between the psychological variables were significant. Intention to purchase more fuel-efficient car was predicted by positive attitude, stronger social norm and integrated norm, and higher perceived behavioral control. Integrated norm had the strongest effect on the intention to purchase more fuel-efficient car, and perceived behavioral control had the weakest impact. Integrated norm was predicted by attitude, social norm, introjected norm, and ecological world view (NEP). Attitude had the strongest, while the impact of ecological world view had the weakest impact on integrated norm.

The most important finding of the study is that intention had strong and direct impact on CO_2 emissions of the purchased car, and its impact was independent of the purchased car's car type class. In other words, individuals, who had a strong intention to purchase a more fuel-

61

efficient and environmentally friendly car, would make their purchase decisions not only out of consideration of important car features across traditional car size classes but also out of pro-environmental considerations. It seems thus possible to suggest that individuals first make a choice among car type classes by considering various car features and then consider CO_2 emissions of cars within the chosen car type class. This implies that methods aiming to facilitate adoption of cleaner cars could benefit from inducing changes in attitudes and norms. Meanwhile, the strong impact of brand loyalty on purchase of cars from car type Class 4 indicates certain car makes, especially large, powerful, and prestigious cars, still carry important value for some segments of the population. Therefore, incorporation of further technological developments in such cars seems to be essential in making the car fleet cleaner.

Study II: Profiling Car Buyers

Published in *Travel Behaviour and Society* in January 2016.

In the second paper, "Comparison of socio-psychological characteristics of conventional and battery electric car buyers", the possibility that conventional passenger car buyers could be further differentiated into heterogeneous consumer groups, which have different reasons for buying the specific type of car, was explored and compared with a group of battery electric car buyers. Consequently, the purpose of the study was twofold. The first objective was to obtain car type classes, and then consumer groups, through clustering the latest purchased conventional passenger cars using its important car features as indicators. The second objective was to validate the classification approach and explore consumer groups in terms of socio-demographic and psychological profiles.

The dataset, which was collected in 2012 using an online survey among battery electric car owners and internal combustion engine car owners, was used for this investigation. For the analyses, the responses of 1421 conventional passenger car owners who bought a new car for private use in the last two months of 2011, and responses of 372 battery electric car owners who bought a new battery electric car in 2011, were used.

Once again, a latent class cluster analysis similar to the one applied in the Study I was performed in order to identify car type classes among purchased conventional passenger cars. Although model fit indices (e.g., log-likelihood, AIC, and BIC) indicated that cluster solutions get better with increasing number of clusters, a 5-cluster model had the second best entropy R-squared. Moreover, after 5 clusters, the increase in model fit flattened out considerably, and the resulting clusters got smaller in size (i.e., around 100 or less cases within classes). Thus a

5-cluster model was preferred in favor of a better model-parsimony and interpretability. As indicated by the Wald statistic for the contribution of each predictor, all of the clustering predictors contributed significantly to the 5-cluster solution ($p < .05$).

Car type Class 5 (named as 'crossover SUVs & powerful cars') consisted of the most powerful cars with the largest engines (see Table 4). These cars were most likely diesel and four-wheel drives with automatic gear, and the most expensive. More than half of these cars were crossover SUVs, and other third of them were large station wagons. Car type Class 2 (named as 'large family cars & compact SUVs') consisted of the second most powerful cars with larger engines. These cars were also most likely diesel, but only about half being four-wheel drives and with automatic gear. The average price of these cars followed right after the car type Class 5. About a third of them were station wagons, and a third of them were compact SUVs.

Table 4: Profiles of the conventional car type classes ($N = 1421$)

indicators	Class 1 ($N = 373$)	Class 2 ($N = 330$)	Class 3 ($N = 307$)	Class 4 ($N = 216$)	Class 5 ($N = 195$)
Average engine size (l)	1.58	1.98	1.41	1.77	2.27
Average engine power (hp)	108.65	141.08	103.36	113.76	164.23
Average price (NOK[a])	328,970	464,565	268,762	344,796	647,965
Fuel type (%)					
Petrol	0.03	3.80	62.65	2.87	5.12
Diesel	99.97	96.20	26.92	97.13	94.88
Hybrid			10.43		
Gearbox type (%)					
Manual	77.23	47.72	66.91	99.94	21.69
Automatic	0.99	33.22	28.00	0.04	78.30
EMG[*]	13.41			0.01	
DSG[**]	8.37	19.06	5.08	0.01	0.01
Body type (%)					
3-door compact	3.09	0.87	3.18		
5-door compact	20.63	9.39	56.16	0.69	2.08
Fastback	1.63	0.71	1.00		0.83
Station wagon	48.58	35.11	18.59	12.55	31.65
SUV	4.35	31.81	3.53	86.74	54.36
Multivan	17.52	17.58	16.24	0.02	0.92
Sedan	4.19	4.52	0.97		9.65
Convertible			0.32		0.51
Drive system (%)					
Front wheel	96.23	46.51	91.76	66.78	6.09
Back wheel		4.18	1.91	0.01	11.73
Four wheel	3.77	49.30	6.33	33.22	82.18
Typical examples	VW Golf Ford Focus Peugeot 508	VW Sharan VW Tiguan Ford Kuga	Toyota Auris Skoda Fabia VW Polo	Mitsubishi ASX Hyundai i40	Mitsubishi-Outlander BMW X3 Volvo XC70

[a] 1 NOK ≈ 0.1355 Euro; * EMG = Electronic Manuel gearbox; ** DSG = Direct Shift Gearbox

Almost all cars in car type Class 4 (named as 'compact crossovers') were diesel fueled with manual gear. While the average engine size and power of them were lower than in Class 5 and Class 2, the average engine size and power of them were larger than in Class 1 and Class 3. They were most likely compact SUVs with front-wheel drive.

Cars in Class 1 (named as 'mid-size family cars') and Class 3 (named as 'compact cars') were characterized by smaller engines and less engine power, with most cars in those classes having front-wheel drive with manual gear. The difference between Class 1 and Class 3 was that half of the cars in Class 3 were 5-door compact cars with a rather high probability of standard petrol engines, whereas half of the cars in Class 1 were more likely station wagons exclusively having diesel engines.

Battery electric cars were mostly consisting of 2nd generation small electric cars (e.g., Citroen C-Zero, Mitsubishi I-MIEV, Peugeot ION), which are back wheel driven five door compact cars with average price of NOK 250,459. There were also substantial amounts of Nissan leaf, which are larger, front wheel driven five door compact cars with an average cost of NOK 280,881. A small fraction of 1st generation smaller electric car (i.e., Think) was also evident, and it has an average price of NOK 230,773.

Subsequently, five groups of conventional passenger car buyers and a group of battery electric car buyers were obtained. The comparison of these six groups on selected demographic and household characteristics using a series of analysis of variances (ANOVAs) indicated that there were significant differences between groups regarding age (Welch F $(5/641.77) = 11.21$, $p \leq .001$), number of people per household (F $(5/1502) = 16.50$, $p \leq .001$), number of children per household (Welch = 18.90, df = 5/654.54, p $\leq$ .001), and number of cars per household (Welch F $(5/654.31) = 34.41$, $p \leq .001$). Subsequent Post hoc Games-Howell tests and Bonferroni test indicated that individuals from the group of battery electric car buyers were significantly younger, and had significantly more household members, children, and cars per household than individuals from any groups of conventional passenger car buyers ($p \leq .001$). The differences between the five groups of conventional passenger car buyers were, however, not significant on these variables.

The group of battery electric car buyers consisted of individuals who had higher education and higher income compared to groups of conventional passenger car buyers. Almost all individuals in the group of battery electric car buyers were working. Among the five groups of conventional passenger car buyers, individuals who bought a new car from Class 2 ('large family cars & compact SUVs') and Class 5 ('crossover SUVs & powerful cars') had higher income than individuals from the other three groups. The group that

purchased a car from car type Class 3 ('compact cars'), meanwhile, had a high percentage of retired individuals and a lower income level than other groups.

Prior to a partial least squares path modelling (PLS-PM) approach to study the main psychological discriminators between these six groups, the measurement models of the latent psychological variables were examined. Several indicators were excluded in order to achieve sound validity and reliability. After modification of the measurement models, all psychological variables had a composite reliability (i.e., DG. rho) larger than 0.7 and convergent validity as indicated by average variance extracted (AVE) greater than 0.5. The squared correlations between psychological variables were smaller than the average variance extracted (AVE) of any constructs in the model. The modified measurement model thus exhibited good reliability (at both indicator and construct level), and good convergent and discriminant validity.

The results of partial least squares path modelling (PLS-PM) analysis indicated that the reference group – buyers of cars from Class 3 ('compact cars') – assessed the car's convenience attributes (Att.C) and performance attributes (Att.P) as important, but the car's environmental attributes (Att.E) as of little importance. They stated a favorable attitude (ATT) towards purchasing a more fuel-efficient and environmentally friendly car, a rather high level of perceived behavioral control (PBC), and a rather strong intention (INT) to buy more fuel-efficient and environmentally friendly car. While scoring rather high on self-transcendence (STV), openness to change (OCV), and conservation-tradition (CTV) value orientations, as well as on the ecological worldview (GEB), the members of this group reported rather low values on awareness of need (AN), awareness of consequences (AC), ascription of responsibility (AR), introjected norm (IJN), integrated norm (IGN), descriptive norm (DN), and subjective social norm (SN) in relation to buying more fuel-efficient and environmentally friendly cars.

The next two groups – buyers of cars from Class 1 ('mid-size family cars') and Class 4 ('compact crossovers') – exhibited no significant difference from each other on examined psychological variables indicated by the 95% confidence intervals of the unstandardized regression coefficients. These two groups evaluated the car's convenience and performance attributes significantly more important than the reference group. For other psychological variables, there were no significant difference between them and the reference group. As 95% confidence intervals of the unstandardized regression coefficients indicated, these two groups showed significant differences from the buyers of cars from Class 5 ('crossover SUVs & powerful cars') on many of the psychological variables.

The remaining two groups – buyers of cars from Class 2 ('large family cars & compact SUVs') and Class 5 ('crossover SUVs & powerful cars') – also exhibited no significant difference between each other on examined psychological variables. These two groups, however, differed significantly from other groups, especially from the group of battery electric car buyers, on most of the psychological variables examined. In general, they evaluated the car's convenience and performance attributes as very important, reported rather weak intentions, and not so favorable attitudes to buy a car that is more fuel-efficient and environmentally friendly. For norm related constructs, they reported the lowest values of all groups.

The last group – buyers of battery electric cars – generally evaluated car attributes as of little importance. Although members of this group still reported low awareness of consequences, ascription of responsibility and subjective social norm, the values were significantly higher than in the reference group. In addition, perceived behavioral control, attitude, and intention to buy more fuel-efficient and environmentally friendly were the highest among all groups.

To summarize, the highest level of distinction existed between the buyers of battery electric cars and buyers of conventional passenger cars. Among the five groups of conventional passenger car buyers, the difference was larger between buyers of big/powerful cars (i.e., Class 2 and Class 5) and buyers of small to medium size cars (i.e., Class 1, Class 3 and Class 4) than within these segments. Attitude toward convenience and performance attributes of car, attitude and intention toward purchasing more fuel-efficient and environmentally friendly car, awareness of consequences, and integrated norm turned out to be the main discriminators between the groups.

The findings imply that tailored marketing measures can be efficient in encouraging consumers to adopt cleaner cars. Given the low level of perceived social pressure and intrinsic motives towards buying cleaner cars among individuals, stakeholders (e.g., government, industry, marketers, and environmental groups) need to construct a discourse to highlight and raise awareness among the general public about the positive sides of adopting cleaner cars. At the same time, crowding-out of 'intrinsic motivation' by extrinsic incentives (Frey & Oberholzer-Gee, 1997; Frey & Jegen, 2001) provided by the government should be addressed, and the social desirability of a change of purchase behavior should be emphasized.

Study III: An Integrative Approach to Car Type Choice

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In the third paper, "A comprehensive socio-psychological approach to car type choice", an extended version of integrative model for choice of car type was suggested based on the results of the previous two studies. Using the same dataset analyzed in Study II, it was examined how combinations of variables from different causal sources specified in the model affect consumers' car type choice.

The dependent variable of the model, i.e. purchase of a more fuel-efficient car type, was an ordinal variable, which was created with increasing fuel-efficiency among car type classes identified in Study II. For this, a one-way between subjects analysis of variances (ANOVA) was performed on average fuel efficiency of the five internal combustion engine car type classes. The results showed that the average fuel efficiency differed significantly across the five internal combustion engine car type classes (Welch's F (4, 540.29) = 360.87, $p \leq .001$). Dunnett's T3 post-hoc comparisons indicated Class 3 ('compact cars') and Class 4 ('compact crossovers') did not differ significantly in their average fuel efficiency ($p > .05$). All other comparisons between car type classes showed significant difference ($p \leq .001$). Consequently, Class 3 and Class 4 were combined into one group, and four groups among conventional passenger cars were retained with increasing average fuel efficiency. The created dependent variable - purchase of a more fuel-efficient car type - thus had five categories representing four internal combustion engine car groups and one battery electric car group. The least fuel-efficient internal combustion engine car group was coded as 1 and the battery electric cars group was coded as 5.

The confirmatory factor analysis, which was performed to test the measurement model of the psychological variables under investigation, indicated that the three perceived behavioral control items did not reflect one common latent variable. Therefore, one single perceived behavioral control item (i.e., "It was mostly up to me whether I would buy a fuel-efficient and environmentally friendly car") was selected in the subsequent analysis based on face validity. In addition, several indicators were also excluded from the measurement model due to low factor loadings and/or cross loadings. After modification, the statistical fit of the revised measurement models was acceptable (χ^2 = 11251.93, df = 2359, $p \leq .001$; RMSEA = .05; CFI = .94; TLI = .94).

The structural equation modeling analyses, which were performed to test the hypothesized relationship between car type choice and its predictors, revealed that the

extended version of the integrative model for choice of car type produced an acceptable fit to the data (χ^2 = 14264.26, *df* = 3097, *p* ≤ .001; RMSEA = .05; CFI = .92; TLI = .91). Compared to less complex models (e.g., theory of planned behavior, normative model, and combination of them), the proposed integrative model explained more variance in the final dependent variable – purchase of a more fuel-efficient car type (see Table 5).

The results indicated that the intention to buy a fuel-efficient car had the strongest and positive effect on choice of more fuel-efficient car types among all determinants. The number of cars in a household was the second strongest and positive predictor of purchasing a car from more fuel-efficient car type. However, the remaining socio-demographic and household characteristics had mostly small to medium impacts upon car type choices. Brand loyalty turned out to have the third largest effect on choice of a more fuel-efficient car type, but its effect was negative. In other words, among individuals who purchased a car from fuel-efficient car types, brand switching was more common. Meanwhile, the direct influence of perceived behavioral control on car type choice was positive but only marginally significant. However, it was observed that the perceived behavioral control influenced car type choice mostly through intention and personal norms. The assumption that variables from household characteristics affect perceived behavioral control over buying a car from more fuel-efficient car type was only observed for the number of cars in the household (which had positive impact) and household income (which had negative impact).

Intention to buy a fuel-efficient car was influenced significantly by personal norm, attitude toward buying a fuel-efficient car, perceived behavioral control, evaluation of relative importance of car's performance, convenience and environmental attributes [8]. While evaluation of relative importance of the car's environmental attributes had the strongest positive influence on the intention, evaluation of relative importance of the car's performance and convenience attributes had negative impacts on the intention. Awareness of consequences, social norm, and perceived behavioral control had positive and significant impacts on personal norm. Awareness of need and ecological worldview were confirmed to be preconditions for awareness of consequences as assumed in the model. The influences of specific knowledge about car ownership and use, and ecological worldview on attitude were also significant and positive.

The integrative model tested in the study therefore indicates that, in addition to the

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[8] Evaluation of relative importance of car's performance, convenience and environmental attributes were labelled as perceived hedonic, instrumental and symbolic attributes in the Paper III.

Table 5: Performance of the models

	β	*P*	R^2
Model 1 – Theory of planned behavior (χ^2 = 1177.37, *df* = 100, *p* ≤ .001; RMSEA = .08; CFI = .98; TLI = .97)			
Intention			.55
← Attitude	.41	≤.001	
← Social norm	.46	≤.001	
← Perceived behavioral control (PBC3)	.23	≤.001	
Car type choice			.11
← Intention	.30	≤.001	
← Perceived behavioral control (PBC3)	.08	≤.001	
Model 2 – Normative model (χ^2 = 6161.61, *df* = 345, *p* ≤ .001; RMSEA = .11; CFI = .91; TLI = .90)			
Awareness of need			.69
← Ecological worldview (NEP)	.83	≤.001	
Awareness of consequences			.81
← Awareness of need	.90	≤.001	
Personal norm			.92
← Awareness of consequences	.75	≤.001	
← Social norm	.34	≤.001	
← Perceived behavioral control (PBC3)	.13	≤.001	
Car type choice			.04
← Personal norm	.20	≤.001	
Model 3 – Theory of planned behavior and Normative model combined (χ^2 =7624.57, *df* = 582, *p* ≤ .001; RMSEA = .09; CFI = .92; TLI = .92)			
Awareness of need			.80
← Ecological worldview (NEP)	.89	≤.001	
Awareness of consequences			.85
← Awareness of need	.92	≤.001	
Personal norm			.92
← Awareness of consequences	.75	≤.001	
← Social norm	.32	≤.001	
← Perceived behavioral control (PBC3)	.13	≤.001	
Intention			.78
← Personal norm	.78	≤.001	
← Attitude	.18	≤.001	
← Social norm	-.03	n.s.	
← Perceived behavioral control (PBC3)	.13	≤.001	
Car type choice			.10
← Intention	.28	≤.001	
← Perceived behavioral control (PBC3)	.09	≤.001	

Table 5: Performance of the models (continued)

	β	P	R²
Model 4 – Integrative model for car type choice (χ^2 =13863.60, *df* = 3097, *p* ≤ .001; RMSEA = .05; CFI = .92; TLI = .92)			
Awareness of need			.80
← Ecological worldview (NEP)	.89	≤.001	
Awareness of consequences			.94
← Awareness of need	.38	≤.001	
← Ecological worldview (NEP)	.62	≤.001	
Personal norm			.91
← Awareness of consequences	.78	≤.001	
← Social norm	.26	≤.001	
← Perceived behavioral control (PBC3)	.11	≤.001	
Attitude			.32
← Car ownership/use knowledge	.09	≤.01	
← Ecological worldview (NEP)	.54	≤.001	
Perceived behavioral control (PBC3)			.01
← Number of cars in household	.09	≤.01	
← Driver's license holders in household	-.05	n.s.	
← Household size	-.01	n.s.	
← Household income	-.09	≤.05	
Intention			.92
← Personal norm	.39	≤.001	
← Attitude	.15	≤.001	
← Social norm	-.01	n.s.	
← Perceived behavioral control (PBC3)	.19	≤.001	
← Importance of car's performance attributes	-.13	≤.001	
← Importance of car's convenience attributes	-.12	≤.001	
← Importance of car's environmental attributes	.55	≤.001	
Car type choice			.23
← Intention	.33	≤.001	
← Perceived behavioral control (PBC3)	.05	≤.05	
← Brand loyalty	-.16	≤.001	
← Number of cars in household	.21	≤.001	
← Driver's license holders in household	-.13	≤.001	
← Household size	.13	≤.001	
← Household income	-.09	≤.01	
← Gender	-.06	≤.05	
← Age	-.05	n.s.	
← Education level	.07	≤.01	

β = standardized regression coefficient; R² = explained variance; Gender: female = 0

situational characteristics put forward by traditional car type choice models, past purchase behavior or brand loyalty, and variables from normative and intentional processes are important in influencing adoption of cleaner cars. The psychological constructs identified in the study are usually malleable. This implies that with proper design, management, and

communication strategies, measures to change target behavior would benefit from including messages that could elicit awareness, responsibility, social pressure, and personal norms among individuals who consider purchasing a car. In addition, campaigns should be carried out to eliminate the public perception that purchase of cleaner cars is the tradeoff between environmental attributes and performance/convenience attributes (Kurani & Turrentine, 2004). Moreover, manufacturers and brand managers can benefit from deploying experiential marketing techniques (e.g., interactive online design of the car), in addition to the standard marketing mix (e.g., focusing on functional features and benefits), to ensure consumer satisfaction, trust and attachment or loyalty to their cleaner cars (Brakus, Schmitt, & Zarantonello, 2009; Schmitt, 2000).

Study IV: Rebound and Psychological Spillover Effects

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In the fourth paper, "Positive and negative spillover effects from electric car purchase to car use", we asked if the purchase of a battery electric car would result in a rebound effect in terms of average number of cars owned, driving distance, and car use frequency for specific trips. Meanwhile, we investigated the possibility of psychological spillover effects from the purchase stage to the post purchase stage. Specially, the purpose of the study was to examine differences in car ownership and use between conventional passenger car buyers and battery electric car buyers, and relationships between potential psychological determinants of purchasing a cleaner car (e.g., battery electric car) and respective determinants of reducing car use.

The data set from the survey on car purchase/ownership and the survey on car use, which was collected in 2012, were used for this investigation. The results of analysis of variance (ANOVA) indicated that battery electric car buyers had on average significantly more cars per household (M = 2.09 cars; SD = .64) than conventional passenger car buyers (M = 1.58; SD = .65; $F (1/1787) = 184.50$, $p \leq .001$). Nearly half of conventional passenger car buyers only had one car in their household, 44.5% of them had two, with only 6.1% had more than two cars in their household. For battery electric car buyers, less than a tenth of them had the battery electric car as their only car, whereas three-quarters had two cars and around 15% of them had more than two cars in their household.

Battery electric car buyers reported a slightly higher annual millage in the previous year than conventional car buyers. Although the main effect for car type was not significant

($F_{(1/1762)} = .03$, $p > .05$), the annual millage in the previous year was increasing significantly with the number of cars per household in both groups ($F_{(2/1762)} = 17.81$, $p \leq .001$). In addition, the results showed a significant interaction effect of car type and number of cars per household ($F_{(2/1762)} = 4.69$, $p \leq .01$). More specifically, while conventional car buyers whose household own only one car reported significantly higher annual millage than battery electric car buyers whose households own only one car, battery electric car buyers whose households own two or more cars drove significantly longer in the previous year than conventional car buyers whose households own two or more cars.

When expected annual millage was compared, battery electric car buyers reported they would drive less than conventional car buyers. The results indicated a significant main effect from car type ($F_{(1/1502)} = 5.44$, $p < .05$) and the number of cars per household ($F_{(2/1502)} = 17.80$, $p \leq .001$), but no significant interaction effect from car type and number of cars per household ($F_{(2/1502)} = 2.02$, $p > .05$). In particular, there was no significant difference in expected annual mileage between individuals who own two or more cars regardless of car type, while individuals who only own a battery electric car reported lower expected annual mileage than individuals who only own a conventional car.

Moreover, individuals who only own a battery electric car reported almost identical annual mileage in the previous year and expected annual mileage for the current year. While all individuals who own two or more cars reported lower expected mileage than the previous year's annual mileage, the difference in mileage were much larger for individuals who own a battery electric car. For the electric car buyers who had more than two cars in the household, the standard deviation of the annual mileage in the previous year was extremely high, resulting in a very large bootstrapped confidence interval.

The comparison of car use frequency for seven specific trips revealed that battery electric car buyers reported to use their car(s) significantly more often than conventional car buyers for any kind of trips. For about 67% of trips to work/study, battery electric car buyers used their battery electric car. For trips to hospital/physician, shopping trips for household, trips to take/bring children to/from kindergarten, trips to visit family or friends, and leisure trips, battery electric car buyers used their battery electric car between 36% - 49% of the time. The battery electric car was used least for weekend away/holidays (around 8%).

The ten psychological constructs used in this study were measured by a minimum of three items each in both the buy and use stage, except for perceived behavioral control[9]. Principal component analyses on psychological constructs showed discriminant validity between these constructs in each stage. The reliability of the measurement models was assessed at the construct level using Cronbach's alpha, which ranged from 0.65 to 0.91 for constructs in the buy stage and 0.57 to 0.88 for constructs in the use stage.

The results of the structural equation modelling analyses (SEM) indicated that 8 out of the 10 'Model A's (described in the method section), i.e. with attitude (ATT), integrated norm (IGN), introjected norm (IJN), descriptive norm (DN), subjective social norm (SN), ascription of responsibility (AR), awareness of consequence (AC), and awareness of need (AN) in both buy and use stage, had sufficient model fit for the purpose of the study (see Table 6). The 'Model A' with intention (INT), however, had a relatively low fit. Model fit criteria for 'Model A' with perceived behavioral control (PBC) could not be estimated since only one item was used to measure the construct. Including the interaction between the purchased car type and the latent variable specific to car purchase in the model, i.e. 'Model B' (described in the method section), increased model fit in 2 out of 9 models indicated by a negative ΔBIC: awareness of consequences and introjected norms (see Table 6).

The results indicated that all relations between the same psychological variables for the buy stage (e.g., attitude towards buying more fuel-efficient car) and use stage (e.g., attitude towards reducing car use) were significant and positive. However, the grade of

Table 6: Unstandardized regression weights of 'Model A's and 'Model B's with model fit criteria

	Model A						Model B				
	B_{use}	B_{type}	BIC	RMSEA	CFI	TIL	B_{use}	B_{type}	$B_{intract}$	BIC	ΔBIC
ATT	.34*	-.28*	49314.13	.09	.94	.93	.37*	-.23*	-.17*	49314.79	0.66
INT	.42*	-.39*	35758.96	.10	.89	.83	.42*	-.38*	-.01	35766.41	7.45
PBC	.14*	.08					.15*	.20	-.04		
IGN	.62*	-.46*	34165.55	.05	.98	.98	.65*	-.43*	-.10	34168.48	2.93
IJN	.58*	-.37*	33912.35	.07	.97	.97	.62*	-.29*	-.17*	33906.66	-5.69
DN	.62*	-.04	32224.39	.06	.96	.95	.62*	-.05	-.01	32231.85	7.46
SN	.60*	.03	32715.78	.08	.94	.92	.62*	.02	-.08	32721.52	5.74
AR	.74*	.05	34059.07	.09	.93	.89	.75*	.06	-.06	34065.04	5.97
AN	.65*	.15	32422.30	.04	.99	.99	.65*	.15	-.01	32429.77	7.47
AC	.47*	-.49*	32789.45	.10	.94	.92	.52*	-.41*	-.23*	32780.96	-8.49

* $P < .05$

[9] Three perceived behavioural control items were too different to be integrated into one latent variable in both domains. Thus, only the item with the highest face validity was selected for subsequent analysis.

congruency for the psychological variables between the buy stage and the use stage varied considerably. While the ascription of responsibility (i.e., the responsibility attribution to self as one causes these consequences) was largely stable across the buy and use stage, the level of perceived behavioral control (i.e., the recognition of the own ability to perform a certain action) depended heavily on the stage. Additionally, attitudes and intentions were relatively specific to the use and buy stage as well. The norm related constructs overall exhibited high congruency between the buy and use stage.

Car type had a significant negative impact on the use related constructs for attitude, intention, integrated norm, introjected norm, and awareness of consequences. If the unstandardized regression weights were used, individuals who bought a battery electric car had on average .28 scale points lower attitudes, .39 scale points lower intentions, .46 scale points weaker moral obligations (integrated norm), .37 scale points weaker introjected norms to reduce their car use, and .49 scale points weaker awareness of consequences of car use than individuals who bought a conventional passenger car. For the remaining constructs in the stage of car use reduction, impacts of the purchased car type were negligible. Furthermore, the relationship between introjected norm about buying fuel-efficient car and introjected norm about reducing car use was significantly weaker for individuals who bought a battery electric car. The same results were observed for and awareness of consequences regarding car purchase and car use reduction.

The findings imply that a combination of the right purchase decision with pro-environmental post-purchase behavior is needed to achieve significant gains from technological advances adoption. Though estimated annual mileage did not imply any direct rebound effect, a probable increase in car ownership and frequent car use for the specific trips, together with the reduced motivation to reduce car use among battery electric car owners, may result in an increase in the total car traffic volume. At the same time, the reduced internal motivation to car use reduction among battery electric car owners may well become a source of resentment against traffic demand management tools, which are eventually inevitable in the process of sustainable car traffic. For environmental policy, the study implies that strategies encouraging consumer adoption of cleaner cars should also focus on the post-purchase stage of the behavior.

DISCUSSION

While passenger cars provide unprecedented possibilities for mobility, they are also associated with some of the most urgent problems the global community faces. Although advances in car technology are seen as a major strategy to tackle these severe challenges, the potential of such technological advances is heavily dependent on people's willingness to adopt (Potoglou & Kanaroglou, 2007), as well as their behavior in the post-purchase stage (Gärling & Steg, 2007).

The primary aim of the thesis was to explore and integrate the determinants influencing the adoption of cleaner cars (e.g., more fuel-efficient internal combustion engine cars and/or battery electric cars) as opposed to non-efficient ones, and to contribute to a broader understanding of the importance of these determinants. In particular, the focus was on the integration of determinants adopted from traditional economic models of car purchase decisions. More specifically, the thesis investigates the determinants put forward in choice modelling studies, with determinants put forward by socio-psychological models, in order to arrive at an understanding of how these determinants in combination might influence people's adoption and use of cleaner cars. In addition, the probability of rebound and spillover effects resulting from adoption of cleaner cars was explored. The explorations and integrations were conducted in the context of car purchase decisions and use in Norway with a special emphasis on battery electric car purchases.

Four studies were carried out to fulfill the aims of the thesis. In the following section, the main findings of the studies will be discussed with regard to pertinent research, in addition to their implications for policy and marketing. The general discussion of the thesis ends with an evaluation of the qualities and challenges of the studies.

Motivations behind Adoption of Cleaner Cars

Closely associated with the primary focus of the thesis, one of the objectives was to compare and contrast groups of conventional passenger car buyers and a group of battery electric car buyers on a range of potential determinants of adopting cleaner cars, which have been identified in previous research in choice modelling studies (Ahn et al., 2008; Caulfield et al., 2010; Potoglou & Kanaroglou, 2007; Whelan, 2007) and put forward by socio-psychological models (Bamberg & Möser, 2007; Klöckner & Blöbaum, 2010; Stern, 2000). Given the argument described in the introduction about categorizing passenger cars into car type classes

by analyzing important car features, identification of consumer segments based on their actual car type choice (i.e., their purchased cars' car type class) was considered to provide a sound segmentation of consumer groups. Accordingly, the close examination of potential determinants of the behavior was suggested to reveal the manifold motivational base of the consumer groups in depth.

In the second study (Paper II), it was discovered that socio-demographic characteristics differed mainly between individuals who bought a conventional passenger car and individuals who bought a battery electric car. The differences between groups of conventional passenger car buyers on socio-demographics were trivial. The results of the study indicated that buyers of battery electric cars were better educated, and had a higher level of awareness and acceptance of the problem than others. This confirms previous research findings about knowledge and pro-environmental consumer behavior (Fraj-Andrés & Martínez-Salinas, 2007; Laroche, Toffoli, Kim, & Muller, 1996). Given the fact that most of the battery electric cars were bought as an additional car or a replacement car to the household car fleet, it is not surprising to find the group of battery electric car buyers were economically well-off. Given the well-established relation between education level and income level, it is also intuitive that this group generally had high education levels.

Considering research findings that the purchase of more fuel-efficient cars and/or alternative fuel cars are affected by positive attitudes toward the new technology and innovativeness (Heffner et al., 2007b; Jansson, 2011; Musti & Kockelman, 2011; Peters et al., 2011; Turrentine & Kurani, 2007), it is also possible that the technical affinity of this group, not only the financial capabilities and considerations, might have contributed their adoption of battery electric cars. In addition, the significantly larger household size and more children in the household were observed in the group of battery electric car buyers. This finding seems to contradict previous studies that suggest that larger households less likely prefer hybrid electric cars (Musti & Kockelman, 2011). Yet, it is possible that the larger households chose the battery electric car perhaps for commute-use reasons due to reasonably cheap operation cost.

The comparison of potential psychological determinants of car type choice indicated an emerging general pattern among all groups of car buyers. For all groups, the results revealed that perceived social pressure (i.e., descriptive norm and subjective social norm) and intrinsic motives (i.e., moral norms and antecedes) toward buying more fuel-efficient and environmentally friendly cars were generally low with differing variations among the groups. Meanwhile, high levels of environmental concern (i.e., ecological world view) and altruistic values (i.e., self-transcendence and conservation-tradition) without much variation were

76

observed among all groups of car buyers. The apparent mismatch between the high level of altruistic values and environmental consciousness and the low level of normative concerns appear to be the result of a defensive denial strategy (Schwartz & Howard, 1980).

The defensive denial hypothesis states that individuals redefine high-cost situations in such a way that the activation of moral norms does not seem appropriate. Nevertheless, the relatively stable elements of personal belief structure, such as ecological world view and value orientations, are rarely affected by situational circumstances. On the other hand, in line with previous research, the Norwegian government's regulations and incentives might have resulted in crowding-out of consumers' 'intrinsic motivation' (Frey & Oberholzer-Gee, 1997; Frey & Stutzer, 2006), hence reducing the likelihood of activated moral norms. Furthermore, behaviors associated with high cost products might be less affected by interpersonal influences (i.e., social pressure) than personal capabilities and the extrinsic incentives. It might also be possible that people do not like to admit their personal investment decisions are affected by others.

While positive attitudes toward buying a more fuel-efficient car and high perceived behavioral control over buying it were experienced among all groups of car buyers to different degrees, the behavioral intention varied largely among the groups. It was noted that the behavioral intention was the weakest among buyers of big/powerful passenger cars (Class 2 and Class 5), but reached the strongest among the group of battery electric car buyers. The most plausible explanation for this attitude-behavioral intention relation is that those incentives and regulations from the Norwegian government might have caused positive changes in general public attitudes and perceived behavioral control over purchasing more fuel-efficient cars. However, in addition to the high level of positive attitude and perceived behavioral control, social norm or pressure is also required to form the behavioral intention (Ajzen, 1985, 1991). As the results indicated, normative concerns were not elucidated among all groups of car buyers. Moreover, situational constrains (e.g., larger household, residence location), previous vehicle experiences and brand loyalty might have circumvented cognitive deliberation among some of those car buyers. As a result, buyers of big/powerful passenger cars did not elaborate much on environmental consequences of their purchase compared to buyers of cleaner cars.

Furthermore, individuals who bought conventional passenger cars, especially from Class 2 and Class 5, might pay closer attention to the car's attributes during the decision-making process as the car is most probably bought as a main car; and therefore their positive attitudes toward buying a more fuel-efficient car might be traded off by their doubts about

convenience and performance attributes of cleaner cars. On the other hand, buyers of battery electric cars might be less occupied with evaluating car attributes while making the purchase decision. It would be that battery electric cars were mostly bought as an additional car or a replacement car to the household car fleet, and the overall evaluations of the car's attributes were less important for the purchase of such cars than for main cars (Schuitema, Anable, Skippon, & Kinnear, 2013). Accordingly, their behavioral intention was the strongest and determined possibly by changes in attitudes and perceived behavioral control, which have been impacted by those incentives and regulations from the Norwegian government.

Although individuals who bought small to medium size conventional cars from Class 1, Class 3 and Class 4 exhibited similar motivations of not purchasing a battery electric car as the buyers of big and powerful cars, their values on the potential psychological determinants indicate they were significantly more inclined to environmental protection. The same argument outlined above concerning the overall evaluation of car attributes, attitudes toward purchasing more fuel-efficient car, and whether the car bought as main or additional car to the household car fleet might be applied here as well. Additionally, these individuals might not have adequately strong economy to afford an additional battery electric car despite holding pro- environmental beliefs as the buyers of battery electric car. Consequently they might choose the alternative, i.e. purchasing a conventional car that is less environmentally harmful.

By examining socio-psychological profiles of groups of car buyers, this study contributed to the research in sustainable consumer behavior by verifying the manifold motivation profiles of individuals in high cost situations (Cleveland, Kalamas, & Laroche, 2005; Jansson et al., 2009; Stern, 2000). The examination of a wide range of socio-psychological variables in relation to purchase of a car could help in the understanding of consumer behavior for a high-cost high-involvement product, which has been called for in previous research (Stern, 2000; Thøgersen, 1999b). Meanwhile, the findings may provide points to consider while designing and implementing measure to facilitate adoption of cleaner cars.

To design effective measures to promote fuel-efficient cars and or battery electric cars, the results of the study suggest that campaigns have to be diversified in relation to the heterogeneous target population. In other words, demographic and household characteristics together with interests and attitudes of heterogeneous audience need to be considered for marketing campaigns to diffuse such cars. Cialdini and his colleagues (Cialdini & Goldstein, 2004; Griskevicius, Cialdini, & Goldstein, 2008) suggest that consumers will rely, to a higher degree, on social norms to guide their behavior in conditions of greater uncertainty. It might

therefore be necessary to highlight social norms and pressure among the general public to adopt cleaner cars. However, the results found in the study (Paper II) lend no conclusive support for this argument. It seems that individuals who purchased a new car rely less on perceived social pressure or social norm for the adoption of fuel-efficient cars or battery electric cars, which possibly results from people's tendency to underestimate the degree of social influence on their big purchase decisions. In other words, people just do not accept that their purchase decisions are influenced by others.

Given the low intrinsic motivation (e.g., problem awareness, responsibility attribution, and personal norm) evident among all groups of car buyers in the study, the adoption of cars with emergent technologies is most likely limited if no strong government policy is in place (Turcksin et al., 2013). Nevertheless, those incentives and regulation from the Norwegian government could be the cause for the low intrinsic motivations found among car buyers. This implies programs to raise awareness of the problems associated with car traffic are needed in addition to the current extrinsic incentives and regulations from the government. Stakeholders (e.g., government, industry, marketers and environmental groups) may therefore need to highlight environmental impacts of personal car travel, and encourage positive spillover effects from adopting cleaner cars to reducing car travel by appealing to individuals moral values.

Moreover, findings regarding knowledge, awareness and acceptance of problems among adopters of cleaner cars imply that contributing to the knowledge and associated learning of population may benefit promotion of cleaner cars (e.g., more fuel-efficient cars and/or alternative fuel cars). Based on this reason, the target population needs to be supported with a pro-environmental culture to create and set its own goals and rewards, and to uplift its own knowledge. Furthermore, the results of this study also confirmed previous research findings that purchase of cars with emergent technology is principally driven by convenience and performance attributes, whereas environmental attributes are of little importance (Turcksin et al., 2013). Hence, reducing the general public's concerns about the convenience and performance attributes of cars with technological advances (e.g., more fuel-efficient cars and battery electric cars) might well benefit further diffusion of such cars.

An Integrative Approach to Adoption of Cleaner Cars

The primary focus of the thesis was to evaluate the importance of demographic and household characteristics, psychological factors, and brand loyalty on people's car type choice. Although

variables at the individual-level were under scrutiny in this thesis, the impacts of macro-level conditions were not considered unimportant. Instead, the starting point of the research was to investigate the role of individual-level variables under the facilitating context, i.e. current developments in fuel technology worldwide, economic growth and stability in Norway, and the Norwegian government's rather aggressive policy measures promoting cars with emergent technologies.

Considering the argument that individuals' behavioral options of changing to cleaner cars in today's car market may not be appropriately reflected by traditional car size classes, it is deemed necessary to categorize cars into car type classes by taking into account important car features (e.g., engine power, fuel type, drive system) that differ between as well as within traditional car size classes. This contention was also based on the rationale that people start to consider several cars with similar attributes, which they refine down over time to the one they actually purchase.

The importance of determinants put forward in choice modelling studies (i.e., socio-demographics and household characteristics), and of determinants suggested in different psychological models was investigated in two separate studies (Study I and Study III) using a comprehensive action determination model as a base for integration of the determinants. The attempted integration was based on the perspective on pro-environmental behavior as complex tradeoff between contextual/situational factors, psychological variables, personal capabilities, and past behavior or habit (Stern, 2000). Though, as a general rule, a simpler model with good explanatory power should be preferred over a complex one attempting to accommodate different theoretical frameworks, a more comprehensive one may provide a better understanding of multifaceted motivation of people's behavior. This in turn can be used to design and implement a combined set of intervention measures to handle the challenges originated form the car travel. Moreover, the integrative model turned out to have at least twice as much explanatory power than simpler theoretical frameworks in Study III.

The results of both studies confirmed that psychological factors have a substantial influence on adoption of cleaner cars. This is in line with previous research investigating individual-level psychological factors and adoption of fuel-efficient or alternative fuel cars (Jansson et al., 2010; Peters et al., 2011). However, the relatively low impact of socio-demographics and household characteristics upon individuals' car type choices in both studies indicates that these variables have low explanatory ability if psychological determinants are controlled for. The finding seems to contradict previous studies that have implicitly or explicitly assumed the influences of psychological factors are limited in circumstances where

contextual or situational forces have much weight on high-cost behaviors performed occasionally (Bloch, Sherrell, & Ridgway, 1986; Ouellette & Wood, 1998).

The difference between the findings in this thesis and previous research in terms of socio-demographics, household characteristics and psychological factors may be related to the focus of the research. In previous research (e.g., Bloch et al., 1986), the focus was whether to purchase a major household good or not. Subsequently, the socio-demographics and household characteristics might be found useful in explaining individuals' adoption of products irrespective of type. In contrast, the specific focus on the people's choice of more fuel-efficient car types (i.e., cleaner cars) in this thesis was different from the decision of whether to buy a car or not. It might be argued that the purchase of high-cost product like cars involves a series of separate decisions with different predictors (Bamberg, 2012). At the initial stage, socio-demographics (as a proxy for personal capabilities) and existence of facilitating/hindering context (e.g., incentive structure or high tax rate) might be important regarding to buy a car or not. Once this stage is passed (i.e., a decision has been made to buy a car), the decision regarding when and which product type to buy becomes salient. At the later stage, the psychological factors – mostly mediated through intention – likely come into play in the decision processes of purchasing cleaner cars, which are relatively cheaper in Norway due to the incentive structure.

Another significant finding of both studies was the influence of brand loyalty on individuals' car type choice. The results indicate that people who are already loyal to a certain brand of car, especially in the large and powerful car type class, would most likely continue to purchase the same brand of car. A possible explanation would be that prestigious, powerful, and large cars may offer a certain level of affective and symbolic function (or social status) to some individuals (Steg, 2005). This result also complements past studies in the area of behavioral brand loyalty that indicate the significance of brand loyalty and past purchase experience on future car purchases (Ewing, 2000; Kiel & Layton, 1981; Newman & Staelin, 1972).

On the other hand, it is interesting that brand loyalty was not equally relevant to the same extent for the buyers of less fuel-consuming car type classes. Within more fuel-efficient car type classes, it seems that people are less occupied with brand, and brand switching is presumably more common. The reason might be that brands in more fuel-efficient car type class carry less affective and symbolic meaning, and differences between them might be perceived to be smaller than the differences in the large and powerful car type classes. As manufacturers today are developing more fuel-efficient cars in almost all classes and

81

categories (including alternatively fueled cars) with similar features, it might be further speculated that loyalty is reduced. In addition, battery electric cars, which were regarded as the most fuel-efficient car type, just hit the Norwegian car market when the research was initiated. As a result, loyalty to certain battery electric car brand among the respondents had yet hardly developed. Nevertheless, the latest development in the battery electric car market, especially battery electric cars from the prestigious (e.g., Tesla) and well-known brands (e.g., BMW, Mercedes, Volkswagen), is now affecting the dynamics of adoption of battery electric cars. Yet, further empirical investigations are required to confirm or refute the above speculations.

In both studies, the strongest effect on choosing cleaner car types was observed for intention, which in turn mediated all other psychological influences. Notably, intention predicted directly the CO_2 emission levels of the car even if it was controlled for car type class in the first study (Paper I). Given that car type classes based on important car features (e.g., engine power, fuel type, drive system) would determine CO_2 emissions and thus explain the variance within the CO_2 emissions to a large degree, the strong direct impact of the intention on the CO_2 emissions of the purchased car confirms the important role of psychological variables in people's choice of cleaner cars within a class. This leads to a subsequent consideration of whether it would then mean that people actually select cars with less CO_2 emissions within a car type class if they intend to be fuel-efficient or environmentally friendly. In other words, based on the study's findings, it can be assumed that the selection process should first differentiate car type class and then CO_2 emission levels within the class.

Normative constructs (e.g., personal norms and antecedes), attitudes, and perceived behavioral control were found to significantly influence the intention to choose a more fuel-efficient car. This confirms the results of previous research indicating pro-environmental behavioral intention mediate the impact of all other psychological variables on pro-environmental behavior (Bamberg & Möser, 2007; Klöckner, 2013; Klöckner & Blöbaum, 2010). Moreover, in the other study (Paper III), the result indicated that the intention to adopt a more fuel-efficient car was stronger if individuals evaluated the car's environmental attributes as more important. On the other hand, the intention was weakened if individuals evaluated the car's convenience and performance attributes to be more important. This suggests that people still hold the perception that choosing a more fuel-efficient involves sacrificing pleasure, comfort, safety, and performance associated with the car to some extent (Kurani & Turrentine, 2004).

Together, the results imply that an integrated set of determinants from choice modelling studies, psychological theories with regard to pro-environmental behavior, and past purchase behavior or brand loyalty provide a comprehensive understanding of cleaner car adoption. As a result, the comprehensive action determination model approach is confirmed as having promising potential in explaining purchase decisions about high-cost and high-impact products like passenger cars. The main implication for consumer research is that future research would be more valuable if psychological factors are included in explaining the purchase of high-cost efficiency-increasing products, instead of relying mainly on socio-demographics or household characteristics.

Although the one-off registration tax, tax reliefs, and other incentives for more fuel-efficient cars likely helped in increasing the sales of such cars in Norway, uncertainty about how long highly debated financial incentives and other benefits will last causes further concern. Moreover, changes in government policy and incentive structure might negatively affect consumer attitudes and perceptions of both regulations and the environmental impact of cars. Research evidence has indicated that a substantial proportion of consumers question the positive impacts of promoted environmentally friendly cars and call for more communication and debate on the subject (Egbue & Long, 2012). Possible changes in government policy may thus further fuel public resentment and widen the gap in the understanding of the environmental impact of such cars. Therefore, it seems necessary to underpin the high willingness to purchase fuel-efficient cars caused by policy incentives with matching psychological motive structures to make them robust.

Based on this background, incentive structures and policy decisions that consider consumers' multi-layered motivations would have a high level of success in the long run. With proper design, management, and communication strategies, packages that contain messages to elicit pro-environmental norms, and attitudes toward adopting more fuel-efficient and environmentally friendly cars will further increase the diffusion rate of such cars. From a business and marketing perspective, the results reported in Paper III, where consumers seemed to hold the perception of owning a fuel-efficient car as a trade-off against convenience and performance attributes, provide several insights for targeting potential adopters of fuel-efficient cars and/or battery electric cars. Firstly, it seems necessary to offer consumers both information and personal experience highlighting that fuel-efficient cars do not necessarily need to be smaller (at least in the same car type class), unreliable, or less pleasant in most everyday situations. This information would help consumers to overcome fears or doubts about the technical performance and practical aspects of such cars. Secondly,

environmental attributes, such as energy label and fuel-efficiency, should be promoted as popular features. Since the environmental effects of cars and traffic are widely known, highlighting the link between fuel-consumption and environmental problems would likely be effective. Finally, establishing and developing satisfaction, trust and attachment or loyalty to cleaner cars need to be one of the priorities for manufacturers and brand managers of such cleaner cars.

Rebound and Spillover Effects Associated with Adoption of Cleaner Cars

Since a change in a particular behavior and/or attitudes in a target area may lead to changes in behavior and/or attitude in other relevant areas (Frey, 1993; Jensen, 1992; Scott, 1977; Thøgersen, 1999a), it was attempted to investigate whether adoption of cleaner cars, more specifically adoption of battery electric car compared to conventional cars, would result in rebound effects as well as spillover effects from purchase to car use. However, it needs to be noted that the study was based on a cross-sectional retrospective design. Most of the variables under examination were based on self-reports, and they were not studied before the actual purchase behavior. Consequently, the self-reported changes in car use behavior and its potential determinants might not be the result of purchasing the battery electric car. The changes might simply have existed before the purchase. For example, positive attitudes toward reducing car use and positive attitudes toward buying more fuel-efficient car and/or battery electric car might have existed even before the purchase of such cars. Though this impedes reaching firm conclusion about the existence of rebound and/or spillover effects associated with adoption of battery electric cars, the findings can be useful in stimulating further research on the topic as well for evaluation of strategies currently implemented in Norway.

Given the finding that only a few individuals had the battery electric car as their only car, it is likely that most individuals kept at least one conventional car besides the newly bought battery electric car. This suggests that battery electric cars were most probably bought either as a substitute for one of the conventional passenger cars or as an additional car to the household car fleet. This implies that irrespective of the battery electric car being bought as an additional car or as a substitute, average household car ownership would probably not decrease. For individuals who did not substitute one of their conventional passenger cars with a battery electric car, this would then indicate a possible direct rebound effect in terms of car ownership. If this scenario holds true, at least for some proportion of battery electric car

buyers, it is then partially at odds with the findings from de Haan et al.'s (2006) study where no direct rebound effect in terms of car ownership was evident among Swiss hybrid car buyers. On the other hand, it might as well be possible that some battery electric car buyers had substituted one of their conventional passenger cars with a battery electric car. In this case, the average number of cars in the household car fleet is unchanged, which would then be in line with de Haan et al.'s (2006) study. One explanation would be that battery electric cars have range limitations compared to hybrid cars, which makes it difficult to drive battery electric cars for long distances (which are common in the Norwegian context). Therefore, most individuals had probably decided to keep conventional cars, at last one, in their household.

In terms of self-reported annual mileage for the previous year and expected annual mileage for the current year, the results indicated a significantly lower annual mileage for the previous year and expected annual mileage for the current year for individuals who had a battery electric car as their only car than for individuals who had a conventional passenger car only. In addition, individuals who had a battery electric car as their only car reported almost identical annual mileage in the previous year and expected annual mileage for the current year (i.e., no direct rebound effect in terms of expected annual mileage). This implies individuals who drove less with their only conventional passenger car most likely have substituted the car with a battery electric car. At the same time these individuals may probably drive their battery electric car not longer than they would drive with a conventional passenger car. The reason may be that these individuals could be genuinely concerned about the negative impacts of car use, and therefore they might drive less and/or avoid long distance car trips beforehand. Further, as being environmentally conscious, they might have preferred to further reduce their negative impacts on environment by substituting their only conventional passenger car with a battery electric car.

Meanwhile, the results showed self-reported annual mileage for the previous year and expected annual mileage for the current year increased significantly with the number of cars per household irrespective of car type. While expected mileage for all individuals who owned more than two cars were generally lower than the previous year's driving distance, individuals who bought a battery electric car would probably drive substantially less (i.e., no direct rebound effect in terms of expected annual mileage). This indicates individuals drove longer than others might also have added a battery electric car to their household's car fleet or substituted one of their conventional passenger cars with a battery electric car. Although the purchase and running costs of battery electric cars are generally low, the technical limitations

of the battery electric car (i.e., range limits, charging stations under construction) might have prevented individuals from using it for longer trips. As a result, individuals who bought battery electric cars as a substitute or additional car might have reported that they would drive less than in the previous year. Moreover, a social desirability bias might have occurred when individuals responded to the questionnaire. It is therefore possible that individuals who bought a battery electric car might have reported their future car use to be less than in the previous year.

The analyses of specific car trips indicated that individuals who bought a battery electric car reported to use the car more often for any kind of trips than individuals who bought a conventional passenger car. They also substituted most part of any given trips (except holiday trips) with using the battery electric car. Although most individuals did not seem to buy the battery electric car as the main car in their household, the pattern of battery electric car use imply that they use the battery electric car as the main car. Given the incentive structure found in Norway (e.g., free toll roads, free parking for battery electric cars), using the battery electric car for most of the daily car trips is a rational choice maximizing the expected benefits for those who bought the battery electric car (Scott, 2000). Moreover, the more frequent usage could likely result from the fact that battery electric car buyers in general had a larger household size with greater mobility needs. In turn, these factors could have encouraged those individuals buying a battery electric car in the first place. Although increased car use for specific trips among individuals who bought a battery electric car implies some signs of direct rebound effect, it does not necessarily translated into direct rebound effect in terms of mileage. What should be noted here is that while expected mileage was decreased among battery electric car buyers, a substantial part of this expected mileage might be covered with using a battery electric car.

The attempted analysis of potential psychological spillover effects indicated that while all norm-related potential predictors were strongly congruent between the purchase stage and the reduce stage, congruency between the two stages for the constructs from the theory of planned behavior were generally low. Particularly, congruency between perceived behavioral control over purchasing more fuel-efficient cars and perceived behavioral control over reducing car use was the lowest. A plausible explanation is that perceived behavioral control is related to a specific behavior and the ability to purchase a more fuel-efficient car (e.g., battery electric car) may be totally different from the ability to reduce car use. It would also be possible that people who felt not able to reduce their car use simply had chosen to purchase battery electric car (which they were capable of) (Thøgersen & Noblet, 2012) in order to

reduce cognitive dissonance (Festinger, 1957). In such cases, the congruency between perceived behavioral control at the purchase stage and the reduce stage would probably be negative. Moreover, this low congruency might be the results of the measurement of the construct as well. It is noted previously that perceived behavioral control was only measured with one item based on the face validity in the purchase and use stages.

The significant negative effects of the interaction between car type and awareness of the consequences for car purchase/ownership, and of interaction between car type and interjected norms for car purchase/ownership on the respective psychological determinants of car use reduction could be explained in relation to the norm activation theory (Schwartz, 1977). When individuals bought a battery electric car, they could possibly feel that their car use no longer has negative consequences for the environment, even if they would still think that car traffic in general is a problem for the environment. They might have a cleaner conscience because they already own an environmentally friendly car. Consequently, they might not perceive personal responsibility to car use reduction, and might ignore the other negative impacts of car use, such as car accidents, congestion, and space demands. As a result, their interjected norms (i.e., guilty feeling) in relation to car use reduction would not be activated. On the other hand, it might be possible that individuals who felt unable but had a bad conscience about their ability to reduce their car use might buy a battery electric car to feel less guilty about their car use (Thøgersen & Noblet, 2012).

Although the relationship between the psychological determinants of car purchase and the respective determinants of car use reduction seem to be in line with previous research on the positive psychological spillover effects between different behavioral domains (Thøgersen, 2004; Thøgersen & Ölander, 2003), it should be noted that the congruency or correlation between the same psychological construct in purchase and use (i.e., reduce) stage do not necessarily reflect the influence of the determinant at the purchase stage on the respective determinant at the post purchase stage. The correlations might be, at least partly, originate from the rather close formulation of measurements in purchase and use stage as well. Moreover, as described early, the correlational design of the study could not allow verification of possible psychological spillover effects associated with adoption of battery electric cars.

While the results of the study did not lend conclusive support for either rebound effect or psychological spillover effect resulting from the adoption of battery electric car, the study carries several implications. From a public policy perspective, the implication is that the effect and design of the existing policy measures may need to be re-evaluated. Although current incentives given by the Norwegian government are effective in promoting battery electric cars

87

and other fuel-efficient cars, it is highly probable that average household car ownership would increase if the policy and related benefits are continued in their current form. Therefore, plans have to be made to address possible rebound effect in relation to number of cars household own and increasing volume of battery electric car traffic. However, reduced motivations regarding car use reduction among battery electric car owners may well become a source of resentment against traffic demand management tools, which are eventually inevitable in the process of sustainable car traffic.

In addition, the results showed that individuals who substituted their only conventional passenger car with a battery electric car had a lower expected annual mileage. Even if this may purely be an effect of the buying behavior of this specific group, who only needs a battery electric car for short trips because they do not take long car trips in the first place, it seems beneficial to focus more on incentives that reward making the battery electric car a household's only car or include hybrid cars in the funding scheme. Moreover, since some signs of positive psychological spillover effects seem to have occurred between determinants of car purchase and car use reduction, it is imperative to consider strategies encouraging consumers' right purchase and subsequent sustainable use concurrently. As it is often deployed in government intervention strategies, it might well be the time to apply the 'stick' (e.g., applying reduced road tolls, parking fee for battery electric cars) since the 'carrot' (e.g., tax incentives, reduced annual fee) has resulted in wider acceptance of the product. This suggestion implies that attempts to change traffic behavior in an environmentally friendly direction could be more effective if the focus is both on individual's' purchase and subsequent use of the car.

Limitations

As described in the methods section, a cross-sectional retrospective design was used to investigate how potential determinants influenced people's car purchase and subsequent use behavior. Although such a study design enables examination of a wide variety of potential casual variables at a given point of time among a larger target population at reasonable cost, it has several shortcomings that affect interpretation of study results reported previously.

Firstly, the cross-sectional study does not allow asserting causality since behavior and its hypothesized determinants are simultaneously assessed (Carlson & Morrison, 2009; Mann, 2003). Though the hypothesized relationships between variables under investigation in the reported studies were based on generally accepted theoretical frameworks, there was lack of

evidence that those determinants actually underlie the adoption cleaner cars among the studied sample. In social psychology, it has long been debated whether attitudinal factors lead to behavior or are the result of behavior (Thøgersen & Ölander, 2006). It might be that changes in behavior caused changes in those determinants. For example, it is plausible that car owners reconstructed their perceptions and attitudes to match previously made purchase decision. In addition, even if it was attempted to shorten the time lag between the actual purchase behavior and the data collection[10], the retrospective nature of the studies might further intensify the fundamental issue of causality and reconstruction. It is possible that post-purchase experience might have affected car owners' views about the car. Accordingly, the responses might have been different if some of the purchase-related variables had been measured at the time of purchase.

Likewise, with regard to the analyses of possible rebound and spillover effects, the results could be more conclusive if car ownership, purchase and use behaviors, and their potential psychological determinants were assessed prior to car purchase and after the purchase. Specifically, respondents should have been asked whether the new car replaced an older existing car or was purchased as an addition car to the household car fleet. In the same way, information about car use frequency for specific trips prior to the purchase of the new car could have given clearer result to conclude that there was a rebound effect. Similarly, a stronger statement about psychological spillover effects could have been made if changes in potential psychological determinants of car use reduction were closely related to the purchased car type. Nevertheless, it is a challenging task to identify the target population of people who soon will buy a car. Subsequently, not a cross-sectional but a longitudinal study might have fitted the research question better.

While having strived to cover a substantial part of the target population through combining online survey with preceding postal invitation letters, a coverage error and sampling error (Dillman, Tortora, & Bowker, 1998) still could not be avoided. Although 90% of the Norwegian households had access to both computer and internet at home, there could be a significant part of target population left out from participating in the online survey. Given that almost all survey samples regardless of the research topic are self-selected to some degree, a self-selection bias could not be ruled out in the resulting sample of the respondents. It might be that some groups were less receptive to the research topic as well as the online survey. Consequently, they might not have responded to the invitation to take part in the

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[10] Data were collected 4-5 months after the purchase for the conventional passenger car, and up to a year following purchase for the battery electric car.

study. For example, with regard to the controversy around using online survey and associated issues like violations of personal protection and privacy (Cho & Larose, 1999), some of the target population might have simply decided not to participate in the study, which might be one of the reasons for the low response rate of the study. Unfortunately, it was not under our control that all groups in the population were equally present in the obtained sample.

This self-selection bias was obviously evident in the main data collection where the response rate for battery electric car buyers was significantly higher than the response rate for conventional car buyers. As a result, the self-selection bias might have led to biased data as the respondents who decided to take the survey would probably not represent the entire target population well. This is certainly an issue for the generalizability of the findings reported in the papers. Although there are different ways to test for non-response bias, due to the lack of knowledge about the target population characteristics[11], restricted budget for the proposed research, and data anonymization process, non-response bias analysis was not conducted.

Closely related to the self-section bias, social desirability response bias might be evident in the studies. Even though the online survey method deployed in the studies is assumed to provide a way to minimize the influence of a social desirability bias (Dillman, Sangster, Tarnai, & Rockwood, 1996) and response bias (Dillman, 2000; Krosnick, Narayan, & Smith, 1996), respondents might still have adjusted their answers to what they thought the researcher wanted. Particularly, since the questionnaire measures were biased towards a pro-environmental direction, a social conformity bias might have occurred. The specific problem may be that buyers of conventional passenger cars and buyers of battery electric cars might have responded to the questions in different ways in the main data collection. In addition, although measurements were taken to ensure correct translation of relevant scales and formulated measures from English to Norwegian in order to keep the original phrasing and to convey the meaning, still there might be potential problems that are not within our control.

The retrospective design, self-section bias and the low response rate thus could hamper the generalizability of the findings to the target population. It is tempting to suggest that the results of the studies included in this thesis are likely generalizable to other purchase decisions on high-cost high-impact products, which like the purchase of new passenger cars carry large symbolic and economic importance (Hirschman, 1982; Lambert-Pandraud, Laurent, & Lapersonne, 2005). Also, generalization of the findings across different countries

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[11] Only addresses of the selected sample were available, but identifying information was deleted just after the project ended.

and cultural groups should be done with utmost care due to the fact that the reported studies here were conducted in the Norwegian context. Norway has a very active policy to support purchases of fuel-efficient cars and/or battery electric cars (e.g., a strong relation between CO_2 emissions of a car and the tax level, and strong incentives to very fuel-efficient cars and battery electric cars). This policy creates a political context that forms a costs structure that pushes purchases away from high emitting cars. At the same time, Norway has one of the oldest car fleets in Europe, basically due to a high one-off registration tax on car purchases, which reduces the diffusion rate of low emission cars.

Furthermore, the subsample of battery electric car owners investigated in this thesis represents what Rogers (2003) calls early majority of the adopters. This means the findings about socio-psychological characteristics of battery electric car buyers may have limited generalizability to later adopters. Further studies thus could benefit from investigating a larger sample of battery electric car buyers who are now shaping a clear majority in Norway. What is more important is that the decision to purchase a battery electric car might also be influenced by other variables that were not included in the analysis in this thesis. For example, policy measures (Green, Skerlos, & Winebrake, 2014), range anxiety (Eppstein, Grover, Marshall, & Rizzo, 2011; Nilsson, 2011), and infrastructure development (Eberle, Müller, & von Helmolt, 2012) have been identified as important factors influencing the adoption of electric cars. Therefore, evaluation and further integration of these variables together with factors investigated in this thesis may provide even better understating of the manifold motivations of individuals.

CONCLUSION

Alleviating the negative impacts of car traffic on natural resources, environment, and collective well-being requires a broad understanding of the manifold motivations of people's purchase and use of cleaner cars. In this thesis, the importance of exploring and integrating determinants from different perspectives in explaining purchase and use of more fuel efficient cars and/or battery electric cars is examined. More specifically, this thesis demonstrated the usefulness of integrating causal variables identified in traditional choice modelling studies of car purchase with behavioral determinants put forward by various socio-psychological frameworks in explaining the adoption of cleaner cars. This integration, within a specific context where environmental problems of the current behavior are severe, has resulted in several theoretically oriented conclusions and suggestions for further research.

The thesis demonstrates that an integrative model for choice of car type class based on comprehensive action determination model was effective in explaining individuals' purchases of more fuel-efficient cars and/or battery electric cars. Given the tension between parsimony and the explanatory power of simple versus complex models, it is not always clear cut whether a simpler model is better than a complex model. Yet considering the complexity of the behavior under investigation in the thesis, a complex model might provide different points to consider when designing and implementing measures to encourage adoption of cleaner cars. Moreover, findings suggest that the integrative model outperforms substantially the simpler models in terms of explanatory power. The results of the thesis can therefore be used to highlight the feasibility of corroborating such a comprehensive model in explaining high cost high impact product choice of individuals.

An important objective of the thesis was not only to explore and integrate determinants from different perspectives but also to explore the relationships between corresponding determinants of behaviors in different domains. For example, by examining the impact of attitude towards purchasing fuel-efficient and more environmentally friendly car on attitude towards subsequent car use reduction, the possibility of a positive psychological spillover effect in different behavioral domains was examined. Meanwhile, the signs of possible direct rebound effects resulting from the adoption of technological advances (i.e., adoption of battery electric cars) indicated people's right purchase decisions may not necessarily translate into sustainable action in the post-purchase stage. These results therefore imply that the reduction of negative impacts associated with car traffic can only be achieved through a combination of right decisions at both the purchase and the post-purchase stage.

The theoretical implication is that understanding individuals' purchase motivations is important when an understanding for post-purchase activity is desired. Significant gains toward environmentally sustainable car traffic can only be achieved through targeting and encouraging both pro-environmental purchase activity and subsequent environmentally friendly post-purchase behavior.

Moreover, the analyses of socio-psychological profiles of car buyer groups reveal people's manifold motivations in high-cost high-impact product choice situations. Does this matter in terms of developing a policy-relevant understanding of individuals' behavior? It probably does. In the first place, the finding that adopters of battery electric cars differed from non-adopters or mainstream groups on a majority of variables implies encouragement of pro-environmental behavior may benefit from raising general knowledge and fostering positive changes in attitudinal variables among public. Secondly, the finding that non-adopter groups as well exhibited distinct psychological profiles indicates a clear understanding of the multiplicity of motivations is important to further increase understanding and encouragement of pro-environmental behaviors. Awareness raising and fostering attitudinal changes among these groups should, however, be targeted to each segment. In these circumstances, the conclusion can be drawn that the complexity of people's behaviors warns against using a simplistic prescription for change (Jackson, 2005).

Considering the continuous increase in personal travel and the use of passenger cars, it is not very controversial to claim that technological advances that increase efficiency should be effective in alleviating the negative impacts of road transportation. Although these measures are important, and examples of successful implementation have been emerging at different locations, there is also a recognized need to continuously decrease the environmental effects of the increasing passenger car fleet by reducing traffic volume. As previously mentioned, the purchase behavior and post purchase behavior are closely related. Thus potential determinants of purchase behavior possibly have impacts on corresponding determinants of post purchase behavior. This relationship indicates future research could benefit from examining individuals' actual purchase behavior and its possible determinants together with the same individuals' actual pre and post purchase behavior and their possible determinants. By doing so, a genuine understanding of consumer action opens up a much more creative landscape for policy innovation than has previously been recognized.

REFERENCES

Aarts, H., Verplanken, B., & Knippenberg, A. (1998). Predicting behavior from actions in the past: Repeated decision making or a matter of habit? *Journal of Applied Social Psychology, 28*(15), 1355-1374.

Abrahamse, W., Steg, L., Gifford, R., & Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality?. *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(4), 317-324.

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of environmental psychology*, *25*(3), 273-291.

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, *27*(4), 265-276.

Addinsoft. (2012). XLSTAT software(Version 12). Paris: Addinsoft.

Ahn, J., Jeong, G., & Kim, Y. (2008). A forecast of household ownership and use of alternative fuel vehicles: A multiple discrete-continuous choice approach. *Energy Economics*, *30*(5), 2091-2104.

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behaviour* (pp. 11-39). Heidelberg: Springer.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I. (2002). Perceived behavioral control, self-Efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology, 32*(4), 665-683.

Anable, J. (2005). 'Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory. *Transport Policy, 12*(1), 65-78.

Bamberg, S. (2012). Processes of change. In L. Steg, A. E. van den Berg, & J. I. M. de Groot (Eds.), *Environmental psychology: An introduction* (pp. 267-280). New York: Wiley & Sons.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14-25.

Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behavior, 35*(2), 264-285.

Bem, D. J. (1972). Self-perception theory. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (pp. 1-62). New York: Academic Press.

Berkhout, P. H., Muskens, J. C., & Velthuijsen, J. W. (2000). Defining the rebound effect. *Energy policy*, *28*(6), 425-432.

Bettman, J. R. (1979). *Information processing theory of consumer choice*. Reading, Mass: Addison-Wesley.

Black, J. S., Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on househould energy adaptations. *Journal of Applied Psychology, 70*(1), 3-21.

Bagozzi, R. P., & Yi, Y. (1989). The degree of intention formation as a moderator of the attitude-behavior relationship. *Social Psychology Quarterly*, 266-279.

Baker, F. B., & Kim, S. H. (Eds.). (2004). *Item response theory: Parameter estimation techniques*. New York: M. Dekker.

Bloch, P. H., Sherrell, D. L., & Ridgway, N. M. (1986). Consumer search: An extended framework. *Journal of Consumer Research*, *13*(1), 119-126.

Braathen, N. A. (2012). CO_2-Based Taxation of Motor Vehicles. In Zachariadis T.(ed.), *Cars and carbon: Automobiles and European climate policy in a global context* (pp. 181-200). Dordrecht: Springer.

Brakus, J. J., Schmitt, B. H., & Zarantonello, L. (2009). Brand experience: what is it? How is it measured? Does it affect loyalty?. *Journal of marketing*, *73*(3), 52-68.

Bratt, C. (1999). Consumers environmental behavior: Generalized, sector-based, or compensatory? *Environment and Behavior*, *31*(1), 28-44.

Brownstone, D., Bunch, D. S., Golob, T. F., & Ren, W. (1996). A transactions choice model for forecasting demand for alternative-fuel vehicles. *Research in Transportation Economics*, *4*, 87-129.

Brownstone, D., Bunch, D. S., & Train, K. (2000). Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. *Transportation Research Part B: Methodological*, *34*(5), 315-338.

Carlson, M. D., & Morrison, R. S. (2009). Study design, precision, and validity in observational studies. *Journal of palliative medicine*, *12*(1), 77-82.

Caulfield, B., Farrell, S., & McMahon, B. (2010). Examining individuals preferences for hybrid electric and alternatively fuelled vehicles. *Transport Policy*, *17*(6), 381-387.

Chin, W. W. (2010). How to write up and report PLS analyses. In V. E. Vinzi, W. W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of partial least squares* (pp. 655-690). Heidelberg: Springer.

Cho, H., & Larose, R. (1999). Privacy issues in Internet surveys. *Social Science Computer Review*, *17*(4), 421-434.

Choo, S., & Mokhtarian, P. L. (2004). What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. *Transportation Research Part A: Policy and Practice, 38*(3), 201-222.

Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology, 55*, 591-621.

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in experimental social psychology*, *24*(20), 1-243.

Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance.

Cleveland, M., Kalamas, M., & Laroche, M. (2005). Shades of green: Linking environmental locus of control and pro-environmental behaviours. *Journal of Consumer Marketing*, *22*(4), 198-212.

Coad, A., de Haan, P., & Woersdorfer, J. S. (2009). Consumer support for environmental policies: An application to purchases of green cars. *Ecological Economics, 68*(7), 2078-2086.

Cornelissen, G., Pandelaere, M., Warlop, L., & Dewitte, S. (2008). Positive cueing: Promoting sustainable consumer behavior by cueing common environmental behaviors as environmental. *International Journal of Research in Marketing*, 25(1), 46–55.

Costa, P. S., Santos, N. C., Cunha, P., Palha, J. A., & Sousa, N. (2013). The use of Bayesian latent class cluster models to classify patterns of cognitive performance in healthy ageing. *PloS One*, *8*(8), 1-8.

Dagsvik, J. K., Wennemo, T., Wetterwald, D. G., & Aaberge, R. (2002). Potential demand for alternative fuel vehicles. *Transportation Research Part B: Methodological*, *36*(4), 361-384.

Dargay, J. M. (2001). The effect of income on car ownership: evidence of asymmetry. *Transportation Research Part A: Policy and Practice*, *35*(9), 807-821.

Dargay, J. M. (2002). Determinants of car ownership in rural and urban areas: A pseudo-panel analysis. *Transportation Research Part E: Logistics and Transportation Review, 38*(5), 351-366.

Dargay, J., & Gately, D. (1999). Income's effect on car and vehicle ownership, worldwide: 1960–2015. *Transportation Research Part A: Policy and Practice, 33*(2), 101-138.

de Haan, P., Mueller, M. G., & Peters, A. (2006). Does the hybrid Toyota Prius lead to rebound effects? Analysis of size and number of cars previously owned by Swiss Prius buyers. *Ecological Economics*, *58*(3), 592-605.

de Haan, P., Mueller, M. G., & Scholz, R. W. (2009). How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars - Part II: Forecasting effects of feebates based on energy-efficiency. *Energy Policy, 37*(3), 1083-1094.

de Haan, P., Peters, A., & Scholz, R. W. (2007). Reducing energy consumption in road transport through hybrid vehicles: investigation of rebound effects, and possible effects of tax rebates. *Journal of Cleaner Production, 15*(11), 1076-1084.

de Jong, G., Fox, J., Daly, A., Pieters, M., & Smit, R. (2004). Comparison of car ownership models. *Transport Reviews, 24*(4), 379-408.

Deutskens, E., De Ruyter, K., Wetzels, M., & Oosterveld, P. (2004). Response rate and response quality of internet-based surveys: An experimental study. *Marketing Letters, 15*(1), 21-36.

Dickerson, C., Thibodeau, R., Aronson, E., & Miller, D. (1992). Using cognitive dissonance to encourage water conservation. *Journal of Applied Social Psychology*, *22*(11), 841–854.

Dillman, D. A. (2000). *Tailored design of mail and other self-administered surveys*. New York: Wiley-Interscience.

Dillman, D. A., Sangster, R. L., Tarnai, J., & Rockwood, T. H. (1996). Understanding differences in people's answers to telephone and mail surveys. *New Directions for Evaluation*, *1996*(70), 45-61.

Dillman, D. A., Tortora, R. D., & Bowker, D. (1998). *Principles for constructing web surveys*. In the 1998 Joint Statistical Meetings of the American Statistical Association, Dallas, Texas.

Du Toit, M. (Ed.). (2003*). IRT from SSI: Bilog-MG, Multilog, Parscale, Testfact*. Lincolnwood, IL: Scientific Software International.

Dunlap, R. E., & Van Liere, K. D. (1978). The "new environmental paradigm". *The journal of environmental education*, *9*(4), 10-19.

Dunlap, R., Van Liere, K. D., Mertig, A., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of social issues*, *56*(3), 425-442.

Eberle, U., Müller, B., & von Helmolt, R. (2012). Fuel cell electric vehicles and hydrogen infrastructure: Status 2012. *Energy & Environmental Science, 5*(10), 8780-8798.

EEA. (2000). *Are We Moving in the Right Direction? Indicators on Transport and Environmental Integration in the EU: TERM2000. Environmental Issue Report No. 12. Indicator 4: Traffic Noise: Exposure and Annoyance*. Copenhagen: European Environment Agency.

EEA. (2005). *Household consumption and the environment. EEA Report no. 11*. Copenhagen: European Environment Agency.

EEA. (2007). *EN16 Final energy consumption by sector:Assessment made on 01 April 2007*. European Environment Agency. Retrieved July 7, 2013, from http://www.eea.europa.eu/data-and-maps/indicators/en16-final-energy-consumption-bysector

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy, 48*(C), 717-729.

EPA. (2005). *National Emissions Inventory: Air Pollutant Emissions Trends Data and Estimation Procedures, 1970–2002 Average. Annual Emissions, All Criteria Pollutants*. Washington, D.C.: Environmental Protection Agency.

Eppstein, M. J., Grover, D. K., Marshall, J. S., & Rizzo, D. M. (2011). An agent-based model to study market penetration of plug-in hybrid electric vehicles. *Energy Policy, 39*(6), 3789-3802.

Epstein, S. (1973). The self-concept revisited: Or a theory of a theory. *American Psychologist*, *28*(5), 404-416.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist*, *49*(8), 709-724.

Ewing, G. O., & Sarigöllü, E. (1998). Car fuel-type choice under travel demand management and economic incentives. *Transportation Research Part D: Transport and Environment*, *3*(6), 429-444.

Ewing, G., & Sarigöllü, E. (2000). Assessing consumer preferences for clean-fuel vehicles: A discrete choice experiment. *Journal of Public Policy & Marketing*, *19*(1), 106-118.

Ewing, M. T. (2000). Brand and retailer loyalty: Past behavior and future intentions. *Journal of Product & Brand Management, 9*(2), 120-127.

Feinberg, J. (1996). Psychological egoism. In J. Feinberg (Ed.), *Reason and responsibility: Readings in some basic problems of philosophy* (9th ed.). Belmont, CA: Wadsworth PublishingCompany.

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford: Stanford University Press.

Fielding, K. S., McDonald, R., & Louis, W. R. (2008). Theory of planned behaviour, identity and intentions to engage in environmental activism. *Journal of Environmental Psychology, 28*(4), 318-326.

Figenbaum, E., Eskeland, G. S., Leonardsen, J., & Hagman, R. (2013). *85 g CO_2 per kilometer i 2020. Er det mulig?* [*85 g CO_2 per kilometer in 2020. Is it possible?*] (TØI report 1264). Oslo: Norwegian Institute of Transport Economics.

Finnveden, G., & Moberg, Å. (2005). Environmental systems analysis tools – an overview. *Journal of Cleaner Production, 13*(12), 1165-1173.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, Mass: Addison-Wesley.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York: Psychology Press.

Flamm, B. (2009). The impacts of environmental knowledge and attitudes on vehicle ownership and use. *Transportation research part D: transport and environment*, *14*(4), 272-279.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal ofMmarketing Research*, *18*(1), 39-50.

Fraj-Andrés, E., & Martínez-Salinas, E. (2007). Impact of environmental knowledge on ecological consumer behaviour: An empirical analysis. *Journal of International Consumer Marketing, 19*(3), 73-102.

Frey, B. S. (1993). Motivation as a limit to pricing. *Journal of Economic Psychology*, *14*(4), 635-664.

Frey, B. S., & Jegen, R. (2001). Motivation crowding theory. *Journal of Economic Surveys, 15*(5), 589-611.

Frey, B. S., & Oberholzer-Gee, F. (1997). The cost of price incentives: An empirical analysis of motivation crowding-out. *The American Economic Review, 87*(4), 746-755.

Frey, B. S., & Stutzer, A. (2006). *Environmental morale and motivation*. Institute for Empirical Research in Economics, University of Zurich.

Gatersleben, B., & Vlek, C. (1998). Household consumption, quality of life, and environmental impacts: A psychological perspective and empirical study. In K. J. Noorman & T. S. Uiterkamp (Eds.), *Green households: Domestic consumers, environment, and sustainability* (pp. 141-183). London: Earthscan Publications.

Gert, B. (1967). Hobbes and psychological egoism. *Journal of the History of Ideas*, 503-520.

Girod, B., & de Haan, P. (2009). Mental rebound. Rebound research report 3. Swiss Federal Institute of Technology in Zurich, IED - Institute for Environmental Decisions, NSSI - Natural and Social Science Interface. URL: http://dx.doi.org/10.3929/ethz-a-006224327

Green, E. H., Skerlos, S. J., & Winebrake, J. J. (2014). Increasing electric vehicle policy efficiency and effectiveness by reducing mainstream market bias. *Energy Policy, 65*(C), 562-566.

Greene, D. L. (1998). *Survey evidence on the importance of fuel availability to the choice of alternative fuels and vehicles*. DigitalCommons@ McMaster.

Greene, D. L., Kahn, J. R., & Gibson, R. C. (1999). Fuel economy rebound effect for US household vehicles. *The Energy Journal*, 1-31.

Griskevicius, V., Cialdini, R. B., & Goldstein, N. J. (2008). Social norms: An underestimated and underemployed lever for managing climate change. *International Journal of Sustainability Communication, 3*, 5-13.

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on attitude-behavior relationships a natural experiment with curbside recycling. *Environment and Behavior, 27*(5), 699-718.

Gärling, T., & Steg, L. (Eds.). (2007). *Threats from car traffic to the quality of urban life: Problems, causes, and solutions*. Elsevier.

Haenlein, M., & Kaplan, A. M. (2004). A beginner's guide to partial least squares analysis. *Understanding Statistics, 3*(4), 283-297.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *The Journal of Marketing Theory and Practice, 19*(2), 139-152.

Harland, P., Staats, H., & Wilke, H. A. (1999). Explaining proenvironmental intention and behavior by personal norms and the theory of planned behavior1. *Journal of applied social psychology*, *29*(12), 2505-2528.

Haughton, D., Legrand, P., & Woolford, S. (2009). Review of three latent class cluster analysis packages: Latent Gold, poLCA, and MCLUST. *The American Statistician, 63*(1), 81-91.

Heffner, R. R., Kurani, K. S., & Turrentine, T. S. (2007a). Symbolism and the Adoption of Fuel-Cell Vehicles. *World Electric Vehicle Association Journal*, *1*, 24-31.

Heffner, R. R., Kurani, K. S., & Turrentine, T. S. (2007b). Symbolism in California's early market for hybrid electric vehicles. *Transportation Research Part D: Transport and Environment, 12*(6), 396-413.

Hertwich, E. G. (2005a). Life cycle approaches to sustainable consumption: A critical review. *Environmental Science & Technology, 39*(13), 4673-4684.

Hertwich, E. G. (2005b). Consumption and the rebound effect: An industrial ecology perspective. *Journal of Industrial Ecology*, 9(1-2), 85-98.

Hickman, R., Ashiru, O., & Banister, D. (2010). Transport and climate change: Simulating the options for carbon reduction in London. *Transport Policy*, *17*(2), 110-125.

Hirschman, E. C. (1982). Symbolism and technology as sources for the generation of innovations. *Advances in Consumer Research, 9*(1), 537-541.

Holden, E., & Norland, I. T. (2005). Three challenges for the compact city as a sustainable urban form: household consumption of energy and transport in eight residential areas in the greater Oslo region. *Urban studies*, *42*(12), 2145-2166.

Hu, L. t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.

Hunecke, M., Haustein, S., Grischkat, S., & Böhler, S. (2007). Psychological, sociodemographic, and infrastructural factors as determinants of ecological impact caused by mobility behavior. *Journal of Environmental Psychology, 27*(4), 277-292.

IEA. (2008). *Energy Balance of the OECD and Non-OECD Countries*. Paris: International Energy Agency.

IEA. (2011). *World energy outlook 2011*. Paris: International Energy Agency.

IEA. (2013). Global EV outlook: Understanding the electric vehicle landscape to 2020. Retrieved from http://www.iea.org/

Jackson, T. (2005*). Motivating sustainable consumption: a review of evidence on consumer behaviour and behavioural change*. London: Sustainable Development Research Network.

Jacoby, J., & Chestnut, R. W. (1978). *Brand loyalty: Measurement and management*. N.Y.: John Wiley & Sons.

Jansson, J. (2011). Consumer eco-innovation adoption: assessing attitudinal factors and perceived product characteristics. *Business Strategy and the Environment*, *20*(3), 192-210.

Jansson, J. (2009). *Car (ing) for our environment?: Consumer eco-innovation adoption and curtailment behaviors: The case of the alternative fuel vehicle* (Doctoral dissertation).

Jansson, J., Marell, A., & Nordlund, A. (2009). Elucidating green consumers: A cluster analytic approach on proenvironmental purchase and curtailment behaviors. *Journal of Euromarketing, 18*(4), 245-267.

Jansson, J., Marell, A., & Nordlund, A. (2010). Green consumer behavior: Determinants of curtailment and eco-innovation adoption. *Journal of Consumer Marketing, 27*(4), 358-370.

Jensen, R. (1992). Reputational spillovers, innovation, licensing and entry. *International Journal of Industrial Organization*, *10*(2), 193-212.

Jöreskog, K. G., & Wold, H. (1982). The ML and PLS techniques for modeling with latent variables: Historical and comparative aspects. In K. G. Jöreskog & H. Wold (Eds.), *Systems under indirect observation: Causality, structure, prediction* (pp. 263-270). Amsterdam: North-Holland.

Kahn, M. E. (2007). Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. *Journal of Environmental Economics and Management, 54*(2), 129-145.

Kaiser, F. G. (2006). A moral extension of the theory of planned behavior: Norms and anticipated feelings of regret in conservationism. *Personality and Individual Differences, 41*(1), 71-81.

Kaiser, F. G., Wölfing, S., & Fuhrer, U. (1999). Environmental attitude and ecological behaviour. *Journal of Environmental Psychology, 19*(1), 1-19.

Kallgren, C. A., Reno, R. R., & Cialdini, R. B. (2000). A focus theory of normative conduct: When norms do and do not affect behavior. *Personality and social psychology bulletin*, *26*(8), 1002-1012.

Karlaftis, M., & Golias, J. (2002). Automobile ownership, households without automobiles, and urban traffic parameters: Are they related? *Transportation Research Record: Journal of the Transportation Research Board, 1792*(1), 29-35.

Khazzoom, J. D. (1980). Economic implications of mandated efficiency in standards for household appliances. *The Energy Journal*, *1*(4), 21-40.

Kiel, G. C., & Layton, R. A. (1981). Dimensions of consumer information seeking behavior. *Journal of marketing Research*, 233-239.

Klein, L. R., & Lansing, J. B. (1955). Decisions to purchase consumer durable goods. *The Journal of Marketing*, 109-132.

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour – A meta-analysis. *Global Environmental Change, 23*(5), 1028-1038.

Klöckner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology, 30*(4), 574-586.

Klöckner, C. A., & Matthies, E. (2004). How habits interfere with norm-directed behaviour: A normative decision-making model for travel mode choice. *Journal of Environmental Psychology, 24*(3), 319-327.

Klöckner, C. A., & Matthies, E. (2012). Two pieces of the same puzzle? Script-based car choice habits between the influence of socialization and past behavior. *Journal of Applied Social Psychology, 42*(4), 793-821.

Klöckner, C. A., Matthies, E., & Hunecke, M. (2003). Problems of operationalizing habits and integrating habits in normative decision-making models. *Journal of Applied Social Psychology, 33*(2), 396-417.

Krosnick, J. A., Narayan, S., & Smith, W. R. (1996). Satisficing in surveys: Initial evidence. *New Directions for Evaluation*, *1996*(70), 29-44.

Kurani, K. S., & Turrentine, T.S. (2004). Automobile buyer decisions about fuel economy and fuel efficiency. UC Davis: Institute of Transportation Studies (UCD). Retrieved from http://escholarship.org/uc/item/6zq891d1

Kvisle. H.H. (2012, January 5). *Heidundranes elbilsalg i 2011* [Electric vehicle sale in 2011]. Retrieved December 16, 2012 from http://www.elbil.no/elbiler/566-heidundranes-elbilsalg-i-2011.

Kågeson, P. (2005). Reducing CO_2 emissions from new cars. *A progress report on the car industry's voluntary agreement and an assessment of the need for policy instruments. T&E–European Federation for Transport and Environment. Brüssel*.

Lambert-Pandraud, R., Laurent, G., & Lapersonne, E. (2005). Repeat purchasing of new automobiles by older consumers: Empirical evidence and interpretations. *Journal of Marketing*, *69*(2), 97-113.

Lane, B., & Potter, S. (2007). The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. *Journal of cleaner production*, *15*(11), 1085-1092.

Laroche, M., Toffoli, R., Kim, C., & Muller, T. E. (1996). The influence of culture on pro-environmental knowledge, attitudes, and behavior: A Canadian perspective. *Advances in Consumer Research, 23*, 196-202.

Lindenberg, S., & Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. *Journal of Social issues*, *63*(1), 117-137.

Mann, C. J. (2003). Observational research methods. Research design II: cohort, cross sectional, and case-control studies. *Emergency Medicine Journal*, *20*(1), 54-60.

Mannering, F., & Winston, C. (1985). A dynamic empirical analysis of household vehicle ownership and utilization. *The RAND Journal of Economics*, 215-236.

Mannering, F., & Winston, C. (1991). Brand loyalty and the decline of American automobile firms. *Brookings Papers on Economic Activity: Microeconomics, 1991*, 67-114.

Mannering, F., Winston, C., & Starkey, W. (2002). An exploratory analysis of automobile leasing by US households. *Journal of Urban Economics, 52*(1), 154-176.

Matthies, E. (2003). One to bind them all: How the modified moral decision making model can be used for the integration of measures to promote pro-environmental travel mode choices. In T. Craig (Ed.), *Crossing boundaries–The value of interdisciplinary research* (pp. 103-109). Aberdeen: Robert Gordon University.

Matthies, E., Klöckner, C. A., & Preißner, C. L. (2006). Applying a modified moral decision making model to change habitual car use: How can commitment be effective? *Applied Psychology, 55*(1), 91-106.

Metz, B., Davidson, O., Bosch, P., Dave, R., & Meyer, L. (Eds.). (2007). *Climate change 2007: mitigation.Ccontribution of working group III to the fourth assessment report of the intergovernmental panel on climate change*. Cambridge: Cambridge University Press.

Miller, K. (2005). *Communication theories: Perspectives, processes, and contexts*. New York: McGraw-Hill.

Mogridge, M. J. H. (1983). *The car market: A study of the statics and dynamics of supply-demand equilibrium*. London: Pion Limited.

Mogridge, M. J. H. (1989). The prediction of car ownership and use revisited: the beginning of the end?. *Journal of Transport Economics and Policy*, 55-74.

Mourato, S., Saynor, B., & Hart, D. (2004). Greening London's black cabs: a study of driver's preferences for fuel cell taxis. *Energy Policy*, *32*(5), 685-695.

Mueller, M. G., & de Haan, P. (2009). How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars—Part I: Model structure, simulation of bounded rationality, and model validation. *Energy Policy*, *37*(3), 1072-1082.

Musti, S., & Kockelman, K. M. (2011). Evolution of the household vehicle fleet: Anticipating fleet composition, PHEV adoption and GHG emissions in Austin, Texas. *Transportation Research Part A: Policy and Practice*, *45*(8), 707-720.

Muthén, L. K., & Muthén, B. O. (2010). Mplus (version 6) [computer software]. *Los Angeles, CA: Muthén & Muthén*.

Muthén, L. K., & Muthén, B. O. (2012). Mplus (version 7) [computer software]. *Los Angeles, CA: Muthén & Muthén*.

Ness, B., Urbel-Piirsalu, E., Anderberg, S., & Olsson, L. (2007). Categorising tools for sustainability assessment. *Ecological Economics, 60*(3), 498-508.

Newman, J. W., & Staelin, R. (1972). Prepurchase information seeking for new cars and major household appliances. *Journal of Marketing Research*, 249-257.

Nilsson, M. (2011). *Electric vehicles: The phenomenon of range anxiety*. ELVIRE Report, June.

Norwegian Directorate of Customs and Excise. (2004). *Engangsavgift på motorvogner mv. 2004* [One-off registration tax on motor vehicles, etc...2004]. Oslo: Directorate of Customs and Excise.

Norwegian Directorate of Customs and Excise. (2007). *Engangsavgift på motorvogner mv. 2007* [One-off registration tax on motor vehicles, etc...2007)]. Oslo: Directorate of Customs and Excise.

Norwegian Directorate of Customs and Excise. (2009). *Engangsavgift på motorvogner mv. 2009* [One-off registration tax on motor vehicles, etc...2009]. Oslo: Directorate of Customs and Excise.

Norwegian Directorate of Customs and Excise. (2012). *Engangsavgift på motorvogner mv. 2012* [One-off registration tax on motor vehicles, etc...2012]. Oslo: Directorate of Customs and Excise.

Norwegian Directorate of Customs and Excise. (2013, November 29). *Elbil* [Electric vehicle]. Retrieved from http://www.toll.no/templates_TAD/Topic.aspx?id=196413&epslanguage=no/

Norwegian EV Association. (n.d.). *Elbilenes mangfoldige fordeler* [Electric vehicle's various advantages]. Retrieved from http://www.elbil.no/elbilfakta/elbilens-fordeler

Norwegian Ministry of Environment. (1994). Summary of issues raised at the symposium on sustainable consumption. In: *Symposium: Sustainable consumption. 19–20 January 1994, Oslo, Norway, pp. 22–25*. Oslo: Ministry of Environment.

Norwegian Ministry of Transport and Communications. (2013, October 10). *Nullutslippsteknologi og alternative drivstoff* [Zero emission technology and alternative fuels]. Retrieved February 23, 2014, from http://www.regjeringen.no/nb/dep/sd/tema/miljovennlig_transport/nullutslippsteknologi-og-alternative-dri.html?id=279703#

Norwegian Road Federation. (2014). *Bilsalget: 2005-2014* [Car sales: 2005-2014]. Retrieved January 23, 2014, from http://ofvas.no/bilsalget/

OECD. (2002). *Towards Sustainable Household Consumption?: Trends and Policies in OECD Countries*. Paris: OECD Publishing.

Oliver, R. L. (1999). Whence consumer loyalty? *Journal of Marketing*, *63*(4), 33-44.

Oreg, S., & Katz-Gerro, T. (2006). Predicting proenvironmental behavior cross-nationally values, the theory of planned behavior, and value-belief-norm theory. *Environment and Behavior*, *38*(4), 462-483.

Ostrom, E. (1998). A behavioral approach to the rational choice theory of collective action: Presidential address, American Political Science Association, 1997. *American Political Science Review*, *92*(1), 1-22.

Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin, 124*(1), 54-74.

Ozaki, R., & Sevastyanova, K. (2011). Going hybrid: An analysis of consumer purchase motivations. *Energy Policy, 39*(5), 2217-2227.

O'Garra, T., Mourato, S., & Pearson, P. (2005). Analysing awareness and acceptability of hydrogen vehicles: A London case study. *International Journal of Hydrogen Energy*, *30*(6), 649-659.

Pachauri, R. K., & Reisinger, A. (Eds.). (2007). *Climate change 2007 synthesis report: Summary for policymakers*. IPCC Secretariat.

Payne, J. W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational Behavior and Human Performance*, *16*(2), 366-387.

Peters, A. (2009). *How Do People Buy Fuel-efficient Cars?* (Doctoral dissertation).

Peters, A., Gutscher, H., & Scholz, R. W. (2011). Psychological determinants of fuel consumption of purchased new cars. *Transportation Research Part F: Traffic Psychology and Behaviour, 14*(3), 229-239.

Peters, A., Mueller, M. G., de Haan, P., & Scholz, R. W. (2008). Feebates promoting energy-efficient cars: Design options to address more consumers and possible counteracting effects. *Energy Policy*, *36*(4), 1355-1365.

Peters, A., Sonnberger, M., Dütschke, E., & Deuschle, J. (2012). *Theoretical perspective on rebound effects from a social science point of view: Working paper to prepare empirical psychological and sociological studies in the REBOUND project* (No. S2/2012). Working paper sustainability and innovation.

Peters, G. P., & Hertwich, E. G. (2008). Post-Kyoto greenhouse gas inventories: production versus consumption. *Climatic Change*, *86*(1-2), 51-66.

Peyre, H., Leplège, A., & Coste, J. (2011). Missing data methods for dealing with missing items in quality of life questionnaires. A comparison by simulation of personal mean score, full information maximum likelihood, multiple imputation, and hot deck techniques applied to the SF-36 in the French 2003 decennial health survey. *Quality of Life Research, 20*(2), 287-300.

Potoglou, D., & Kanaroglou, P. S. (2007). Household demand and willingness to pay for clean vehicles. *Transportation Research Part D: Transport and Environment*, *12*(4), 264-274.

Potoglou, D., & Kanaroglou, P. S. (2008). Modelling car ownership in urban areas: a case study of Hamilton, Canada. *Journal of Transport Geography*, *16*(1), 42-54.

Raggi, M., Mary, S., Santini, F., & Paloma, S. G. Y. (2013). *A classification of European NUTS3 regions* (No. JRC85163). Institute for Prospective and Technological Studies, Joint Research Centre.

Ricci, M., Bellaby, P., & Flynn, R. (2008). What do we know about public perceptions and acceptance of hydrogen? A critical review and new case study evidence. *International Journal of Hydrogen Energy*, *33*(21), 5868-5880.

Roberts, J. A., & Bacon, D. R. (1997). Exploring the subtle relationships between environmental concern and ecologically conscious consumer behavior. *Journal of Business Research, 40*(1), 79-89.

Rogers, E. M. (2003). *Diffusion of Innovations*. New York: Free Press.

Sambandam, R., & Lord, K. R. (1995). Switching behavior in automobile markets: a consideration-sets model. *Journal of the Academy of Marketing Science*, *23*(1), 57-65.

Schmitt, B. H. (2000). *Experiential marketing: How to get customers to sense, feel, think, act, relate*. Simon and Schuster.

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice*, *48*, 39-49.

Schwartz, S. H. (1977). Normative Influences on Altruism. *Advances in Experimental Social Psychology, 10*, 221-279.

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology, 25*(1), 1-65.

Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? *Journal of Social Issues, 50*(4), 19-45.

Schwartz, S. H., & Howard, J. A. (1980). Explanations of the moderating effect of responsibility denial on the personal norm-behavior relationship. *Social Psychology Quarterly*, 441-446.

Schwartz, S. H., & Howard, J. A. (1981). A normative decision-making model of altruism. In J. P. Rushton, & R. M. Sorrentino (Eds.), *Altruism and helping behavior* (pp. 89e211). Hillsdale, NJ: Lawerence Erlbaum.

Scott, C. A. (1977). Modifying socially-conscious behavior: The foot in the door technique. *Journal of Consumer Research*, *4*(3), 156–164.

Scott, J. (2000). Rational choice theory. In G. Browning, A. Halcli & F. Webster (Eds.), *Understanding contemporary society: Theories of the present* (pp. 126-138). London: Sage.

Scown, C. D., Taptich, M., Horvath, A., McKone, T. E., & Nazaroff, W. W. (2013). Achieving deep cuts in the carbon intensity of US automobile transportation by 2050: complementary roles for electricity and biofuels. *Environmental science & technology*, *47*(16), 9044-9052.

Small, K. A., & Van Dender, K. (2007). Fuel efficiency and motor vehicle travel: the declining rebound effect. *The Energy Journal*, 25-51.

Soland, M. (2013). *"Relax... Greentech Will Solve the Problem!": Socio-psychological Models of Responsibility Denial Due to Greentech Optimism* (Doctoral dissertation).

Spangenberg, J. H., & Lorek, S. (2002). Environmentally sustainable household consumption: from aggregate environmental pressures to priority fields of action. *Ecological economics*, *43*(2), 127-140.

Statistics Norway. (2004). *Framskriving av folkemengden 2002-2050: Nasjonale og regionale tall* [Population Projections 2002-2050: National and Regional Figures]. Oslo, Norway: Statistisk sentralbyrå.

Statistics Norway. (2010a, April 27). *Tabell 01963: Registrerte kjøretøy, etter drivstofftype og kjøringens art (K) (avslutta serie)* [Table 01963: Registered vehicles, by fuel type and type of driving]. Retrieved October 22, 2010, from http://www.ssb.no/tabell/01963

Statistics Norway. (2010b, September 12). *Bruk av IKT i husholdningene, 2010, 2. kvartal* .[ICT usage in households, 2010, 2nd quarter]. Retrieved October 22, 2010, from https://www.ssb.no/teknologi-og-innovasjon/statistikker/ikthus/aar/2010-09-24

Statistics Norway. (2010c, June 25). *Befolkningens utdanningsnivå, 1. oktober 2009* [Population's level of education, 1 October , 2009]. Retrieved Novermber 12, 2011, from http://www.ssb.no/utdanning/statistikker/utniv/aar/2010-06-25#content

Statistics Norway. (2012a, December 18). *Registrerte inntekter for busette personar. Talet på personar med beløp og beløp i millionar kroner. 2009-2011* [Registered income for residents. The number of persons with amounts, and amounts in million. 2009-2011]. Retrieved January 17, 2013, from https://www.ssb.no/a/kortnavn/ifhus/tab-2012-12-18-01.html

Statistics Norway. (2012b, September 6). *Befolkning og areal i tettsteder, 1. januar 2012* [Population and land area in urban settlements, 1 January 2012]. Retrieved Novermber 21, 2012, from http://www.ssb.no/befolkning/statistikker/beftett

Statistics Norway. (2013, June 18). *Befolkningens utdanningsnivå, 1. oktober 2012* [Population´s level of education, 1 October 2012]. Retrieved July 12, 2013, from http://www.ssb.no/utdanning/statistikker/utniv

Statistics Norway. (2014a, April 1). *Tabell 07849: Registrerte kjøretøy, etter kjøringens art og drivstofftype (K)* [Table 07849: Registered vehicles, by type of driving and fuel type]. Retrieved April 12, 2014, from http://www.ssb.no/tabell/07849

Statistics Norway. (2014b, February 20). *Folkemengden, 1. januar 2014* [Population, 1 January 2014]. Retrieved march 7, 2014, from https://www.ssb.no/befolkning/statistikker/folkemengde/aar/2014-02-20?fane=tabell

Steg, L. (2005). Car use: Lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice, 39*(2), 147-162.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309-317.

Steinhorst, J., Klöckner, C. A., & Matthies, E. (2015). Saving electricity–For the money or the environment? Risks of limiting pro-environmental spillover when using monetary framing. *Journal of Environmental Psychology*, *43*, 125-135.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*(3), 407-424.

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review, 6*(2), 81-98.

Stern, P. C., Dietz, T., & Guagnano, G. A. (1998). A brief inventory of values. *Educational and psychological measurement*, *58*(6), 984-1001.

Stoll-Kleemann, S., O'Riordan, T., & Jaeger, C. C. (2001). The psychology of denial concerning climate mitigation measures: evidence from Swiss focus groups. *Global environmental change*, *11*(2), 107-117.

Stuart, H., Sarrell, P. V., Guinipero, L., & Kolchin, M. (1991). *Purchasing: Principles and applications*. NJ: Printice Hall.

Stutzman, T. M., & Green, S. B. (1982). Factors affecting energy consumption: Two field tests of the Fishbein-Ajzen model. *The Journal of Social Psychology*, *117*(2), 183-201.

Tanner, J. C. (1978). Long-term forecasting of vehicle ownership and road traffic. *Journal of the Royal Statistical Society.141*(1), 14-63.

Tenenhaus, M., & Hanafi, M. (2010). A bridge between PLS path modeling and multi-block data analysis. In V. E. Vinzi, W. W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of partial least squares* (pp. 99-123). Heidelberg: Springer.

Thiel, C., Perujo, A., & Mercier, A. (2010). Cost and CO 2 aspects of future vehicle options in Europe under new energy policy scenarios. *Energy policy*, *38*(11), 7142-7151.

Thøgersen, J. (1996). Recycling and morality: A critical review of the literature. *Environment and Behavior, 28*(4), 536-558.

Thøgersen, J. (1999a). Spillover processes in the development of a sustainable consumption pattern. *Journal of Economic Psychology, 20*(1), 53-81.

Thøgersen, J. (1999b). The ethical consumer. Moral norms and packaging choice. *Journal of Consumer Policy, 22*(4), 439-460.

Thøgersen, J. (2004). A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior. *Journal of Environmental Psychology*, *24*(1), 93-103.

Thøgersen, J. (2005). How may consumer policy empower consumers for sustainable lifestyles? *Journal of Consumer Policy*, *28*, 143-178.

Thøgersen, J. (2006). Norms for environmentally responsible behaviour: An extended taxonomy. *Journal of Environmental Psychology, 26*(4), 247-261.

Thøgersen, J., & Crompton, T. (2009). Simple and painless? The limitations of spillover in environmental campaigning. *Journal of Consumer Policy*, *32*(2), 141-163.

Thøgersen, J., & Noblet, C. (2012). Does green consumerism increase the acceptance of wind power?. *Energy Policy*, *51*, 854-862.

Thøgersen, J., & Ölander, F. (2003). Spillover of environment-friendly consumer behaviour. *Journal of environmental psychology*, *23*(3), 225-236.

Thøgersen, J., & Ölander, F. (2006). The dynamic interaction of personal norms and environment-friendly buying behavior: A panel study. *Journal of Applied Social Psychology, 36*(7), 1758-1780.

Tompkins, M., Bunch, D., Santini, D., Bradley, M., Vyas, A., & Poyer, D. (1998). Determinants of alternative fuel vehicle choice in the continental United States. *Transportation Research Record: Journal of the Transportation Research Board*, (1641), 130-138.

Triandis, H. C. (1977). *Interpersonal behavior*. Monterey, CA: Brooks/Cole Publishing Company.

Triandis, H. C. (1979). Values, attitudes, and interpersonal behavior. In *Nebraska symposium on motivation*. University of Nebraska Press.

Tukker, A. (2006). Identifying priorities for environmental product policy. *Journal of Industrial Ecology*, 10(3), 1-4.

Tukker, A., Huppes, G., Suh, S., Heijungs, R., Guinee, J., de Koning, A., Geerken, T., Jansen, B., van Holderbeke, M., & Nielsen, P. (2006). *Environmental impacts of products*. Seville, Spain: European Science and Technology Observatory/Institute of Prospective Studies.

Tukker, A., & Jansen, B. (2006). Environmental impacts of products: A detailed review of studies. *Journal of Industrial Ecology, 10*(3), 159-182.

Tukker, A., Charter, M., Vezzoli, C., Stø, E., & Andersen, M. M. (2008). *System innovation for sustainability 1. Perspectives on radical changes to sustainable consumption and production*. Greenleaf Publishing.

Tukker, A., Cohen, M. J., Hubacek, K., & Mont, O. (2010). The impacts of household consumption and options for change. *Journal of Industrial Ecology, 14*(1), 13-30.

Turcksin, L., Mairesse, O., & Macharis, C. (2013). Private household demand for vehicles on alternative fuels and drive trains: a review. *European Transport Research Review*, *5*(3), 149-164.

Turrentine, T. S., & Kurani, K. S. (2007). Car buyers and fuel economy? *Energy Policy, 35*(2), 1213-1223.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124-1131.

van Dierendonck, D., Díaz, D., Rodríguez-Carvajal, R., Blanco, A., & Moreno-Jiménez, B. (2008). Ryff's six-factor model of psychological well-being, a Spanish exploration. *Social Indicators Research*, *87*(3), 473-479.

van Rijnsoever, F., Farla, J., & Dijst, M. J. (2009). Consumer car preferences and information search channels. *Transportation Research Part D: Transport and Environment, 14*(5), 334-342.

Vandenbergh, M. P., Stern, P. C., Gardner, G. T., Dietz, T., & Gilligan, J. M. (2010). Implementing the behavioral wedge: Designing and adopting effective carbon emissions reduction programs. *Environmental Law Reporter (ELR)*, *40*, 10547.

Vermunt, J. K., & Magidson, J. (2002). Latent class cluster analysis. In J. A. Hagenaars & A. L. McCutcheon (Eds.), *Applied latent class analysis* (pp. 89-106). Cambridge: Cambridge University Press.

Vermunt, J., & Magidson, J. (2010). Latent GOLD (Version 4.5). Belmont: Statistical Innovations Inc.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology, 10*(1), 101-134.

Verplanken, B., Aarts, H., Knippenberg, A., & Moonen, A. (1998). Habit versus planned behaviour: A field experiment. *British journal of social psychology*, *37*(1), 111-128.

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing*, *25*(1), 90-103.

Wall, R., Devine-Wright, P., & Mill, G. A. (2007). Comparing and Combining Theories to Explain Proenvironmental Intentions The Case of Commuting-Mode Choice. *Environment and Behavior*, *39*(6), 731-753.

Walnum, H. J., Aall, C., & Løkke, S. (2014). Can Rebound Effects Explain Why Sustainable Mobility Has Not Been Achieved?. *Sustainability*, *6*(12), 9510-9537.

Weidema, B., Nielsen, A., Christiansen, K., Norris, G., Notten, P., Suh, S., & Madsen, J. (2005). *Prioritisation within the integrated product policy*. Copenhagen, Denmark: 2.0 LCA Consultants for the Danish Environmental Protection Agency.

Weigel, R. H. (1983). Environmental attitudes and the prediction of behavior. In N. R. Feimar & E. S. Geller, Environmental psychology. *Directions and perspectives* (pp. 257-287). New York: Praeger.

Weinzettel, J., Steen-Olsen, K., Hertwich, E. G., Borucke, M., & Galli, A. (2014). Ecological footprint of nations: Comparison of process analysis, and standard and hybrid multiregional input–output analysis. *Ecological Economics*, *101*, 115-126.

Whelan, G. (2001). *Methodological advances in modelling and forecasting car ownership in Great Britain.* Paper presented at the proceedings of the European Transport Conference, 10-12 september 2001, Homerton College, Cambridge, UK.

Whelan, G. (2007). Modelling car ownership in Great Britain. *Transportation Research Part A: Policy and Practice, 41*(3), 205-219.

WHO. (2004). *Health Aspects of Air Pollution: Results from the WHO Project "Systematic Review of Health Aspects of Air Pollution in Europe"*. World Health Organization, Geneva.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843-863.

Wörsdorfer, J. S. (2010). Consumer needs and their satiation properties as drivers of the rebound effect. *The case of energy efficient washing machines. Jena: Max Planck Institute of Economics, Evolutionary Economics Group (Papers on Economics & Evolution, 1016)*.

APPENDIX

This section presents the initially distributed letters of invitation, and questionnaires used for online surveys.

«Eier_A»
«Adresse_A»
«Pnr» «Poststed_A»

01.04. 2011

Forespørsel om å delta i forskningsprosjektet "Kjøp og bruk av ny personbil"

I forbindelse med min doktorgrad gjennomfører jeg et prosjekt om kjøp og bruk av ny personbil. Hensikten med prosjektet er å undersøke faktorer som kan ha betydning for bileierskap og bilbruk. Målet er å bidra til økt forståelse for befolkningens verdier og syn på bileierskap, bilbruk, miljø og natur. Prosjektet vil bli utført av undertegnede i samarbeid med Førsteamanuensis Christian Klöckner ved Psykologisk institutt, Norges teknisk-naturvitenskapelige universitetet (NTNU).

Sammen med 2000 andre som kjøpte ny personbil i desember 2010, får du denne forespørselen om å delta i forskningsprosjektet. Utvalget er trukket fra Det sentrale motorvognregister, Statens vegvesen/Vegdirektoratet.

Å delta i prosjektet innebærer å fylle ut to elektroniske spørreskjema på nett. Det vil ta ca. 30-45 minutter å besvare hvert spørreskjema. Jeg ønsker å få kunnskap om hvordan du tok avgjørelsen om hvilken type bil du skulle kjøpe, om dine holdninger og om din bilbruk. I tillegg vil det bli samlet inn bakgrunnsopplysninger.

For at undersøkelsen skal bli pålitelig og av virkelig verdi, er det avgjørende at så mange som mulig deltar. I den anledning vil jeg opplyse om at de som sender inn **BEGGE** skjemaene i **utfylt stand** før 28.mai 2011 er med i trekning av 2 iPad.

Det er frivillig å delta i prosjektet og du kan når som helst trekke deg og kreve personopplysningene som er gitt anonymisert, uten å måtte begrunne dette nærmere. Navne- og adresselisten og spørreskjemaene blir oppbevart på forskjellige steder. Det er ingen andre enn min veileder og jeg som vil få tilgang til de personidentifiserende opplysningene. Vi er underlagt taushetsplikt og opplysningene vil bli behandlet strengt konfidensielt.

Resultatene av studien vil bli publisert som gruppedata, uten at den enkelte kan gjenkjennes. Doktorgradsprosjektet forventes å være avsluttet til jul 2013. Etter at prosjektet er avsluttet vil opplysningene bli anonymisert. Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Dersom du ønsker å delta i undersøkelsen, følger du instruksjonen på baksiden av dette arket og fyller ut spørreskjemaene.

Har du spørsmål i forbindelse med denne henvendelsen, eller ønsker å bli informert om resultatene fra undersøkelsen når de foreligger, kan du gjerne ta kontakt med meg eller førsteamanuensis Christian Klöckner på adressen under.

Med vennlig hilsen og på forhånd takk for hjelpen!

Alim Nayum   Christian Klöckner

Alim Nayum
Psykologisk institutt
NTNU, 7491 Trondheim
Tel: +47-73 59 78 96
alim.nayum@svt.ntnu.no

Christian Klöckner
Psykologisk institutt
NTNU, 7491 Trondheim
Tel: +47-73 59 19 77
christian.klockner@svt.ntnu.no

Kjære deltager!

Hvis <u>hovedansvaret for kjøp og bruk</u> av den sist anskaffede personbilen er <u>samme person</u>, ber vi om at denne personen fyller ut <u>både spørreskjema I og spørreskjema II</u>.

Hvis <u>den som har hovedansvaret for bruk</u> av den sist anskaffede personbilen <u>ikke er den samme som kjøpte den</u>, ber vi om at <u>den som kjøpte personbilen</u> svarer på <u>spørreskjema I</u>, og at *den som bruker bilen oftest* svarer på *spørreskjema II*.

<u>Internettadressen for å gå til spørreskjema I</u>:   https://survey.svt.ntnu.no/bilkjop

<u>Internettadressen for å gå til spørreskjema II</u>:   https://survey.svt.ntnu.no/bilbruk

Deltaker - ID til spørreskjema I og II: **«ID»** (Samme deltaker - ID brukes til begge spørreskjemaene)

Vi ber om at spørreskjema I fylles ut først. For å gå til spørreskjema I, skriv inn den første internettadressen nevnt ovenfor i adressefeltet til nettleseren din. De fleste spørsmålene i skjemaene besvares ved å sette kryss/merke i ringen ved det svaralternativet du mener passer best.

Mange spørsmål er formulert som påstander eller utsagn. Noen spørsmål gjelder kunnskap om noen av de miljømessige effektene av å eie og bruke bil. I et spørreskjema er det ikke alltid mulig å gi nøyaktig uttrykk for hva en mener. Svar ut fra det du synes passer best selv om du er usikker. Spørreskjemaet er ingen eksamen, og det finnes ingen «riktige» eller «gale» svar.

Når du har svart på spørsmålene, sender du inn dine svar elektronisk med å klikke på "Ferdig"-knappen. Vi ønsker at spørreskjema II også fylles ut så snart som mulig. Vi håper at det blir interessant å fylle ut skjemaene.

LYKKE TIL!

NTNU
Fakultet for samfunnsvitenskap
og teknologiledelse
Psykologisk institutt

«Eier_A»
«Adresse_A»
«Pnr» «Poststed_A»

02.04.2012

Forespørsel om å delta i forskningsprosjektet «Kjøp og bruk av ny personbil»

I forbindelse med min doktorgrad gjennomfører jeg et prosjekt om kjøp og bruk av ny personbil. Hensikten med prosjektet er å undersøke faktorer som kan ha betydning for bileierskap og bilbruk. Målet er å bidra til økt forståelse for befolkningens verdier og syn på bileierskap, bilbruk, miljø og natur. Prosjektet vil bli utført av undertegnede i samarbeid med professor og veileder Christian Klöckner ved Psykologisk institutt, Norges teknisk-naturvitenskapelige universitetet (NTNU).

Sammen med andre som kjøpte ny personbil til privat bruk i november og desember 2011, får du denne forespørselen om å delta i forskningsprosjektet. Utvalget er trukket fra Det sentrale motorvognregister, Statens vegvesen / Vegdirektoratet.

Å delta i prosjektet innebærer å fylle ut to spørreskjemaer på nett. Internettadressene til skjemaene finner du på baksiden av dette arket. Jeg ønsker å få kunnskap om hvordan du tok avgjørelsen om hvilken type bil du skulle kjøpe, om dine holdninger og om din bilbruk. I tillegg vil det bli samlet inn bakgrunnsopplysninger.

For at undersøkelsen skal bli pålitelig og av virkelig verdi, er det avgjørende at så mange som mulig deltar. I den anledning vil jeg opplyse om at de som sender inn *begge* skjemaene i *utfylt stand* <u>før 28. mai 2012</u> er med i trekning av to iPad 3.

Det er frivillig å delta i prosjektet og du kan når som helst trekke deg og kreve personopplysningene som er gitt anonymisert, uten å måtte begrunne dette nærmere. Navne- og adresselisten og spørreskjemaene blir oppbevart på forskjellige steder. Det er ingen andre enn min veileder og jeg som vil få tilgang til de personidentifiserende opplysningene. Vi er underlagt taushetsplikt og opplysningene vil bli behandlet strengt konfidensielt.

Resultatene av studien vil bli publisert som gruppedata, uten at den enkelte kan gjenkjennes. Doktorgradsprosjektet forventes å være avsluttet ved slutten av 2013. Etter at prosjektet er avsluttet vil datamaterialet bli anonymisert. Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS (NSD).

Dersom du ønsker å delta i undersøkelsen, følger du instruksjonen på baksiden av dette arket og fyller ut spørreskjemaene.

Har du spørsmål i forbindelse med denne henvendelsen, eller ønsker å bli informert om resultatene fra undersøkelsen når de foreligger, kan du gjerne ta kontakt med meg eller professor Christian Klöckner på adressen under.

Med vennlig hilsen og på forhånd takk for hjelpen!

Alim Nayum   Christian Klöckner

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NTNU, 7491 Trondheim
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Christian Klöckner
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NTNU, 7491 Trondheim
Tel: +47-73 59 19 77
christian.klockner@svt.ntnu.no

Kjære deltager!

Hvis *hovedansvaret for kjøp og bruk* av den sist anskaffede personbilen ligger hos *samme person*, ber vi om at denne personen fyller ut både *spørreskjema I og spørreskjema II*.

Hvis *den som har hovedansvaret for bruk* av den sist anskaffede personbilen *ikke* er den samme som kjøpte den, ber vi om at den som kjøpte personbilen svarer på spørreskjema I, og at den som bruker bilen oftest svarer på spørreskjema II.

Internettadressen til spørreskjema I:	https://survey.svt.ntnu.no/npbuy
Internettadressen til spørreskjema II:	https://survey.svt.ntnu.no/npuse
Deltaker - ID til spørreskjema I og II:	**«ID»** (Samme deltaker - ID brukes til begge spørreskjemaene)

For å gå til spørreskjemaet, skriver du internettadressen til skjemaet (se ovenfor) i adressefeltet til nettleseren din.

Da vises «veiledning for utfylling av spørreskjemaet» som gir deg mer informasjon om skjemaet. NB: Du trenger din deltaker-ID (ovenfor) for å gå videre med utfyllingen av spørreskjemaene.

Vennligst fyll ut begge spørreskjemaene så snart som mulig. Det vil ta ca. 35 minutter å besvare spørreskjema I og ca. 25 minutter å besvare spørreskjema II.
NB: Start med spørreskjema I.

Avbryter du utfyllingen av spørreskjemaet underveis, vil du kunne komme tilbake til dine svar så lenge du bruker samme datamaskin på samme sted.

Vi håper at det blir interessant å fylle ut skjemaene.

LYKKE TIL!

«Eier_A»
«Adresse_A»
«Pnr» «Poststed_A»

09.04.2012

Forespørsel om å delta i forskningsprosjektet «Kjøp og bruk av ny elbil»

I forbindelse med min doktorgrad gjennomfører jeg et prosjekt om kjøp og bruk av ny elbil. Hensikten med prosjektet er å undersøke faktorer som kan ha betydning for bileierskap og bilbruk. Målet er å bidra til økt forståelse for befolkningens verdier og syn på bileierskap, bilbruk, miljø og natur. Prosjektet vil bli utført av undertegnede i samarbeid med professor og veileder Christian Klöckner ved Psykologisk institutt, Norges teknisk-naturvitenskapelige universitetet (NTNU).

Sammen med andre som kjøpte ny elbil til privat bruk i 2011, får du denne forespørselen om å delta i forskningsprosjektet. Utvalget er trukket fra Det sentrale motorvognregister, Statens vegvesen / Vegdirektoratet.

Å delta i prosjektet innebærer å fylle ut to spørreskjemaer på nett. Internettadressene til skjemaene finner du på baksiden av dette arket. Jeg ønsker å få kunnskap om hvordan du tok avgjørelsen om hvilken type bil du skulle kjøpe, om dine holdninger og om din bilbruk. I tillegg vil det bli samlet inn bakgrunnsopplysninger.

For at undersøkelsen skal bli pålitelig og av virkelig verdi, er det avgjørende at så mange som mulig deltar. I den anledning vil jeg opplyse om at de som sender inn *begge* skjemaene i *utfylt stand* før 28. mai 2012 er med i trekning av en iPad 3.

Det er frivillig å delta i prosjektet og du kan når som helst trekke deg og kreve personopplysningene som er gitt anonymisert, uten å måtte begrunne dette nærmere. Navne- og adresselisten og spørreskjemaene blir oppbevart på forskjellige steder. Det er ingen andre enn min veileder og jeg som vil få tilgang til de personidentifiserende opplysningene. Vi er underlagt taushetsplikt og opplysningene vil bli behandlet strengt konfidensielt.

Resultatene av studien vil bli publisert som gruppedata, uten at den enkelte kan gjenkjennes. Doktorgradsprosjektet forventes å være avsluttet ved slutten av 2013. Etter at prosjektet er avsluttet vil datamaterialet bli anonymisert. Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS (NSD).

Dersom du ønsker å delta i undersøkelsen, følger du instruksjonen på baksiden av dette arket og fyller ut spørreskjemaene.

Har du spørsmål i forbindelse med denne henvendelsen, eller ønsker å bli informert om resultatene fra undersøkelsen når de foreligger, kan du gjerne ta kontakt med meg eller professor Christian Klöckner på adressen under.

Med vennlig hilsen og på forhånd takk for hjelpen!

Alim Nayum   Christian Klöckner

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christian.klockner@svt.ntnu.no

Kjære deltager!

Hvis *hovedansvaret for kjøp og bruk* av den sist anskaffede elbilen ligger hos *samme person*, ber vi om at denne personen fyller ut både *spørreskjema I og spørreskjema II.*

Hvis *den som har hovedansvaret for bruk* av den sist anskaffede elbilen *ikke* er den samme som kjøpte den, ber vi om at <u>den som kjøpte elbilen</u> svarer på <u>spørreskjema I</u>, og at <u>den som bruker elbilen oftest</u> svarer på <u>spørreskjema II</u>.

Internettadressen til spørreskjema I:	https://survey.svt.ntnu.no/evbuy
Internettadressen til spørreskjema II:	https://survey.svt.ntnu.no/evuse
Deltaker - ID til spørreskjema I og II:	**«ID»** (Samme deltaker - ID brukes til begge spørreskjemaene)

For å gå til spørreskjemaet, skriver du internettadressen til skjemaet (se ovenfor) i adressefeltet til nettleseren din.

Da vises «veiledning for utfylling av spørreskjemaet» som gir deg mer informasjon om skjemaet. NB: Du trenger din deltaker-ID (ovenfor) for å gå videre med utfyllingen av spørreskjemaene

Vennligst fyll ut begge spørreskjemaene så snart som mulig. Det vil ta ca. 35 minutter å besvare spørreskjema I og ca. 25 minutter å besvare spørreskjema II.
NB: Start med spørreskjema I.

Avbryter du utfyllingen av spørreskjemaet underveis, vil du kunne komme tilbake til dine svar så lenge du bruker samme datamaskin på samme sted.

Vi håper at det blir interessant å fylle ut skjemaene.

LYKKE TIL!

Spørreskjema I – Kjøp og Eierskap av Ny Personbil

Veiledning for utfylling av spørreskjema

Spørreskjema I fylles ut av den personen i husholdningen som hadde hovedansvaret for kjøpet av den sist anskaffede personbilen (som var kjøpt ny, ikke bruktbil).

Først ber vi deg beskrive kjøp og eierskap av personbiler i husholdningen. Skjemaet gir mulighet til å beskrive opptil 3 personbiler. Det er viktig for kvaliteten til undersøkelsen at du gir informasjon om alle personbilene i husholdningen. Deretter følger noen spørsmål om ulike tema, som holdninger og kunnskaper om de miljømessige effektene av å eie og bruke bil. Hvis du er usikker på hva du skal svare på noen av spørsmålene, er det viktig at du prøver å velge det svaralternativet du tror passer best.

Når du har svart på alle spørsmålene, og fylt ut bakgrunnsopplysningene, sender du inn svarene dine ved å klikke på «Ferdig». Vennligst fyll ut spørreskjema II så snart som mulig! Vi håper at det blir interessant å fylle ut skjemaene.

Vennligst tast inn din deltaker-ID som du finner på baksiden av invitasjonsbrevet: *(*obligatorisk*):

A1

Vennligst beskriv kjøp og eierskap av personbiler i husholdningen:

Hvor mange personbiler er for tiden i bruk i din husholdning *(*obligatorisk*)
   (Om svaret er 1 blir A3 og At skjult; om svaret er 2 blir A4 skjult)

Hvor mange personer i din husholdning, inkludert deg selv, har gyldig førerkort?

Hvor mange personbiler, nye og brukte, har du kjøpt til personlig bruk så langt i livet ditt?

Navngi i kronologisk rekkefølge både brukte og nye biler som du har kjøpt så langt i livet ditt (i hvert fall bilmerke). Start med siste bilkjøp og opp til 9 biler totalt:

1.
2.
3.
4.
5.
6.
7.
8.
9.

121

A2

Vennligst beskriv den sist anskaffede personbilen som var kjøpt ny (ikke bruktbil):

Merke (f.eks. *Volvo*):

Model (f.eks. *V70 D3 Kinetic*):

Årsmodell (f.eks. *2010*):

Motorvolum (f.eks. *1598cc*):

Hestekrefter (f.eks. *165hk*):

Drivstoff:
O Gasolin   O Diesel   O Electric   O Hybrid   O Annet, vennligst spesifiser

Karosseri:
O kabriolet   O Kupé   O Kombi 3-dørs   O Kombi 5-dørs
O kasse   O Pickup   O Sedan   O Stasjonsvogn
O Flerbruksbil   O SUV   O Annet, vennligst spesifiser

Hjuldrift:
O Foran   O Bak   O Fire-hjulstrekkl

Hvordan tilegnet du deg denne bilen?
O Kjøpte ny   O gave   O Annet, vennligst spesifiser

Hovedbruker av denne bilen i husholdningen:
O Meg   O Ektefelle   O Samboer   O Sønn   O datter   O Far
O Mor   O Annet, vennligst spesifiser

Hvor lang tid har du eid eller brukt denne bilen?
[ ] år og [ ] måneder

Omtrent hvor mange kilometer kjøres denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km bilen er kjørt siden dere anskaffet den.].

Omtrent hvor mange kilometer kjører DU denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km du har kjørt bilen totalt].

A3

Vennligst beskriv den andre personbilen som husholdningen kjører hyppigst:

Merke (f.eks. *Volvo*):

Model (f.eks. *V70 D3 Kinetic*):

Årsmodell (f.eks. *2010*):

Motorvolum (f.eks. *1598cc*):

Hestekrefter (f.eks. *165hk*):

Drivstoff:
        O Gasoline   O Diesel   O Electric   O Hybrid   O Annet, vennligst spesifiser

Karosseri:
        O kabriolet   O Kupé   O Kombi 3-dørs   O Kombi 5-dørs
        O kasse   O Pickup   O Sedan   O Stasjonsvogn
        O Flerbruksbil O SUV   O Annet, vennligst spesifiser

Hjuldrift:
        O Foran   O Bak   O Fire-hjulstrekkl

Hvordan tilegnet du deg denne bilen?
        O Kjøpte ny   O Kjøpte brukt   O gave   O Annet, vennligst spesifiser

Hovedbruker av denne bilen i husholdningen:
        O Meg   O Ektefelle   O Samboer   O Sønn   O datter   O Far
        O Mor   O Annet, vennligst spesifiser

Hvor lang tid har du eid eller brukt denne bilen?
        [ ] år og [ ] måneder

Omtrent hvor mange kilometer kjøres denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km bilen er kjørt siden dere anskaffet den.].

Omtrent hvor mange kilometer kjører DU denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km du har kjørt bilen totalt].

A4

Vennligst beskriv den tredje personbilen som husholdningen kjører ofte:

Merke (f.eks. *Volvo*): [ ]

Model (f.eks. *V70 D3 Kinetic*): [ ]

Årsmodell (f.eks. *2010*): [ ]

Motorvolum (f.eks. *1598cc*): [ ]

Hestekrefter (f.eks. *165hk*): [ ]

Drivstoff:
        O Gasoline   O Diesel   O Electric   O Hybrid   O Annet, vennligst spesifiser

Karosseri:
        O kabriolet   O Kupé   O Kombi 3-dørs   O Kombi 5-dørs
        O kasse   O Pickup   O Sedan   O Stasjonsvogn
        O Flerbruksbil O SUV   O Annet, vennligst spesifiser

Hjuldrift:
        O Foran   O Bak   O Fire-hjulstrekkl

Hvordan tilegnet du deg denne bilen?

    O Kjøpte ny   O Kjøpte brukt   O gave   O Annet, vennligst spesifiser

Hovedbruker av denne bilen i husholdningen:

    O Meg   O Ektefelle   O Samboer   O Sønn   O datter   O Far

    O Mor   O Annet, vennligst spesifiser

Hvor lang tid har du eid eller brukt denne bilen?

    [   ] år og [   ] måneder

Omtrent hvor mange kilometer kjøres denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km bilen er kjørt siden dere anskaffet den.].

Omtrent hvor mange kilometer kjører DU denne bilen totalt per år? (Ca. _____ km/år)
[Hvis husholdningen har eid bilen i mindre enn ett år, vennligst oppgi hvor mange km du har kjørt bilen totalt].

A5

Omtrent hvor mange kilometer kjører du totalt per år uavhengig av hvilken bil du kjører?
(Ca. _____ km/år)

B

Hvor viktig syntes du følgende var da du tok avgjørelsen om å kjøpe den nye (ikke brukte) personbilen din?

	Ikke viktig i det hele tatt			Viktig			Ekstremt viktig
	1	2	3	4	5	6	7
Pris	O	O	O	O	O	O	O
Skinninteriør	O	O	O	O	O	O	O
Ekstrautstyr (metallic-lakk, tåkelys, oppvarmede seter e.l.)	O	O	O	O	O	O	O
Miljøvennlige materialer	O	O	O	O	O	O	O
Girkasse	O	O	O	O	O	O	O
Komfort	O	O	O	O	O	O	O
Farge	O	O	O	O	O	O	O
Hastighet	O	O	O	O	O	O	O
"Image"	O	O	O	O	O	O	O
Hestekrefter	O	O	O	O	O	O	O
Merke og modell-variant	O	O	O	O	O	O	O
Servostyring	O	O	O	O	O	O	O
Utslipp av drivhusgasser ved bruk	O	O	O	O	O	O	O
ABS-bremser	O	O	O	O	O	O	O
Drivstofforbruk	O	O	O	O	O	O	O
Utseende	O	O	O	O	O	O	O
Karosseri	O	O	O	O	O	O	O
Vinterdekk	O	O	O	O	O	O	O
Pålitelighet	O	O	O	O	O	O	O
Cruise-kontroll	O	O	O	O	O	O	O
"Følelsen" du får av bilen	O	O	O	O	O	O	O

124

	Ikke viktig i det hele tatt			Viktig			Ekstremt viktig
	1	2	3	4	5	6	7
CO2-reduserende dekk	O	O	O	O	O	O	O
Hjuldrift	O	O	O	O	O	O	O
Utslipp av forurensende kjemikaler ved bruk	O	O	O	O	O	O	O
Kollisjonsputer (Airbags)	O	O	O	O	O	O	O
Bilens energimerke	O	O	O	O	O	O	O
Bilens lengde	O	O	O	O	O	O	O
Bilens størrelse (antall seter, størrelse på lasteplan)	O	O	O	O	O	O	O

C

I hvilken grad er du enig eller uenig i hver av disse påstandene?

	Strongly disagree			Neutral			Strongly agree
	1	2	3	4	5	6	7
Som kunde har jeg ansvar for å påvirke bilindustrien i retning av mer miljøvennlige løsninger	O	O	O	O	O	O	O
Da jeg kjøpte min nye bil ville jeg kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Min egen beslutning om hvilken type bil jeg skulle kjøpe hadde en relevant påvirkning på forbruk av energiressursene	O	O	O	O	O	O	O
Mange av de personene som er viktige for meg antydet at jeg burde vurdere å beskytte miljøet da jeg kjøpte min nye bil	O	O	O	O	O	O	O
Jeg var ikke sikker på ytelsen til miljøvennlige biler	O	O	O	O	O	O	O
Mine verdier fortalte meg at det var/ville vært rett av meg å kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Jeg har av og til dårlig samvittighet fordi jeg ikke eier en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Da jeg kjøpte min nye bil, følte jeg en sterk personlig forpliktelse til å kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Det er et akutt behov for å gjøre noe med den miljøforurensning som er forårsaket av at folk eier store biler	O	O	O	O	O	O	O
Mange av de personene som er viktige for meg eier miljøvennlig biler (f.eks. veldig drivstoffbesparende biler eller elbiler)	O	O	O	O	O	O	O
Min egen beslutning om hvilken type bil jeg skulle kjøpe hadde en relevant påvirkning på miljøet	O	O	O	O	O	O	O
Det høye drivstofforbruket på mange biler er egentlig ikke et miljøproblem	O	O	O	O	O	O	O

	Strongly disagree 1	2	3	Neutral 4	5	6	Strongly agree 7
Jeg føler meg personlig ansvarlig for problemene som er et resultat av den type bil jeg eier	O	O	O	O	O	O	O
Jeg ville av og til hatt dårlig samvittighet hvis jeg ikke eide en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
I prinsippet kan ikke én persons bilkjøp alene bidra til å beskytte miljøet, bevare energiressursene, eller livskvaliteten for fremtidige generasjoner	O	O	O	O	O	O	O
Jeg følte ikke noen forpliktelse til å være miljøvennlig da jeg kjøpte min nye bil	O	O	O	O	O	O	O
Når det gjelder miljøet, er jeg ikke særlig bekymret over at mange store og kraftige biler selges	O	O	O	O	O	O	O
Jeg ville av og til hatt dårlig samvittighet hvis jeg eide en kraftig og stor bil (f.eks. bil med firehjulstrekk, stasjonsvogn, SUV, stor limousin)	O	O	O	O	O	O	O
Det er mange problemer og vanskeligheter forbundet med miljøvennlige biler	O	O	O	O	O	O	O
Da jeg kjøpte min nye bil planla jeg å kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Jeg tror at mange av de personene som er viktige for meg forventet at jeg skulle kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil).	O	O	O	O	O	O	O
Bilindustrien er ansvarlig for det høye drivstofforbruket på de fleste bilene	O	O	O	O	O	O	O
Jeg har av og til dårlig samvittighet fordi jeg eier en kraftig og stor bil (f.eks. bil med firehjulstrekk, stasjonsvogn, SUV, stor limousin)	O	O	O	O	O	O	O
Jeg tror at mange av de personene som er viktige for meg vurderer å kjøpe miljøvennlige biler (f.eks. veldig drivstoffbesparende biler eller elbiler)	O	O	O	O	O	O	O
Min egen beslutning om hvilken type bil jeg skulle kjøpe hadde en relevant påvirkning på livskvalitet for fremtidige generasjoner	O	O	O	O	O	O	O
Det er et akutt behov for å gjøre noe med drivstofforbruket på kraftige biler	O	O	O	O	O	O	O
Det var stort sett opp til meg om jeg ville kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Da jeg kjøpte min nye bil, hadde jeg til hensikt å kjøpe en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O
Dersom jeg ønsket, kunne jeg ha kjøpt en miljøvennlig bil (f.eks. veldig drivstoffbesparende bil eller elbil)	O	O	O	O	O	O	O

D

Generelt synes du at det å kjøpe en drivstoffbesparende og miljøvennlig bil er…

	1	2	3	4	5	6	7	
Veldig galt	○	○	○	○	○	○	○	Veldig bra
Veldig skadelig	○	○	○	○	○	○	○	Veldig fordelaktig
Veldig ugunstig	○	○	○	○	○	○	○	Veldig gunstig
Veldig dumt	○	○	○	○	○	○	○	Veldig klokt
Veldig utilfredsstillende	○	○	○	○	○	○	○	Veldig tilfredsstillende
Veldig ubehagelig	○	○	○	○	○	○	○	Veldig behagelig

E

I hvilken grad er du enig eller uenig i hver av disse påstandene?

	Sterkt uenig			Verken enig eller uenig			Sterkt enig
	1	2	3	4	5	6	7
Vi nærmer oss grensen for det antall mennesker som jorda kan brødfø.	○	○	○	○	○	○	○
Menneskene har rett til å forandre natur-miljøet for å imøtekomme deres behov.	○	○	○	○	○	○	○
Når mennesker griper inn i naturen får det ofte katastrofale følger.	○	○	○	○	○	○	○
Menneskenes dyktighet og klokskap vil sikre at det IKKE blir ulevelig på jorda.	○	○	○	○	○	○	○
Menneskene misbruker miljøet i alvorlig grad.	○	○	○	○	○	○	○
Jorda har overflod av naturressurser, bare vi lærer å gjøre oss nytte av dem.	○	○	○	○	○	○	○
Planter og dyr har like stor rett som oss mennesker til å eksistere.	○	○	○	○	○	○	○
Naturens balanse er stabil nok til å motstå påvirkningene fra moderne industriland.	○	○	○	○	○	○	○
Til tross for våre spesielle evner er vi mennesker fremdeles underlagt naturens lover.	○	○	○	○	○	○	○
Den såkalte "økologiske krisen" som menneskeheten står overfor har blitt sterkt overdrevet.	○	○	○	○	○	○	○
Jorda er som et romskip som har meget begrenset plass og ressurser.	○	○	○	○	○	○	○
Det er meningen at menneskeheten skal herske over resten av naturen.	○	○	○	○	○	○	○
Naturens balanse er ømfintlig og svært lett å forstyrre.	○	○	○	○	○	○	○
Menneskene vil til slutt finne ut nok om naturen slik at de vil være i stand til å kontrollere den.	○	○	○	○	○	○	○
Hvis ting fortsetter på sin nåværende kurs, vil vi snart få oppleve en større økologisk katastrofe.	○	○	○	○	○	○	○

F

Hvor viktig er hver av disse verdiene som styrende prinsipper for deg i ditt liv.

	Mot mine verdier	*Ikke viktig*					*Veldig viktig*
	-1	0	1	2	3	4	5
Familiens trygghet (sikkerhet for ens kjære)	O	O	O	O	O	O	O
En verden i fred (frihet fra krig og konflikter)	O	O	O	O	O	O	O
Innflytelse (kunne påvirke andre mennesker og hendelser)	O	O	O	O	O	O	O
Et spennende liv (stimulerende opplevelser)	O	O	O	O	O	O	O
Rikdom (materielle eiendeler, penger)	O	O	O	O	O	O	O
Selvdisiplin (selvbeherskelse, evne til å motstå fristelser)	O	O	O	O	O	O	O
Et variert liv (et liv fylt med utfordringer, nye opplevelser og forandring)	O	O	O	O	O	O	O
Sosial rettferdighet (å korrigere urettferdighet, ta hånd om de svake)	O	O	O	O	O	O	O
Å hedre foreldrene og andre eldre (å vise respekt)	O	O	O	O	O	O	O
Autoritet (retten til å lede eller styre)	O	O	O	O	O	O	O
Miljøvern (å verne om naturen)	O	O	O	O	O	O	O
Nysgjerrighet (å være interessert i alt, være utforskende)	O	O	O	O	O	O	O

G

For hver av påstandene under, sett merke i den ringen som kommer nærmest din oppfatning av hvor sanne påstandene er.

	Helt sikkert sant	*Antakelig sant*	*Antakelig ikke sant*	*Helt sikkert ikke sant*	*Vet ikke*
Ved å bruke drivstoff med høyere oktantall enn bilen behøver, øker man bilens ytelse	O	O	O	O	O
Effektiviteten til en gjennomsnittlig bilmotor synker dramatisk når man kjører fortere enn 100 km/t	O	O	O	O	O
Hurtig akselerering og hard nedbremsing kan øke drivstofforbruket med opptil 40 %	O	O	O	O	O
Hva slags drivstoff et kjøretøy bruker har ingen effekt på kjøretøyets utslipp	O	O	O	O	O
Bruk av motorvarmer ved temperaturer under 20 minusgrader sparer drivstoff	O	O	O	O	O
Å produsere en ny bil er en stor kilde til forurensning og energibruk allerede før bilen kjøres ut av fabrikken for første gang	O	O	O	O	O
Alle biler forurenser omtrent like mye per kjørte kilometer	O	O	O	O	O
Biler er en av de største kildene til gasser som bidrar til global oppvarming	O	O	O	O	O
Katalysatorer forhindrer at biler forurenser	O	O	O	O	O

	Helt sikkert sant	Antakelig sant	Antakelig ikke sant	Helt sikkert ikke sant	Vet ikke
Regelmessig service vil ikke ha noen innvirkning på bilens utslipp	O	O	O	O	O
Nyere biler slipper ut høyere nivåer av skadelige gasser	O	O	O	O	O
Å stanse motoren når man venter mindre enn 1 minutt er å sløse med drivstoff, siden man bruker mer drivstoff på å starte bilen igjen enn det man sparer	O	O	O	O	O
Dekk med lavt lufttrykk kan forårsake at drivstofforbruket øker med så mye som 6 %.	O	O	O	O	O
Generelt sett har biler med lavere utslipp lavere drivstoffutgifter	O	O	O	O	O
Skifter man gir sent, akselererer bilen raskere og sparer dermed drivstoff	O	O	O	O	O

Bakgrunnsopplysninger

Kjønn:
O Mann   O Kvinne

Ditt fødselsår (4 siffer)

Din sivilstatus:
O Single   O Gift, registrert partner   O Samboende
O Separert/skilt   O Enke/enkemann

Hvor mange personer bor det i din husstand, medregnet deg selv?

Kryss av for antall personer i hver aldersgruppe i din husstand:

	0	1	2	3	4	5	6
Antall voksne 66 år og over:	O	O	O	O	O	O	O
Antall voksne 36-65 år:	O	O	O	O	O	O	O
Antall voksne 18-35 år:	O	O	O	O	O	O	O
Antall barn 13-17 år:	O	O	O	O	O	O	O
Antall barn 6-12 år:	O	O	O	O	O	O	O
Antall barn 3-5 år:	O	O	O	O	O	O	O
Antall barn 0-2 år:	O	O	O	O	O	O	O

Hva er din høyeste fullførte utdannelse?
O Ikke fullført noen utdanning   O Grunnskole
O Videregående skole, yrkesfag   O Videregående skole, allmennfaglig
O Universitet/Høgskole, inntil 4 år   O Universitet/Høgskole, over 4 år
O Doktorgrad

Betrakter du deg for tiden hovedsakelig som …
O Yrkesaktiv   O student   O Alders- eller førtidspensjonist
O Trygdet/arbeidsufør   O Hjemmeværende med husarbeid/omsorg
O Arbeidsledig   O Annet, vennligst spesifiser

Har andre medlemmer av husstanden din inntektsgivende arbeid?

        ◯ Ja   ◯ Nei

Omtrent hvor stor var DIN eget bruttoinntekt (før fradrag og skatt) i fjor?
(NB: Regn bare med din egen inntekt, men ta med evt. pensjon, trygd, biinntekter, renteinntekter osv.)

◯ Ingen inntekt   ◯ 1 – 149,900 kr.   ◯ 150,000 – 249,900 kr.
◯ 250,000 – 349,900 kr.   ◯ 350,000 – 449,900 kr.   ◯ 450,000 – 549,900 kr.
◯ 550,000 – 649,900 kr.   ◯ 650,000 – 749,900 kr.   ◯ 750,000 – 849,900 kr.
◯ 850,000 kr. eller mer

Omtrent hvor stor var din husstands samlede bruttoinntekt (før fradrag og skatt) i fjor?
(NB: Regn med din egen inntekt og inntekter til medlemmene av husstanden, men ta med ev. pensjon, trygd, biinntekter, renteinntekter osv.)

◯ Under 100,000 kr.   ◯ 100,000 – 199,900 kr.   ◯ 200,000 – 299,900 kr.
◯ 300,000 – 399,900 kr.   ◯ 400,000 – 499,900 kr.   ◯ 500,000 – 599,900 kr.
◯ 600,000 – 699,900 kr.   ◯ 700,000 – 799,900 kr.   ◯ 800,000 – 899,900 kr.
◯ 900,000 kr. eller mer

I hvilket fylke bor du?

◯ Østfold   ◯ Akershus   ◯ Oslo   ◯ Hedmark   ◯ Oppland
◯ Buskerud   ◯ Vestfold   ◯ Telemark   ◯ Aust-Agder   ◯ Vest-Agder
◯ Rogaland   ◯ Hordaland   ◯ Sogn og Fjordane   ◯ Møre og Romsdal
◯ Sør-Trøndelag   ◯ Nord-Trøndelag   ◯ Nordland   ◯ Troms
◯ Finnmark

Bor du i …

◯ En stor by   ◯ En forstad til, eller i utkanten av, en stor by
◯ En mindre by   ◯ Et tettsted   ◯ Et spredtbygd strøk

Eventuelle kommentarer:

Oppdateringer av Spørreskjema I til hoved datainnsamling

1. I avsnitt A2-A4 ble spørsmål om CO2 utslipp, pris og girkasse til bilen lagt inn.
2. Elbileiere fikk beskrive elbilen i avsnitt A2 først, og andre biler i avsnitt A3 og A4.
3. I avsnitt C ble de 29 påstandene modifisert og redusert til 27 påstander som følgende:

Dersom jeg ønsket, kunne jeg ha kjøpt en mer drivstoffbesparende og miljøvennlig bil

Min egen beslutning om hvilken type bil jeg skulle kjøpe har en relevant innvirkning på forbruket av energiressurser

Som kunde har jeg ansvar for å påvirke bilindustrien i retning av mer miljøvennlige løsninger

Da jeg kjøpte min nye bil, følte jeg en sterk personlig forpliktelse til å velge en drivstoffbesparende og miljøvennlig bil fremfor en kraftig og stor bil

Å eie en bil som er kraftig og stor gir / ville gitt meg dårlig samvittighet av og til

Mange personer som er viktige for meg eier drivstoffbesparende og miljøvennlige biler

Når det gjelder miljøet, er jeg særlig bekymret over at mange store og kraftige biler selges

Jeg tror at mange personer som er viktige for meg forventet at jeg skulle velge en drivstoffbesparende og miljøvennlig bil

Da jeg kjøpte min nye bil, ønsket jeg å kjøpe en drivstoffbesparende og miljøvennlig bil

Det var mange problemer og vanskeligheter med å kjøpe en drivstoffbesparende og miljøvennlig bil

Min egen beslutning om hvilken type bil jeg skulle kjøpe har en relevant innvirkning på miljøet

Mange personer som er viktige for meg vurderer å kjøpe drivstoffbesparende og miljøvennlige biler

Jeg føler meg ansvarlig for miljøproblemene som er et resultat av den typen bil jeg eier

Det er et akutt behov for å gjøre noe med miljøforurensningen som skyldes at folk eier store biler

Da jeg kjøpte min nye bil, hadde jeg til hensikt å kjøpe en kraftig og stor bil

Å eie en bil som ikke er drivstoffbesparende og miljøvennlig gir / ville gitt meg dårlig samvittighet av og til

Personer som er viktige for meg antydet at jeg burde bytte ut bilen min med en drivstoffbesparende og miljøvennlig bil

Ut fra mine verdier var / ville det vært rett av meg å kjøpe en drivstoffbesparende og miljøvennlig bil

Mange personer som er viktige for meg bytter ut sine kraftige og store biler med drivstoffbesparende og miljøvennlige biler

Jeg tror at mange av de personene som er viktige for meg forventet at jeg skulle kjøpe en drivstoffbesparende og miljøvennlig bil

Det var stort sett opp til meg om jeg ville kjøpe en drivstoffbesparende og miljøvennlig bil

Jeg følte en sterk personlig forpliktelse til å beskytte miljøet da jeg kjøpte min nye bil

Da jeg kjøpte min nye bil, planla jeg å bytte ut bilen jeg hadde med en drivstoffbesparende og miljøvennlig bil

Jeg har /ville hatt dårlig samvittighet av og til fordi jeg eier / hvis jeg eide en kraftig og stor bil

Som bileier har jeg ansvar for å bevare energiressursene og sikre livskvaliteten til fremtidige generasjoner

Det er et akutt behov for å gjøre noe med drivstofforbruket på kraftige biler

Min egen beslutning om hvilken type bil jeg skulle kjøpe har en relevant innvirkning på livskvaliteten til fremtidige generasjoner

4. I avsnitt E ble 5 NEP påstander ikke inkludert:

Menneskene har rett til å forandre natur-miljøet for å imøtekomme deres behov

Når mennesker griper inn i naturen får det ofte katastrofale følger

Menneskene misbruker miljøet i alvorlig grad

Da Jorda har overflod av naturressurser, bare vi lærer å gjøre oss nytte av dem

Menneskene vil til slutt finne ut nok om naturen slik at de vil være i stand til å kontrollere den

5. I bakgrunnsopplysninger ble inntektsnivå justert opp som følgende:

Eget bruttoinntekt:

○ Under 150,000	○ 150,000 – 199,900 kr.	○ 200,000 – 299,900 kr.
○ 300,000 – 399,900 kr.	○ 400,000 – 499,900 kr.	○ 500,000 – 599,900 kr.
○ 600,000 – 699,900 kr.	○ 700,000 – 799,900 kr.	○ 800,000 – 899,900 kr.
○ 900,000 kr. eller mer		

Husstands samlede bruttoinntekt:

○ Under 150,000	○ 150,000 – 249,900 kr.	○ 250,000 – 349,900 kr.
○ 350,000 – 449,900 kr.	○ 450,000 – 549,900 kr.	○ 550,000 – 649,900 kr.
○ 650,000 – 7499,900 kr.	○ 750,000 – 849,900 kr.	○ 850,000 – 999,900 kr.
○ 1, 000,000 kr. eller mer		

6. I bakgrunnsopplysninger ble spørsmålet om bosted endret som følgende:

Der du bor er det ...

○ mindre enn 200 bosatte	○ 200-499 bosatte	○ 500-999 bosatte
○ 1,000-1,999 bosatte	○ 2,000-19,999 bosatte	
○ 20,000-99,999 bosatte	○ 100,000 eller flere bosatte	

Spørreskjema II – Bruk av Ny Personbil

Veiledning for utfylling av spørreskjema

Spørreskjema I fylles ut av den personen i husholdningen som hyppigst bruker den sist anskaffede personbilen.

Først ber vi deg beskrive ditt generelle bilbruksmønster. Deretter følger noen spørsmål om ulike tema, som holdninger og kunnskaper om de miljømessige effektene av å eie og bruke bil. Hvis du er usikker på hva du skal svare på noen av spørsmålene, er det viktig at du prøver å velge det svaralternativet du tror passer best.

Når du har svart på alle spørsmålene, sender du inn svarene dine ved å klikke på «Ferdig». Vi håper at det blir interessant å fylle ut skjemaet.

Vennligst tast inn din deltaker-ID som du finner på baksiden av invitasjonsbrevet:* (*obligatorisk*):

A

Til hvor mange prosent av følgende typer turer bruker du normalt bilen?
(Er du usikker, velger du det svaret du tror blir mest riktig.)

	Tar aldri slike turer	Bruker aldre bil il slike turer	Mindre enn 10 %	10-19 %	20-29 %	30-39 %	40-49 %	50-59 %	60-69 %	70-79 %	80-89 %	90-100 %
Til og fra arbeid eller skole	O	O	O	O	O	O	O	O	O	O	O	O
Levere/hente barna på skole eller barnehage	O	O	O	O	O	O	O	O	O	O	O	O
Handleturer for husholdningen eller andre varer	O	O	O	O	O	O	O	O	O	O	O	O
Turer til sykehus eller lege	O	O	O	O	O	O	O	O	O	O	O	O
Fritidsaktiviteter (f. eks. til kino, trening, pub)	O	O	O	O	O	O	O	O	O	O	O	O
Turer for å besøke familie og venner	O	O	O	O	O	O	O	O	O	O	O	O
Helgeturer eller ferie	O	O	O	O	O	O	O	O	O	O	O	O

Hvor ofte gjør du følgende?

	Aldri			Av og til			Hver gang
	0	1	2	3	4	5	6
Kjører på en måte som holder drivstofforbruket så lavt som mulig	O	O	O	O	O	O	O
Lar motoren gå på tomgang mens jeg venter på kryssende tog eller i trafikkø	O	O	O	O	O	O	O
Går, sykler eller reiser kollektivt til og fra arbeid / skole	O	O	O	O	O	O	O

	Aldri			Av og til			Hver gang
	0	1	2	3	4	5	6
Kjører bil i og til byen	O	O	O	O	O	O	O
Lar motoren gå på tomgang ved røde trafikklys	O	O	O	O	O	O	O
Kjører bilen til avreisepunkter for tur i skog/mark	O	O	O	O	O	O	O
Reiser kollektivt eller sykler i nærområdet (innenfor 30 km)	O	O	O	O	O	O	O
Tar buss eller tog for lengre turer (mer enn 6 timer)	O	O	O	O	O	O	O

B

I hvilken grad er du enig eller uenig i hver av disse påstandene?

	Sterkt uenig			Verken enig eller uenig			Sterkt enig
	1	2	3	4	5	6	7
Det er et akutt behov for å gjøre noe med nedbrytingen av energiressurser som forårsakes av bilbruk	O	O	O	O	O	O	O
Mange personer som er viktige for meg antyder at jeg bør bruke bil i minst mulig grad	O	O	O	O	O	O	O
Mine egne verdier gjør at jeg føler meg forpliktet til å erstatte en del av mine kjøreturer med bruk av andre fremkomstmidler	O	O	O	O	O	O	O
Det er kun staten og bilindustrien som er ansvarlige for problemene som forårsakes av bilbruk	O	O	O	O	O	O	O
Jeg har til hensikt å unngå unødvendige bilturer	O	O	O	O	O	O	O
Mange personer som er viktige for meg erstatter en del av sine kjøreturer med bruk av andre fremkomstmidler	O	O	O	O	O	O	O
Min personlige bilbruk bidrar til nedbryting av energiressurser	O	O	O	O	O	O	O
Det er stort sett opp til meg om jeg vil unngå unødvendige bilturer	O	O	O	O	O	O	O
Å bruke bilen på korte turer gir meg dårlig samvittighet	O	O	O	O	O	O	O
Biltrafikkens betydning for miljøødeleggelsene er unødvendig overdrevet i mediene	O	O	O	O	O	O	O
Min personlige bilbruk bidrar til miljøproblemer (f.eks. luftforurensning, støy og global oppvarming)	O	O	O	O	O	O	O
Mange personer som er viktige for meg reduserer antallet kjøreturer	O	O	O	O	O	O	O
Jeg planlegger å erstatte en del av mine kjøreturer med bruk av andre fremkomstmidler	O	O	O	O	O	O	O
Å unngå unødvendige bilturer er dypt fundert i mitt verdisett	O	O	O	O	O	O	O
Jeg tror at mange personer som er viktige for meg vil støtte meg hvis jeg erstatter en del av	O	O	O	O	O	O	O
kjøreturene med bruk av andre fremkomstmidler	O	O	O	O	O	O	O

	Sterkt uenig			Verken enig eller uenig			Sterkt enig
	1	2	3	4	5	6	7
Jeg får dårlig samvittighet når jeg bruker bil unødvendig	O	O	O	O	O	O	O
Jeg føler meg personlig ansvarlig for problemene som forårsakes av bilbruk	O	O	O	O	O	O	O
Dersom jeg ønsker, kan jeg med letthet redusere antallet kjøreturer	O	O	O	O	O	O	O
Mange personer som er viktige for meg bruker bilen sin nesten uansett hvor de skal	O	O	O	O	O	O	O
Jeg vil gjøre et forsøk på å redusere antallet kjøreturer	O	O	O	O	O	O	O
Det er mange problemer og vanskeligheter med å erstatte en del av mine kjøreturer med bruk av andre fremkomstmidler	O	O	O	O	O	O	O
Det er et akutt behov for å gjøre noe med miljøforurensningen som forårsakes av bilbruk	O	O	O	O	O	O	O
Jeg føler meg forpliktet til å redusere antallet kjøreturer	O	O	O	O	O	O	O
Som bilfører har jeg et ansvar for å bevare energiressursene og livskvaliteten for fremtidige generasjoner	O	O	O	O	O	O	O
Min personlige bilbruk påvirker livskvaliteten til fremtidige generasjoner	O	O	O	O	O	O	O
Jeg tror at mange personer som er viktige for meg forventer at jeg skal redusere antallet kjøreturer	O	O	O	O	O	O	O
Jeg har av og til dårlig samvittighet fordi jeg bruker bilen min for mye	O	O	O	O	O	O	O

C

Generelt, hvordan synes du det ville være å redusere din personlige bilbruk?

	1	2	3	4	5	6	7	
Veldig galt	O	O	O	O	O	O	O	Veldig bra
Veldig skadelig	O	O	O	O	O	O	O	Veldig fordelaktig
Veldig ugunstig	O	O	O	O	O	O	O	Veldig gunstig
Veldig dumt	O	O	O	O	O	O	O	Veldig klokt
Veldig utilfredsstillende	O	O	O	O	O	O	O	Veldig tilfredsstillende
Veldig ubehagelig	O	O	O	O	O	O	O	Veldig behagelig

D

Er du den personen i husholdningen som har fylt ut Spørreskjema I? *(*obligatorisk*)

    O Ja   O Nei (Om svaret er ja, F, G, H og Bakgrunnsopplysninger blir skjult)

E

Totalt antall kilometer DU kjørte i fjor var ca.

Totalt antall kilometer DU regner med å kjøre i år blir ca.

F

I hvilken grad er du enig eller uenig i hver av disse påstandene?

	Sterkt uenig			Verken enig eller uenig			Sterkt enig
	1	2	3	4	5	6	7
Vi nærmer oss grensen for det antall mennesker som jorda kan brødfø.	O	O	O	O	O	O	O
Menneskene har rett til å forandre natur-miljøet for å imøtekomme deres behov.	O	O	O	O	O	O	O
Når mennesker griper inn i naturen får det ofte katastrofale følger.	O	O	O	O	O	O	O
Menneskenes dyktighet og klokskap vil sikre at det IKKE blir ulevelig på jorda.	O	O	O	O	O	O	O
Menneskene misbruker miljøet i alvorlig grad.	O	O	O	O	O	O	O
Jorda har overflod av naturressurser, bare vi lærer å gjøre oss nytte av dem.	O	O	O	O	O	O	O
Planter og dyr har like stor rett som oss mennesker til å eksistere.	O	O	O	O	O	O	O
Naturens balanse er stabil nok til å motstå påvirkningene fra moderne industriland.	O	O	O	O	O	O	O
Til tross for våre spesielle evner er vi mennesker fremdeles underlagt naturens lover.	O	O	O	O	O	O	O
Den såkalte "økologiske krisen" som menneskeheten står overfor har blitt sterkt overdrevet.	O	O	O	O	O	O	O
Jorda er som et romskip som har meget begrenset plass og ressurser.	O	O	O	O	O	O	O
Det er meningen at menneskeheten skal herske over resten av naturen.	O	O	O	O	O	O	O
Naturens balanse er ømfintlig og svært lett å forstyrre.	O	O	O	O	O	O	O
Menneskene vil til slutt finne ut nok om naturen slik at de vil være i stand til å kontrollere den.	O	O	O	O	O	O	O
Hvis ting fortsetter på sin nåværende kurs, vil vi snart få oppleve en større økologisk katastrofe.	O	O	O	O	O	O	O

G

Hvor viktig er hver av disse verdiene som styrende prinsipper for deg i ditt liv.

	Mot mine verdier	Ikke viktig					Veldig viktig
	-1	0	1	2	3	4	5
Familiens trygghet (sikkerhet for ens kjære)	O	O	O	O	O	O	O
En verden i fred (frihet fra krig og konflikter)	O	O	O	O	O	O	O
Innflytelse (kunne påvirke andre mennesker og hendelser)	O	O	O	O	O	O	O
Et spennende liv (stimulerende opplevelser)	O	O	O	O	O	O	O

	Mot mine verdier	Ikke viktig					Veldig viktig
	-1	0	1	2	3	4	5
Rikdom (materielle eiendeler, penger)	O	O	O	O	O	O	O
Selvdisiplin (selvbeherskelse, evne til å motstå fristelser)	O	O	O	O	O	O	O
Et variert liv (et liv fylt med utfordringer, nye opplevelser og forandring)	O	O	O	O	O	O	O
Sosial rettferdighet (å korrigere urettferdighet, ta hånd om de svake)	O	O	O	O	O	O	O
Å hedre foreldrene og andre eldre (å vise respekt)	O	O	O	O	O	O	O
Autoritet (retten til å lede eller styre)	O	O	O	O	O	O	O
Miljøvern (å verne om naturen)	O	O	O	O	O	O	O
Nysgjerrighet (å være interessert i alt, være utforskende)	O	O	O	O	O	O	O

H

For hver av påstandene under, sett merke i den ringen som kommer nærmest din oppfatning av hvor sanne påstandene er.

	Helt sikkert sant	Antakelig sant	Antakelig ikke sant	Helt sikkert ikke sant	Vet ikke
Ved å bruke drivstoff med høyere oktantall enn bilen behøver, øker man bilens ytelse	O	O	O	O	O
Effektiviteten til en gjennomsnittlig bilmotor synker dramatisk når man kjører fortere enn 100 km/t	O	O	O	O	O
Hurtig akselerering og hard nedbremsing kan øke drivstofforbruket med opptil 40 %	O	O	O	O	O
Hva slags drivstoff et kjøretøy bruker har ingen effekt på kjøretøyets utslipp	O	O	O	O	O
Bruk av motorvarmer ved temperaturer under 20 minusgrader sparer drivstoff	O	O	O	O	O
Å produsere en ny bil er en stor kilde til forurensning og energibruk allerede før bilen kjøres ut av fabrikken for første gang	O	O	O	O	O
Alle biler forurenser omtrent like mye per kjørte kilometer	O	O	O	O	O
Biler er en av de største kildene til gasser som bidrar til global oppvarming	O	O	O	O	O
Katalysatorer forhindrer at biler forurenser	O	O	O	O	O
Regelmessig service vil ikke ha noen innvirkning på bilens utslipp	O	O	O	O	O
Nyere biler slipper ut høyere nivåer av skadelige gasser	O	O	O	O	O
Å stanse motoren når man venter mindre enn 1 minutt er å sløse med drivstoff, siden man bruker mer drivstoff på å starte bilen igjen enn det man sparer	O	O	O	O	O
Dekk med lavt lufttrykk kan forårsake at drivstofforbruket øker med så mye som 6 %.	O	O	O	O	O
Generelt sett har biler med lavere utslipp lavere drivstoffutgifter	O	O	O	O	O

	Helt sikkert sant	Antakelig sant	Antakelig ikke sant	Helt sikkert ikke sant	Vet ikke
Skifter man gir sent, akselererer bilen raskere og sparer dermed drivstoff	O	O	O	O	O

Bakgrunnsopplysninger

Kjønn:
    O Mann   O Kvinne

Ditt fødselsår (4 siffer)

Din sivilstatus:
    O Single   O Gift, registrert partner   O Samboende
    O Separert/skilt   O Enke/enkemann

Hvor mange personer bor det i din husstand, medregnet deg selv?

Kryss av for antall personer i hver aldersgruppe i din husstand:

	0	1	2	3	4	5	6
Antall voksne 66 år og over:	O	O	O	O	O	O	O
Antall voksne 36-65 år:	O	O	O	O	O	O	O
Antall voksne 18-35 år:	O	O	O	O	O	O	O
Antall barn 13-17 år:	O	O	O	O	O	O	O
Antall barn 6-12 år:	O	O	O	O	O	O	O
Antall barn 3-5 år:	O	O	O	O	O	O	O
Antall barn 0-2 år:	O	O	O	O	O	O	O

Hva er din høyeste fullførte utdannelse?
    O Ikke fullført noen utdanning   O Grunnskole
    O Videregående skole, yrkesfag   O Videregående skole, allmennfaglig
    O Universitet/Høgskole, inntil 4 år   O Universitet/Høgskole, over 4 år
    O Doktorgrad

Betrakter du deg for tiden hovedsakelig som …
    O Yrkesaktiv   O student   O Alders- eller førtidspensjonist
    O Trygdet/arbeidsufør   O Hjemmeværende med husarbeid/omsorg
    O Arbeidsledig   O Annet, vennligst spesifiser

Har andre medlemmer av husstanden din inntektsgivende arbeid?
    O Ja   O Nei

Omtrent hvor stor var DIN eget bruttoinntekt (før fradrag og skatt) i fjor?
(NB: Regn bare med din egen inntekt, men ta med evt. pensjon, trygd, biinntekter, renteinntekter osv.)
    O Ingen inntekt   O 1 – 149,900 kr.   O 150,000 – 249,900 kr.
    O 250,000 – 349,900 kr.   O 350,000 – 449,900 kr.   O 450,000 – 549,900 kr.
    O 550,000 – 649,900 kr.   O 650,000 – 749,900 kr.   O 750,000 – 849,900 kr.
    O 850,000 kr. eller mer

Omtrent hvor stor var din husstands samlede bruttoinntekt (før fradrag og skatt) i fjor?
(NB: Regn med din egen inntekt og inntekter til medlemmene av husstanden, men ta med ev. pensjon, trygd, biinntekter, renteinntekter osv.)

- ○ Under 100,000 kr.
- ○ 100,000 – 199,900 kr.
- ○ 200,000 – 299,900 kr.
- ○ 300,000 – 399,900 kr.
- ○ 400,000 – 499,900 kr.
- ○ 500,000 – 599,900 kr.
- ○ 600,000 – 699,900 kr.
- ○ 700,000 – 799,900 kr.
- ○ 800,000 – 899,900 kr.
- ○ 900,000 kr. eller mer

I hvilket fylke bor du?

- ○ Østfold
- ○ Akershus
- ○ Oslo
- ○ Hedmark
- ○ Oppland
- ○ Buskerud
- ○ Vestfold
- ○ Telemark
- ○ Aust-Agder
- ○ Vest-Agder
- ○ Rogaland
- ○ Hordaland
- ○ Sogn og Fjordane
- ○ Møre og Romsdal
- ○ Sør-Trøndelag
- ○ Nord-Trøndelag
- ○ Nordland
- ○ Troms
- ○ Finnmark

Bor du i …

- ○ En stor by
- ○ En forstad til, eller i utkanten av, en stor by
- ○ En mindre by
- ○ Et tettsted
- ○ Et spredtbygd strøk

Eventuelle kommentarer:

Oppdateringer av Spørreskjema II til hoved datainnsamling

1. I avsnitt A ble spørsmålet " Til hvor mange prosent av følgende typer turer bruker du normalt bilen?" utvidet som " Til hvor mange prosent av følgende typer turer bruker du normalt bilen, uavhengig av hvilken bil du kjører? " og " Til hvor mange prosent av følgende typer turer bruker du normalt elbilen? " for elbileiere.

2. I avsnitt F ble 5 NEP påstander ikke inkludert

   Menneskene har rett til å forandre natur-miljøet for å imøtekomme deres behov

   Når mennesker griper inn i naturen får det ofte katastrofale følger

   Menneskene misbruker miljøet i alvorlig grad

   Da Jorda har overflod av naturressurser, bare vi lærer å gjøre oss nytte av dem

   Menneskene vil til slutt finne ut nok om naturen slik at de vil være i stand til å kontrollere den

3. I bakgrunnsopplysninger ble inntektsnivå justert opp som følgende:

   Eget bruttoinntekt:
   - Under 150,000
   - 150,000 – 199,900 kr.
   - 200,000 – 299,900 kr.
   - 300,000 – 399,900 kr.
   - 400,000 – 499,900 kr.
   - 500,000 – 599,900 kr.
   - 600,000 – 699,900 kr.
   - 700,000 – 799,900 kr.
   - 800,000 – 899,900 kr.
   - 900,000 kr. eller mer

   Husstands samlede bruttoinntekt:
   - Under 150,000
   - 150,000 – 249,900 kr.
   - 250,000 – 349,900 kr.
   - 350,000 – 449,900 kr.
   - 450,000 – 549,900 kr.
   - 550,000 – 649,900 kr.
   - 650,000 – 7499,900 kr.
   - 750,000 – 849,900 kr.
   - 850,000 – 999,900 kr.
   - 1, 000,000 kr. eller mer

4. I bakgrunnsopplysninger ble spørsmålet om bosted endret som følgende:

   Der du bor er det ...
   - mindre enn 200 bosatte
   - 200-499 bosatte
   - 500-999 bosatte
   - 1,000-1,999 bosatte
   - 2,000-19,999 bosatte
   - 20,000-99,999 bosatte
   - 100,000 eller flere bosatte

PAPERS I – IV

In this section, papers are presented in accordance with the aims of the research.

Paper I

Nayum, A., Klöckner, C. A., & Prugsamatz, S. (2013). Influences of car type class and carbon dioxide emission levels on purchases of new cars: A retrospective analysis of car purchases in Norway. *Transportation Research Part A: Policy and Practice, 48*(A), 96-108.

Influences of car type class and carbon dioxide emission levels on purchases of new cars: A retrospective analysis of car purchases in Norway

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ABSTRACT

The impact of socio-demographic and psychological factors on purchases of new cars is examined. Data were gathered in an online retrospective survey using a sample of 198 Norwegian households who purchased a new car in December 2010. A latent class analysis was performed to identify car type classes followed by a path analysis to investigate the determinants of the purchased car type class and the influence on the purchased car's level of carbon dioxide emissions. The results revealed that car type class is the strongest determinant of the car's level of CO_2 emissions. Socio-demographic factors have little impact on choice of car type class when psychological factors are controlled for. Intention to purchase an environmentally friendly car has a direct effect on the car's CO_2 emissions.

1. Introduction

Private car ownership has resulted in important social changes worldwide, in terms of quality of life and mobility. At the same time increased car ownership and use contributes to serious problems such as dependence on fossil fuels (International Energy Agency, 2008), emissions of toxic chemicals (Environmental Protection Agency, 2005), increased respiratory diseases (World Health Organization, 2004), traffic noise (European Environment Agency, 2000), and carbon dioxide (CO_2) emissions that increases global warming (Intergovernmental Panel on Climate Change, 2007).

Various policy measures have been introduced in many countries to reduce the negative impacts of private car ownership and use. Two main routes to such a reduction are (i) successively replacing an aging car fleet with new cars that are fuel-efficient and more environmentally friendly (Department for Transport, 2002), and (ii) reducing car use (Gärling and Steg, 2007) that "can be achieved with higher fuel taxes, toll, congestion tax, road pricing, and also by subsidizing public transport" (de Haan et al., 2007, p. 1077). Only the former is the focus of the present paper.

Increasing purchases of environmentally friendly cars have a large potential to decrease the negative impacts of private car use. Achieving such a goal requires not only the development of cleaner cars with performance characteristics comparable to conventional cars, but also the willingness of consumers to purchase such cars (Potoglou and Kanaroglou, 2007). It is therefore important to understand what factors influence consumers' car purchases directly or indirectly.

In this paper we propose a comprehensive analysis of the determinants of car purchases from a household perspective, including both socio-demographic and psychological variables. Additionally, an empirical study is reported that addresses

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the question of whether decisions to purchase a new car are primarily based on car type class or made across the borders of car type classes such that CO_2 emissions are reduced more than otherwise would be the case.

2. Factors influencing car purchase

Traditionally, researchers have searched for factors that affect consumers' car purchases and ownership, with the primary aim of estimating car makes' market shares (e.g., de Wolff, 1938; Tanner, 1958). Using aggregated data at national or local levels, some have attempted to forecast car ownership (e.g., Mogridge, 1983, 1989; Tanner, 1978). The forecasts are commonly based on econometric models that explain the car ownership as a function of per-capita income (e.g., Dargay and Gately, 1999). Others propose models that use disaggregate choice data (e.g., Dargay, 2002; Karlaftis and Golias, 2002; Kitamura et al., 2000; Mannering and Winston, 1985; Mannering et al., 2002; Whelan, 2007). In such models information is used at the level of the individual or more often the household since car ownership typically is a characteristic of the entire household (Clark, 2009). By using the number and types of cars households own as dependent variables, such models have identified a number of household characteristics that determine car ownership. Clark (2009) concludes that "these characteristics are typically the size of the household (number of adults and children), the status of the household reference person (occupation, educational qualifications and health status), the status of any other adults in the household, and other characteristics (household income, and type and tenure of accommodation)" (p. 528). According to Stern (2000a) such factors are proxies for personal capabilities to perform a certain action by assessing the material and social resources available to the household.

Most car purchase models provide forecasts mainly for car size classes. For example, the car type choice model of Choo and Mokhtarian (2004) distinguishes nine car size classes and explores the effect of demographic and psychological factors on choice of car size. Mueller and de Haan (2009) present a car-choice forecasting model based on agent-based micro-simulation, where market share over categories of CO_2 emissions, curb weight, and rated power are presented for eight car size classes. While average energy use and CO_2 emissions are determined by car type (weight or size) (de Haan et al., 2007), the within variance still remains large throughout all car type classes. For example, an analysis of car models with high sales in Europe yields an average difference of 94 g CO_2/km between the most and the least efficient versions of the same car model (de Haan et al., 2009). Given that important features such as engine size, engine power, fuel type, and drive system differ between as well as within car type classes, models forecasting car purchase based on car size classes are unlikely to fully capture the behavioral options of changing to environmentally friendly cars. In order to validly describe choice options that consumers have, it would therefore be necessary to categorize cars into car type classes by taking the relevant features into account.

Furthermore, critics of the traditional approach such as Whelan (2007) conclude that "...causal forecasting methods are failing to capture the dynamic impacts of the car ownership decision" (p. 206). Many studies have consequently raised the issue of psychological factors related to the decision to purchase private cars (e.g., Flamm, 2009; Lane and Potter, 2007). Substantial evidence from research indicates that many people have concerns about the environment, and to some extent they are influenced by these concerns when purchasing a new car (e.g., Coad et al., 2009; Kahn, 2007). A study of Klocke (2002) reveals the influence of positive environmental-protection attitudes on car purchases. More recently, Peters et al. (2011) proposed and tested a model which integrates psychological variables to explain purchases of fuel-efficient cars. Their results revealed that a positive attitude towards less power and smaller size, that is underlying beliefs about characteristics of fuel-efficient cars, and perceived behavioral control are direct determinants of the purchase of a fuel-efficient car. Social norm as well as personal norm in favor of more fuel-efficient car choice have also been suggested as determinants but failed to show a significant influence (e.g., Klocke, 2002; Peters et al., 2011). In contrast, Jansson et al. (2010) showed that values, beliefs, and norms had an impact on the purchase of alternative-fuel cars.

The psychological factors are especially important because they often do not only have a direct influence on purchases, but potentially they also mediate the impact of situational factors (Lane and Potter, 2007). Therefore, in order to better understand how socio-demographic factors identified by traditional approaches affect car purchases, these factors should be analyzed together with psychological factors.

In the theory of planned behavior (TPB; Ajzen, 1991; Fishbein and Ajzen, 2010) it is posited that people make expectancy-value assessments and therefore they may be viewed as "...utility maximizing actor(s)" (Bamberg and Schmidt, 2003, p. 267). According to the TPB, intention to perform a behavior is a proximal determinant. Intention is in turn determined by (i) attitude towards the behavior defined as an overall evaluation of its possible consequences, (ii) subjective norm being defined as perceived expectations of other important persons, and (iii) perceived behavioral control (PBC) defined as perceived ability to perform the behavior. PBC is influenced by factors such as opportunities and available resources (Peters et al., 2011). PBC is proposed to also have a direct influence on behavior.

Other theories such as the norm-activation model (NAM, Schwartz, 1977; Schwartz and Howard, 1981) and the value-belief-norm theory (VBN, Stern et al., 1999) emphasize explicit normative and moral motives. These theories posit that people choose actions because they feel morally obliged. The driving force of behavior is thus a strong intrinsic feeling of obligation, or personal norm, to engage in a specific behavior. The VBN theory links value theory (Schwartz, 1994), the NAM, and the New Environmental Paradigm (NEP; Dunlap et al., 2000) perspective through a causal chain of five variables leading to behavior: personal values, general environmental attitude (NEP), awareness of adverse consequences of own action (AC), ascription of responsibility to self (AR), and personal norm for action (PN).

Consistent findings indicate that consumers' pre-purchase search is limited, even for major durable goods such as private cars (Beatty and Smith, 1987). Rather than extensive searching for information, consumers rely on their own experiences, are influenced by situational factors, and make choices by means of short-cutting heuristics rather than after deliberation (Furse et al., 1984; Punj and Stewart, 1983). Evidence from past research suggests that decisions made repeatedly under stable circumstances often have a satisfying outcome despite being "instigated without the mediation of attitudes or intentions" (Anable, 2005, p. 68). Although the TPB suggests that past actions and experiences inform attitudes and norms, much evidence shows that repeated action in a stable context is a strong determinant of future behavior (Ouellette and Wood, 1998). Arguably, large investments such as car purchases are not the same as repeated every day consumption behavior and therefore influence of past behavior is trivial. Research still shows that brand loyalty, operationalized as the number of previous consecutive purchases of the same make, strongly influences future car replacement purchases (Hocherman et al., 1983; Mannering and Winston, 1991; Manski and Sherman, 1980). This line of argument suggests that brand loyalty serves the same function as habits in everyday behavior by short-cutting the decision making process. This should be particularly true in a domain where a brand has a high impact on purchases (Friedman, 1986).

None of the reviewed theories adequately represents the fact that human behavior has many determinants. Each model misrepresents the importance of some determinants. More recently, several theories have therefore been proposed and tested that integrate the various psychological determinants proven to influence behavior (e.g., Bamberg and Möser, 2007; Kaiser, 2006; Klöckner and Blöbaum, 2010; Peters et al., 2011). One example is the comprehensive action determination model (CADM), which aims to be more comprehensive in explaining behavior by combining all of the central features of the theories presented above (see Klöckner and Blöbaum, 2010, for a broader discussion of the model).

Fig. 1 presents how the CADM has been adapted, together with socio-demographic variables identified in other research, to explain the impact of the purchase of a new car based on its CO_2 emission level mediated by car type class. It posits (i) that car type class determines the CO_2 emission level of the purchased car, and (ii) that variables from four different areas predict both the choice of car type class directly and the actual CO_2 emission level of the car indirectly. These variables are intentional processes, past purchase behavior (i.e., brand loyalty), normative processes, and socio-demographic variables. Whereas intention, brand loyalty, and situational influences are expected to have a direct impact on choice of car type class, the impact of norms and attitudes are proposed to be mediated by intention. CADM distinguishes between descriptive norm, subjective social norm, introjected norm, and integrated norm. This is consistent with the four types of norms that Thøgersen (2006) identifies: (i) subjective social norm that describes whether important others approve or disapprove the behavior in question, (ii) descriptive norm that describes whether others themselves perform this specific behavior, (iii) introjected norm that is a superficially internalized personal norm enforced by anticipated guilt or pride, and (iv) integrated norm that is a deeply internalized personal norm based on conscious reflection on and evaluation of behavioral outcome. In line with
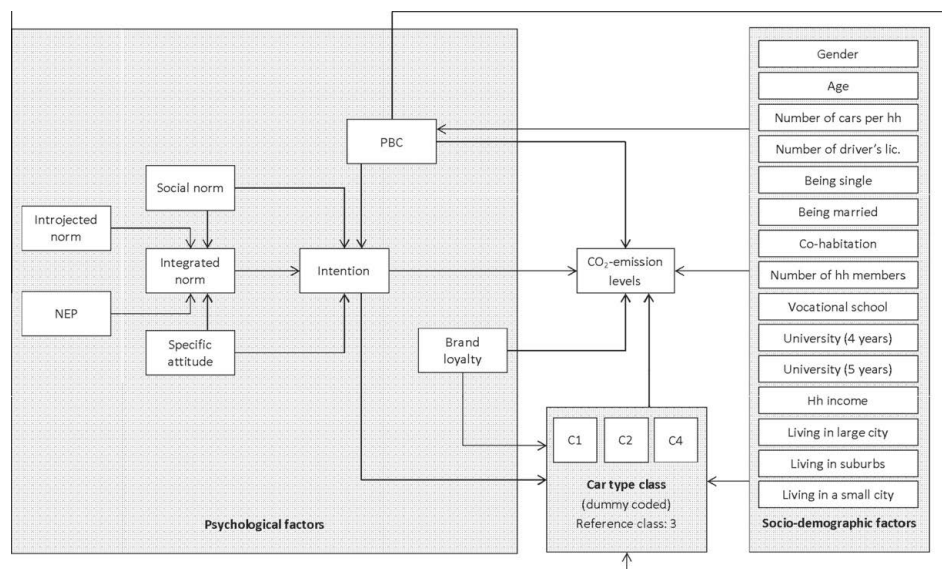
Fig. 1. Theoretical model to explain CO_2 emissions of purchased car and choice of car type class, together with factors identified by traditional models forecasting car purchase (adapted from Klöckner and Blöbaum, 2010).

the VBN, the beliefs consumers hold about the environment are assumed to be a precondition of the integrated norm that is activated. However, in contrast to the VBN, CADM does not include a direct link between norms and behavior, because previous research has shown that the impact of norms on behavior is usually mediated by intention when intention is an element of the model (e.g., Bamberg and Möser, 2007; Klöckner and Blöbaum, 2010).

In a survey of Norweigian residents purchasing new cars, the CADM adapted to car purchase will be tested, impling that the following hypotheses are valid:

H1. Car type class mediates the impact of the socio-demographic and psychological variables on the objective CO_2 emission level of the purchased car.

H2. Brand loyalty has an impact on car-make selection. Although car producers often sell cars in several car classes, producers who have their market segment in the prestigious, more expensive car type class benefit from their customers' loyalty. This in turn translates to a positive relation between brand loyalty and purchasing a car in one of the car type classes with larger cars.

H3. Perceived behavioral control at least partially mediates the impact of the socio-demographic variables on intention.

H4. Social norm, integrated norm and attitude towards possessing an environmentally friendly car have a negative indirect influence on the CO_2 level of the purchased car via intention. General environmental attitude (NEP) and introjected norm trigger integrated norm.

3. Method

3.1. Participants

The Norwegian Public Roads Administration's Head Office provided names and addresses for Norwegian residents who purchased a new car for private use in December 2010. A total number of 5283 names and addresses were obtained, from which 2000 were randomly selected. An invitation letter to participate in a web-based survey was then sent to each one between April and May 2011. The invitation letter described the aim of the survey, provided instructions for how to fill out the questionnaire, information about anonymity and confidentiality rules, and a URL to the survey and a login ID. An incentive was offered to those who fully completed the questionnaire before the deadline in the form of participating in a reward drawing of two iPads.

Before the end of deadline, a total of 333 attempts were made with 288 different login IDs. Of these 288 respondents, 232 filled out parts of the questionnaire (response rate = 11.7%). From this sample the following were excluded: (1) cases with 50% of missing data or more for a multi-item predictor; (2) cases that were extreme univariate and multivariate outliers. This resulted in a final sample of 198 participants. A description of the sample is given in Table 1. Comparisons of the sample with the general Norwegian population revealed that larger households, higher educated, and higher income households are over-represented. With the exception of gender, specific data to compare the demographic composition of the sample with the population of Norwegians who purchase new cars were not obtainable. Given that the sample consists of buyers of new cars, higher income levels are expected. Of the final sample 80.8% are men, a slight over-representation of men in the population of new car buyers in which approximately 70% are men.

3.2. Questionnaire

The questionnaire consisted of three modules as described in the following. The questions were answered in on average approximately 30 min.

3.2.1. Car information

Since the focus is on choice of car type class, participants were asked to give detailed information about the last purchased private car including make, year of purchase, model, model year, engine size, engine power, fuel type, body type, and drive wheel. These attributes were not only used for identification of car type classes, but also to identify the CO_2 emissions for each car in the Norwegian data base on car type registrations. The CO_2 emissions included in the database are the basis for car tax deductions and are averaged CO_2 emissions provided by the car producers in standardized tests (as included in the registration documents). We use CO_2 emissions as an indicator of the purchase of a fuel-efficient/environmentally friendly car as it allows for a direct comparison of the energy demand and pollution of the cars across fuel types. Participants were also asked to name up to nine cars they have most recently purchased. Brand loyalty was then inferred by dividing the number of times they had purchased the same brand by the total number of previous car purchases.

Table 1
Sample descriptive (*n* = 198).

	Sample size	Descriptive
Gender (% men)	196	80.8
Age (years) (*M/SD*)	191	51.60/13.10
Civil status (%)	198	100
Single	15	7.60
Married/registered partner	136	68.70
Cohabiting	38	19.20
Separated/divorced	6	3.00
Widow/widower	3	1.50
Number of household members (*M/SD*)	197	2.74/1.21
Number of cars in household (*M/SD*)	198	1.54/0.65
Number of driver's license holders (*M/SD*)	197	1.92/0.67
Highest education (%)	198	100
Elementary school	9	4.50
Upper secondary school (general studies)	8	4.00
Upper secondary school (vocational studies)	37	18.70
University/college (up to 4 years)	68	34.30
University/college (over 4 years)	69	34.80
Doctor grade	7	3.50
Employment status (%)	195	98.50
Working	154	77.80
Retired	33	16.70
Ill	8	4.00
Annual household gross income, in NOK[a] (%)	198	100
300,000–399,900	9	4.50
400,000–499,900	16	8.10
500,000–599,900	23	11.60
600,000–699,900	20	10.10
700,000–799,900	21	10.60
800,000–899,900	22	11.10
Over 900,000	87	43.90
Residential area (%)	197	99.50
Large city	66	33.30
Suburb of a large city	30	15.20
Small city	49	24.70
Village	36	18.20
Rural area	16	8.10

[a] 1 NOK is approximately equal to 0.13 Euro.

3.2.2. Psychological variables

Each of the psychological variables included in the theoretical model was measured by several items, and most of them developed specifically for the topic of car purchase. The items were based on Fishbein and Ajzen's (2010) general recommendations, and on previous studies of environmental behavior (Fielding et al., 2008; Hunecke et al., 2007; Kaiser, 2006; Klöckner and Matthies, 2004; Matthies et al., 2006). In a few cases the exact wordings were adopted while most of the items were modified to different degrees. Unless otherwise stated, participants rated their agreement on seven-point Likert-type scales ranging from strongly disagree (= 1) to strongly agree (= 7). Negatively formulated items were reversed coded in the data analyses.

With regard to the operationalization of norms, we followed Thøgersen's (2006) extended norm taxonomy in measuring subjective social norm, descriptive norm, introjected norm, and integrated norm. A set of 11 items were used.

Four items were formulated to measure perceived behavioral control, but only two of them were used in the subsequent data analyses. Three items served to measure intention. Finally, the general attitude towards environment and nature was assessed, as well as specific attitude towards purchasing a fuel-efficient and environmentally friendly car. A short form of the New Ecological Paradigm Scale (NEP, Dunlap et al., 2000) was used to measure general environmental attitude. For the specific attitude, participants were asked to rate their attitudes toward purchasing fuel-efficient and environmentally friendly cars. The responses were recorded on a 7-step scale from 1 (very bad/harmful/unfavorable/foolish/unsatisfying/unpleasant) to 7 (very good/beneficial/favorable/wise/satisfying/pleasant).

3.2.3. Socio-demographic variables

Questions about socio-demographic characteristics of the participants and their households (see Table 1) were asked in a final module.

3.3. Data analysis strategy

Firstly, we carried out exploratory factor analyses (EFA) applying maximum likelihood estimation to check on the uni-dimensionality of the psychological variables. This resulted in several items being excluded. The results indicated that descriptive norm and subjective social norm form a distinct factor. We refer to this factor as *social norm*, which includes two items from the descriptive norm and two items from the subjective social norm. For all the other variables, uni-dimensionality was confirmed.

Following this, the analyses to test the hypotheses were divided into two steps. In the first step, a latent class analysis was conducted to identify classes of cars that people purchased, based on the following variables: engine size, engine power, body type of car (categorical), drive wheel (categorical), fuel type (categorical), and make (categorical). The software tool LatentGOLD 4.5 was used to conduct the analysis. The resulting latent classes were used to predict the most likely class membership of each purchased car.

A path analysis was then conducted to test the proposed model (see Fig. 1) with both CO_2 emissions of the purchased car and its car type class as dependent variables. In this model we tested the hypothesis that the chosen type of car, which is represented by car type class membership, mediates the impact of the socio-demographic and psychological variables on objective CO_2 emission levels of the purchased car. Due to the restricted sample size, the psychological variables were not modeled as latent variables but mean scores were used instead, and the latent class analysis was not combined with the structural model but conducted in a separate step. MPLUS 6.1 was used for the path analysis.

4. Results

4.1. Measures

Table 2 presents the wording, means, standard deviations, and reliability coefficients (Cronbach's α) of the psychological variables. The items measuring PBC and general environmental attitude (NEP) have very high mean scores. The integrated norm items are at the neutral range of the response scale. However, the items measuring social norm to purchase a fuel-efficient and environmentally friendly car, expressed by the perceived expectations as well as perceived behavior of important others, have rather low mean scores. The introjected norm items that are constructed as anticipated guilt also have rather low mean scores. With the exception of perceived behavioral control that is based on only two items, reliability of the measures are acceptable (>.70), ranging from $\alpha = 0.75$ to 0.90.

4.2. Latent class analysis

Models with one to six classes were estimated to observe how model fit changes with increasing number of classes. Table 3 shows that the model with four classes emerged as the one with the best relative model fit on the Bayesian information criterion (BIC). To test whether the improvement in the log-likelihoods in each step was significant, a series of bootstrapped $-2LL$ difference tests were conducted. A significant result of this test means that adding another class would significantly improve model fit. For further analysis of the model, four latent classes were selected based on the best BIC, although the $-2LL$ difference test indicates a significant improvement of the models with five and six classes. The improvement was larger for the step from three to four classes than for any other except the step from one to two classes.

Table 4 reports the Wald statistic and *p*-value for the contribution of each variable, and how much of the variance in the indicator is explained by the class model. All variables except *make* contribute significantly to the four-class solution. Variation explained in the indicators by the class model ranges from 6.3% for *make* to 69.7% for *engine size*. This implies that more than two thirds of variance in *engine size* is explained by membership in one of the four classes and only one third is intra-class variation. The cluster profiles with respect to the variables are presented in Table 5 (with either mean scores for the clusters or percentages of the most relevant categorical alternatives). Classes 2 and 3 are characterized by cars with smaller engines and less engine power, with most cars in those classes having front-wheel drives. The difference between Classes 2 and 3 is that in Class 2 the cars are five-door estate cars with a rather high probability of standard petrol engines, whereas the cars in Class 3 are more likely station wagons almost exclusively having diesel engines. Class 1 consists of larger station wagons and SUVs, most of them front-wheel drives but with a significant fraction of four-wheel drives. Engine size and power of cars in Class 1 are larger than in Classes 2 and 3. Almost all cars in Class 1 are diesel cars. Class 4 is the class consisting of the most powerful cars with the largest engines, most likely diesel and four-wheel drives. Most of these cars are SUVs and large.

4.3. Path analysis

In the second step the most likely car type class membership, which is predicted by the four-class model for each purchased car, was used as a variable in a path model that aimed at accounting for CO_2 emissions levels of the purchased cars. Car type class membership was included as a potential mediator of the psychological and socio-demographic variables on

Table 2
Wording, means (M), and standard deviations (SD) of the items and corresponding reliability coefficients of the psychological measures (Cronbach's α) (N = 198).

Measures/vitems		M	SD
Social norm (α = .75)			
1.	Many of the people that are important to me own environmentally friendly cars (e.g., very fuel-efficient or electrical cars)	2.76	1.46
2.	I believe that many of the people that are important to me are considering buying environmentally friendly cars (e.g., very fuel-efficient or electrical cars)	3.11	1.47
3.	Many of the people that are important to me insinuated that I should consider environmental protection when buying the car	2.07	1.31
4.	I believe that many of the people that are important to me expected me to buy an environmentally friendly car (e.g., very fuel-efficient or electrical cars)	2.61	1.51
Introjected norm (α = .78)			
1.	I sometimes have a bad conscience because I do not own an environmentally friendly car (e.g., very fuel-efficient or electrical car)	2.76	1.76
2.	I would sometimes have a bad conscience if I did not own an environmentally friendly car (e.g., very fuel-efficient or electrical cars)	3.21	1.70
3.	I would sometimes have a bad conscience if I owned a powerful and spacious car (e.g., 4-wheel drives, station wagon, SUVs, large limousines).	3.53	1.91
4.	I sometimes have a bad conscience because I own a powerful and spacious car (e.g., 4-wheel drives, station wagon, SUVs, large limousines).	2.68	1.54
Integrated norm (α = .77)			
1.	My values told me that it was/would be the right thing to buy an environmentally friendly car (e.g., very fuel-efficient or electrical car).	4.13	1.76
2.	I felt a strong personal obligation to buy an environmentally friendly car (e.g., very fuel-efficient or electrical cars)	3.20	1.77
3.	I did not feel any kind of obligation to be environmental friendly when I bought the car (recoded)	4.07	1.70
Perceived behavioral control (PBC) (α = .48)			
1.	It was mostly up to me whether I would buy an environmentally friendly car (e.g., very fuel efficient car)	5.27	1.54
2.	If I wanted I could have bought an environmentally friendly car (e.g., very fuel efficient car)	4.53	1.85
Intention (α = .90)			
1.	When I bought my new car I wanted to buy an environmentally friendly car	4.29	1.74
2.	When I bought my new car I planned to buy an environmentally friendly car	3.61	1.95
3.	When I bought my new car I intended to buy an environmentally friendly car	3.68	1.88
Specific attitude towards purchasing fuel-efficient car (α = .88)			
In general you think buying a fuel-efficient and environmentally friendly car is...			
1.	Very bad = 1 ... neither = 4 ... very good = 7	6.06	0.88
2.	Very harmful = 1 ... neither = 4 ... very beneficial = 7	5.75	0.97
3.	Very unfavorable = 1 ... neither = 4 ... very favorable = 7	5.42	1.19
4.	Very foolish = 1 ... neither = 4 ... very wise = 7	5.73	1.01
5.	Very unsatisfying = 1 ... neither = 4 ... very satisfying = 7	5.09	1.35
6.	Very unpleasant = 1 ... neither = 4 ... very pleasant = 7	4.92	1.20
General environmental attitude – a short NEP scale (α = .78)			
1.	We are approaching the limit of the number of people the earth can support	4.58	1.67
2.	When humans interfere with nature, it often produces disastrous consequences	4.88	1.44
3.	Human ingenuity will insure that we do NOT make the earth unlivable (recoded)	4.10	1.52
4.	Humans are severely abusing the environment	4.97	1.40
5.	Despite our special abilities humans are still subject to the laws of nature	5.78	1.23
6.	The Earth is like a spaceship with very limited room and resources	4.41	1.54
7.	Humans were meant to rule over the rest of nature (recoded)	4.97	1.60
8.	The balance of nature is very delicate and easily upset	5.14	1.42
9.	Humans will eventually learn enough about how nature works to be able to control it (recoded)	4.63	1.45
10.	If things continue on their present course, we will soon experience a major ecological catastrophe	4.63	1.45

Table 3
Results of the model fit tests for the latent class models with one to six classes (n = 198).

	LL	BIC	Parameters	Δ−2LL	p
1 class	−2148.17	4507.88	40	–	–
2 classes	−1972.14	4372.64	81	352.06	<.001
3 classes	−1889.18	4423.52	122	165.84	<.001
4 classes	−1778.43	4418.84	163	221.50	<.001
5 classes	−1681.91	4442.63	204	193.03	<.001
6 classes	−1636.32	4568.27	245	91.18	<.001

CO_2 emission levels. The model was specified according to Fig. 1. Car type class membership was dummy coded with Class 3 (on average the most environmentally friendly car type class) as a reference category.

Table 4
Contribution of the tested variables to the class (Wald-test) and explained variance (R^2).

	Wald-test	p	R^2
Engine size	1258.68	<.001	.697
Engine power	287.92	<.001	.413
Fuel type	24.29	.019	.382
Body type of car	36.61	.048	.163
Drive system	34.26	<.001	.368
Make	47.94	.950	.063

Table 5
Profiles of the four car type classes (for categorical variables only the most relevant alternatives are named).

	Class 1	Class 2	Class 3	Class 4
Class size (%)	34.71	22.54	20.31	22.44
Average engine size (l)	1.95	1.49	1.60	2.21
Average Engine power (hp)	138.84	113.44	107.03	158.38
Fuel type (%)				
Petrol	0.08	54.57	1.29	9.15
Diesel	98.46	36.50	98.70	90.83
Other	1.45	8.92	0.01	0.01
Body type of car (%)				
Three door estate	1.13	9.51	4.88	0.02
Five door estate	13.65	65.34	30.44	7.24
Fastback	0.00	2.23	2.48	0.01
Station wagon	36.69	7.01	42.21	28.41
SUV	32.57	0.15	0.15	57.38
Other	12.95	15.75	19.83	6.94
Drive system (%)				
Front wheel	59.05	91.15	87.38	3.59
Back wheel	0.02	6.52	0.03	18.14
Four wheel	40.93	2.33	12.58	78.27
Most popular makes (%)				
	VW (20.1)	Toyota (24.5)	Peugeot (22.3)	Volvo (31.3)
	Ford (16.7)	VW (11.7)	VW (22.2)	BMW (17.9)
	Skoda (14.1)	Opel (9.0)	Ford (18.2)	Mitsubishi (13.3)
	Volvo (10.3)	Nissan (8.9)	Volvo (12.5)	Mercedes (11.2)
	Audi (8.4)	Ford (8.8)	Skoda (9.9)	Audi (9.2)

Table 6 reports the results of maximum-likelihood estimation of model parameters. The model fit indices indicate a good fit of the model (χ^2 = 73.05, df = 60, p = .120; *RMSEA* = .033 [CI .000 .058]; *CFI* = .980; *TLI* = .946; *SRMR* = .025). All proposed relations between the psychological variables are significant. Intention is predicted by specific attitude, social norm, integrated norm and perceived behavioral control. Integrated norm has the strongest effect on the intention to buy an environmentally friendly car, and perceived behavioral control has the weakest impact. Integrated norm is predicted by specific attitude, social norm, introjected norm, and general environmental attitude (NEP). Specific attitude has the strongest, while the impact of general environmental attitude (NEP) has the weakest impact on integrated norm. Membership in car type Class 1 (compared to the reference Class 3) is determined by lower perceived behavioral control (PBC), higher age and university degree. Membership in car type Class 2 is determined significantly by smaller household size and living in a suburban area. Membership in car type Class 4 is only determined significantly by brand loyalty. Perceived behavioral control is weakly affected by the socio-demographic variables. Only being single and living in a smaller household affect PBC significantly. Overall, the socio-demographic factors have little impact on both car type class membership and PBC. Car type class membership is weakly determined by the model variables (between 9% and 19% of the variance).

The level of CO_2 emissions of the car is strongly determined by car type class. Purchasing a car from Class 1 or Class 4 leads to high CO_2 emissions. In addition, the intention to purchase an environmentally friendly car has a direct impact not mediated by car type class. People with stronger intention purchase cars with lower CO_2 emissions. On average men purchase cars with higher emissions than women, an effect that is not mediated by car type class. Furthermore, living in the suburbs of a larger city reduces the CO_2 levels of the purchased car. The effects of PBC, age, university education, and brand loyalty on CO_2 emissions of the purchased car are mediated by purchasing a car in Class 1 or Class 4.

5. Discussion and conclusion

The goal was to test an integrated model of socio-demographic and psychological determinants of the purchase of new cars, both by modeling car type class choice and the resulting CO_2-emission levels. Four hypotheses were derived based on

Table 6
Estimated model parameters ($n = 195$; significant parameters are in boldface).

	B	SE	P	β	R^2
$CO_2 \leftarrow$ intention	**−2.84**	**.80**	**<.001**	**−.19**	
$CO_2 \leftarrow$ PBC	−1.49	.97	.124	−.08	
$CO_2 \leftarrow$ brand loyalty	1.93	4.21	.647	.02	
$CO_2 \leftarrow$ class 1	**21.45**	**3.65**	**<.001**	**.43**	
$CO_2 \leftarrow$ class 2	−4.77	3.98	.230	−.08	
$CO_2 \leftarrow$ class 4	**33.89**	**4.83**	**<.001**	**.43**	
$CO_2 \leftarrow$ number of cars in household	−3.29	2.34	.160	−.09	
$CO_2 \leftarrow$ number of driver's license holders	−1.09	2.50	.662	−.03	
$CO_2 \leftarrow$ gender (0 = female; 1 = male)	**10.23**	**3.51**	**.004**	**.16**	
$CO_2 \leftarrow$ age	.15	.14	.281	.08	
$CO_2 \leftarrow$ being single	−2.12	7.64	.781	−.02	
$CO_2 \leftarrow$ being married	.90	6.64	.892	.02	
$CO_2 \leftarrow$ co-habiting	.37	7.10	.958	.01	
$CO_2 \leftarrow$ number of household members	.43	1.55	.781	.02	
$CO_2 \leftarrow$ upper secondary school (vocational)	−6.98	4.79	.145	−.11	
$CO_2 \leftarrow$ university (up to 4 years)	−1.29	4.32	.764	−.03	
$CO_2 \leftarrow$ university (over 4 years)	−1.13	4.25	.790	−.02	
$CO_2 \leftarrow$ annual household gross income	.89	.91	.330	.07	
$CO_2 \leftarrow$ living in a large city	−3.96	3.59	.270	−.08	
$CO_2 \leftarrow$ living in the suburbs	**−8.05**	**4.10**	**.049**	**−.12**	
$CO_2 \leftarrow$ living in a small city	−2.42	3.64	.506	−.04	
CO_2					.538
Class 1 $\leftarrow$ intention	−.04	.02	.091	−.12	
Class 1 $\leftarrow$ PBC	**−.06**	**.03**	**.009**	**−.18**	
Class 1 $\leftarrow$ brand loyalty	−.04	.11	.702	−.03	
Class 1 $\leftarrow$ number of cars in household	−.01	.06	.889	−.01	
Class 1 $\leftarrow$ number of driver's license holders	.11	.07	.108	.14	
Class 1 $\leftarrow$ gender (0 = female; 1 = male)	.10	.09	.286	.08	
Class 1 $\leftarrow$ age	**.01**	**.00**	**.006**	**.25**	
Class 1 $\leftarrow$ being single	.19	.20	.348	.10	
Class 1 $\leftarrow$ being married	.22	.18	.204	.21	
Class 1 $\leftarrow$ co-habiting	.32	.19	.093	.25	
Class 1 $\leftarrow$ number of household members	.00	.04	.998	.00	
Class 1 $\leftarrow$ upper secondary school (vocational)	.22	.13	.089	.17	
Class 1 $\leftarrow$ university (up to 4 years)	**.32**	**.11**	**.005**	**.30**	
Class 1 $\leftarrow$ university (over 4 years)	.21	.11	.066	.20	
Class 1 $\leftarrow$ annual household gross income	.02	.02	.453	.07	
Class 1 $\leftarrow$ living in a large city	.11	.10	.232	.11	
Class 1 $\leftarrow$ living in the suburbs	−.05	.11	.659	−.04	
Class 1 $\leftarrow$ living in a small city	.09	.10	.336	.08	
Class 1					1.86
Class 2 $\leftarrow$ intention	.03	.02	.077	.13	
Class 2 $\leftarrow$ PBC	.01	.02	.827	.02	
Class 2 $\leftarrow$ brand loyalty	−.11	.10	.270	−.08	
Class 2 $\leftarrow$ number of cars in household	.05	.05	.311	.08	
Class 2 $\leftarrow$ number of driver's license holders	−.09	.06	.124	−.14	
Class 2 $\leftarrow$ gender (0 = female; 1 = male)	−.08	.08	.350	−.07	
Class 2 $\leftarrow$ age	−.00	.00	.285	−.10	
Class 2 $\leftarrow$ being single	.02	.17	.894	.02	
Class 2 $\leftarrow$ being married	−.03	.15	.820	−.04	
Class 2 $\leftarrow$ co-habiting	−.14	.16	.403	−.13	
Class 2 $\leftarrow$ number of household members	**−.09**	**.04**	**.008**	**−.26**	
Class 2 $\leftarrow$ upper secondary school (vocational)	−.17	.11	.129	−.15	
Class 2 $\leftarrow$ university (up to 4 years)	−.14	.10	.160	−.15	
Class 2 $\leftarrow$ university (over 4 years)	−.06	.10	.552	−.07	
Class 2 $\leftarrow$ annual household gross income	.01	.02	.802	.02	
Class 2 $\leftarrow$ living in a large city	.02	.08	.810	.02	
Class 2 $\leftarrow$ living in the suburbs	**.22**	**.09**	**.017**	**.19**	
Class 2 $\leftarrow$ living in a small city	.05	.08	.564	.05	
Class 2					.169
Class 4 $\leftarrow$ intention	−.01	.01	.312	−.08	
Class 4 $\leftarrow$ PBC	.02	.02	.210	.09	
Class 4 $\leftarrow$ brand loyalty	**.17**	**.07**	**.022**	**.16**	
Class 4 $\leftarrow$ number of cars in household	−.02	.04	.721	−.03	
Class 4 $\leftarrow$ number of driver's license holders	−.03	.05	.486	−.07	
Class 4 $\leftarrow$ gender (0 = female; 1 = male)	.03	.06	.609	.04	
Class 4 $\leftarrow$ age	.00	.00	.231	.12	

Table 6 (continued)

	B	SE	P	β	R^2
Class 4 ← being single	−.15	.14	.286	−.12	
Class 4 ← being married	−.22	.12	.067	−.32	
Class 4 ← co-habiting	−.14	.13	.255	−.18	
Class 4 ← number of household members	.05	.03	.058	.20	
Class 4 ← upper secondary school (vocational)	.03	.09	.725	.04	
Class 4 ← university (up to 4 years)	−.06	.08	.466	−.08	
Class 4 ← university (over 4 years)	−.02	.08	.815	−.03	
Class 4 ← annual household gross income	.03	.02	.126	.15	
Class 4 ← living in a large city	.01	.06	.885	.01	
Class 4 ← living in the suburbs	−.03	.07	.725	−.03	
Class 4 ← living in a small city	.02	.07	.776	.03	
Class 4					.093
PBC ← number of cars in household	.28	.18	.122	.13	
PBC ← number of driver's license holders	−.01	.19	.979	−.00	
PBC ← gender (0 = female; 1 = male)	.17	.27	.523	.05	
PBC ← age	.00	.01	.680	.04	
PBC ← being single	**1.25**	**.58**	**.033**	**.24**	
PBC ← being married	.77	.51	.130	.26	
PBC ← co-habiting	.84	.55	.123	.24	
PBC ← number of household members	**−.27**	**.12**	**.021**	**−.23**	
PBC ← upper secondary school (vocational)	.59	.37	.108	.17	
PBC ← university (up to 4 years)	.57	.33	.079	.20	
PBC ← university (over 4 years)	.26	.33	.431	.09	
PBC ← annual household gross income	.06	.07	.398	.08	
PBC ← living in a large city	.14	.28	.607	.05	
PBC ← living in the suburbs	.31	.31	.321	.08	
PBC ← living in a small city	.31	.28	.263	.10	
PBC					.102
Intention ← specific attitude	**.22**	**.05**	**<.001**	**.22**	
Intention ← PBC	**.15**	**.05**	**.001**	**.15**	
Intention ← social norm	**.21**	**.05**	**<.001**	**.21**	
Intention ← integrated norm	**.49**	**.06**	**<.001**	**.49**	
Intention					.632
Integrated norm ← social norm	**.38**	**.08**	**<.001**	**.28**	
Integrated norm ← introjected norm	**.24**	**.07**	**<.001**	**.23**	
Integrated norm ← specific attitude	**.56**	**.09**	**<.001**	**.34**	
Integrated norm ← NEP	**.18**	**.09**	**.044**	**.11**	
Integrated norm					.519

the comprehensive action determination model (CADM) of ecological behavior proposed by Klöckner and Blöbaum (2010) that integrates the TPB and the VBN constructs. Information about past purchase behavior and socio-demographic determinants identified by the traditional approach were also used in deriving the hypotheses.

All four tested hypotheses were at least partially confirmed. Car type class was shown to be a powerful determinant of CO_2 emission levels of the purchased car and to mediate some of the impacts of the socio-demographic and psychological variables (hypothesis H1). However, intention, gender, and living in the suburbs of a larger city had a direct influence on CO_2 emission levels even after controlling for car type class. Brand loyalty had, as predicted, an impact on the likelihood to purchase a car in the prestigious car type class (hypothesis H2). The results of the path analysis indicated a good fit of the original postulated model. All proposed relations between psychological variables are significant which confirms hypotheses H3 and H4. General environmental attitude (NEP), introjected norm, social norm, and specific attitude explained 51.9% of the variance in integrated norm. Social norm, integrated norm, specific attitude and PBC explained 63.2% of the variance in intention.

The results thus indicated that the level of CO_2 emission of a purchased car is jointly determined by the type of car purchased, a strong intention to buy an environmentally friendly car, and location of residence (living in the suburbs). The most notable finding for the CO_2 emission level is that intention had a direct effect. This contradicts findings in previous studies in which car or fuel type have been the key determinants (e.g., de Haan and Keller, 2000; de Jong et al., 2004; Sterner et al., 1992). This raises the question of whether people actually select cars with less CO_2 emission within a car type class if intending to be a fuel-efficient car. In other words, the present findings suggest that the order of choice is car type class first and then CO_2 emission levels. Overall, the conclusion is that psychological motives are proximal determinants of car purchase, thus augmenting traditional models to explain and forecast car choice behavior with the aim of developing measures to influence car purchases.

Concerning brand loyalty, people who are already loyal to a certain brand of car, especially in the diesel-fueled, large size and four-wheel drives class, will most likely continue to purchase the same brand. The result complements past research on brand loyalty that indicates its significance for future car purchases (e.g., Ewing, 2000). Yet, it is interesting that brand loyalty

is not equally relevant in the less fuel-consuming car classes. Within smaller car type classes, brand switching is presumably becoming more common than before. The reason may be that differences between brands in the smaller car type class are perceived as smaller than the differences in the larger car type classes. As manufacturers today are developing cars in almost all classes and categories (including alternatively fueled cars), it can be further speculated that loyalty is reduced since brand is no longer associated with a certain class. Furthermore, while people in the prestigious car type classes tend to stick to their brand, which also have a symbolic or affective function for them (Steg, 2005), people in the smaller car type classes may be more pragmatic in their brand choice which leads to less loyalty.

Furthermore, our results concerning the socio-demographic variables show that these have little impact on people's car type class choice. Contrary to previous research in this area (e.g. Bloch et al., 1986; Stern, 2000b), we were unable to confirm that socio-demographic variables are significant in the purchase of major household goods and services such as cars. The difference between our findings and previous research in terms of socio-demographic factors may be related to the use of psychological variables to mediate the impact of socio-demographic factors. Another possible explanation is that the high number of socio-demographic factors included in the present study lead to reduced individual impacts on the dependent variable which – together with a relatively small sample size –resulted in insignificant estimates. Furthermore, the Norwegian government's regulation regarding car purchase providing strong incentives to purchase cars with low emissions may have a stronger influence than that of traditional socio-demographic variables.

Two socio-demographic variables that had a direct or mediated impact on car type class or CO_2 emissions were household size and cohabiting. Both can be understood as proxies for having children in the household, which is a known determinant of car type class choice (e.g., Clark, 2009). The surprising result that household income had no influence may be explained by a rebound effect. Investing in more expensive but at the same time more fuel efficient cars within one car class pays off for people who use them more often. This may explain why household income has no direct impact on CO_2 emissions when controlling for car type class. However, another and more plausible explanation is that Norwegian people afford purchasing expensive new cars given that 65% of the sample has an average household income of more than 100,000 Euro.

Another finding is the gender differences with regard to purchases of fuel-efficient cars and CO_2 emissions levels. The reason may be that women often display stronger beliefs than men about consequences for self, others, and the biosphere (Stern et al., 1993), and thus choose low emission cars more often than men.

The present study has some limitations. Firstly, the retrospective design relied on participants' memory of decisions that had already been made. Difficulties also arise with respect to the correlational design which prevents establishing cause and effect. Additionally, the relatively small sample size presents a problem in interpreting the results. The fact that the study used a Norwegian-based sample also has implications for the generalizability of the findings across different countries and cultural groups. Norway has a very active policy to support purchases of environmentally friendly cars (e.g., a strong relation between CO_2 emissions of a car and the tax level or strong incentives to electric cars). This policy creates a political context that both communicates the societal norm that low emission cars are favorable and forms a costs structure that pushes purchases away from high emitting cars. However, at the same time Norway has one of the oldest car fleets in Europe, basically due to a high one-time tax on car purchase which reduces the diffusion rate of low emission cars. The design of future studies regarding the effect of CO_2 emission levels on purchases of a new car should take these limitations into consideration.

Finally, we wish to emphasize the practical implications of this study: car type class categories based on attributes, such as engines size, engine power, fuel type, and drive system would provide a deeper understanding of car purchases. As cars are becoming more similar within and across car type classes, for example offering four wheel-drive in everything from SUVs to Minis, it may be argued that in the future car classes as traditionally differentiated will play a smaller role for purchases, and other factors such as attitudes, intentions, and norms will be relatively more important. In general, fuel efficiency should be promoted as a popular feature. Additionally, financial incentives may emphasize the social desirability of a change of purchase behavior. A good example is the quickly developing market for electric vehicles in Norway which is caused by a strong incentive structure. As a prerequisite, consumers should be better informed about the problems related to fuel consumption and about the broad range of own action within car purchase to reduce these problems.

Acknowledgments

References

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50, 179–211.
Anable, J., 2005. 'Complacent car addicts' or 'aspiring environmentalist'? Identifying travel behavior segments using attitude theory. Transport Policy 12 (1), 65–78.
Bamberg, S., Möser, G., 2007. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behavior. Journal of Environmental Psychology 27, 14–25.
Bamberg, S., Schmidt, P., 2003. Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. Environment and Behavior 35, 264–285.

Beatty, S.E., Smith, S.M., 1987. External search effort: an investigation across several product categories. Journal of Consumer Research 14, 83–95.

Bloch, P.H., Sherrell, D.L., Ridgway, N.M., 1986. Consumer search: an extended framework. Journal of Consumer Research 13, 119–126.

Choo, S., Mokhtarian, P.L., 2004. What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. Transportation Research Part A 38, 201–222.

Clark, S.D., 2009. The determinants of car ownership in England and Wales from anonymous 2001 census data. Transportation Research Part C 17, 526–540.

Coad, A., de Haan, P., Woersdorfer, J.S., 2009. Consumer support for environment policies: an application to purchase of green cars. Methodological Advancement in the Footprint Analysis 68, 2078–2086.

Dargay, J.M., 2002. Determinants of car ownership in rural and urban areas: a pseudo-panel analysis. Transportation Research Part E 38, 351–366.

Dargay, J., Gately, D., 1999. Income's effect on car and vehicle ownership, worldwide: 1960–2015. Transportation Research Part A 33, 101–138.

de Haan, P., Keller, M., 2000. Emission factors for passenger cars: application of instantaneous emission modeling. Atmospheric Environment 34, 4629–44638.

de Haan, P., Mueller, M.G., Scholz, R.W., 2009. How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars. Part II: forecasting effects of feebates based on energy-efficiency. Energy Policy 37, 1083–1094.

de Haan, P., Peters, A., Scholz, R.W., 2007. Reducing energy consumption in road transport through hybrid vehicles: investigation of rebound effects, and possible effects of tax rebates. Journal of Cleaner Production 15, 1076–1084.

de Jong, G.C., Fox, J., Daly, A., Pieters, M., Smit, R., 2004. Comparison of car ownership models. Transport Reviews 24, 379–408.

de Wolff, P., 1938. The demand for passenger cars in the United States. Econometrica, 113–129.

Department for Transport, 2002. Powering Future Vehicles: The Government Strategy. Department for Transport, London.

Dunlap, R.E., Van Liere, K.D., Mertig, A.G., Emmet-Jones, R., 2000. Measuring endorsement of the new ecological paradigm: a revised NEP scale. Journal of Social Issues 56 (3), 425–442.

Environmental Protection Agency, 2005. National Emissions Inventory: Air Pollutant Emissions Trends Data and Estimation Procedures, 1970–2002 Average Annual Emissions, All Criteria Pollutants. Environmental Protection Agency, Washington, DC.

European Environment Agency, 2000. Are We Moving in the Right Direction? Indicators on Transport and Environmental Integration in the EU: TERM2000. Environmental Issue Report No. 12. Indicator 4: Traffic Noise: Exposure and Annoyance. European Environment Agency, Copenhagen.

Ewing, M.T., 2000. Brand and retailer loyalty: past behavior and future intentions. Journal of Product and Brand Management 9, 120–127.

Fielding, K.S., McDonald, R., Louis, W.R., 2008. Theory of planned behavior, identity and intention to engage in environmental activism. Journal of Environmental Psychology 28, 318–326.

Fishbein, M., Ajzen, I., 2010. Predicting and Changing Behavior: The Reasoned Action Approach. Psychology Press, New York.

Flamm, B., 2009. The impacts of environmental knowledge and attitudes on vehicle ownership and use. Transportation Research Part D 14, 272–279.

Friedman, R., 1986. Psychological meaning of products: identification and marketing applications. Psychology and Marketing 3, 1–15.

Furse, D.H., Punj, G.N., Stewart, D.W., 1984. A typology of individual search strategies among purchasers of new automobiles. Journal of Consumer Research 10, 417–431.

Gärling, T., Steg, L. (Eds.), 2007. Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions. Elsevier, Amsterdam.

Hocherman, I., Prashker, J.N., Ben-Akiva, M., 1983. Estimation and use of dynamic transaction models of automobile ownership. Transportation Research Record 944, 134–141.

Hunecke, M., Haustein, S., Grischkat, S., Böhler, S., 2007. Psychological, sociodemographic, and infrastructural factors as determinants of ecological impact caused by mobility behavior. Journal of Environmental Psychology 27, 277–292.

Intergovernmental Panel on Climate Change, 2007. Climate Change 2007: Synthesis Report, Summary for Policy Makers. Intergovernmental Panel on Climate Change, New York.

International Energy Agency, 2008. Energy Balance of the OECD and Non-OECD Countries. International Energy Agency, Paris.

Jansson, J., Marell, A., Nordlund, A., 2010. Green consumer behaviour: determinants of curtailment and eco-innovation adoption. Journal of Consumer Marketing 27, 358–370.

Kahn, M.E., 2007. Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. Journal of Environmental Economics and Management 54, 129–145.

Kaiser, F., 2006. A moral extension of the theory of planned behavior: norms and anticipated feelings of regret in conservationism. Personality and Individual Differences 41, 71–81.

Karlaftis, M., Golias, J., 2002. Automobile ownership, households without automobiles, and urban traffic parameters: are they related? Transportation Research Record Journal of the Transportation Research Board 1792, 29–35.

Kitamura, R., Golob, T.F., Yamamoto, T., Wu, G., 2000. Accessibility and auto use in a motorized metropolis. In: Proceedings at the 79th Transportation Research Board Annual Meeting, Washington, DC.

Klocke, U., 2002. Bedingungen umweltrelevanter Mobilitätsentscheidungen: Umweltschutz durch staatliche Massnahmen, bei der individuellen Verkehrsmittelwahl und beim Autokauf. In: Scholl, W., Sydow, H. (Eds.), Mobilität im Jugend- und Erwachsenenalter Münster. Waxmann, pp. 424–469.

Klöckner, C.A., Blöbaum, A., 2010. A comprehensive action determination model – towards a broader understanding of ecological behavior using the example of travel mode choice. Journal of Environmental Psychology 30, 574–586.

Klöckner, C.A., Matthies, E., 2004. How habits interfere with norm directed behavior – a normative decision-making model for travel mode choice. Journal of Environmental Psychology 24, 319–327.

Lane, B., Potter, S., 2007. The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. Journal of Cleaner Production 15, 1085–1092.

Mannering, F., Winston, C., 1985. A dynamic empirical analysis of household vehicle ownership and utilization. Rand Journal of Economics 16, 215–236.

Mannering, F. Winston, C., 1991. Brand loyalty and the decline of American automobile firms. Brookings Papers on Economic Activity: Microeconomics, 67–114.

Mannering, F., Winston, C., Starkey, W., 2002. An exploratory analysis of automobile leasing by US households. Journal of Urban Economics 52, 154–176.

Manski, C., Sherman, L., 1980. An empirical analysis of household choice among motor vehicles. Transportation Research Part A 14, 349–366.

Matthies, E., Klöckner, C.A., Preißner, C.L., 2006. Applying a modified moral decision making model to change habitual car use – how can commitment be effective? Applied Psychology 55, 91–106.

Mogridge, M.J.H., 1983. The Car Market. Pion Limited, London.

Mogridge, M.J.H., 1989. The prediction of car ownership and use revisited. Journal of Transport Economics and Policy 23, 55–74.

Mueller, M.G., de Haan, P., 2009. How much do incentives affect car purchase? Agent- based microsimulation of consumer choice of new cars, Part I: model structure, simulation of bounded rationality, and model validation. Energy Policy 37, 1072–1082.

Ouellette, J.A., Wood, W., 1998. Habit and intention in everyday life: the multiple processes by which past behavior predicts future behavior. Psychological Bulletin 124, 54–74.

Peters, A., Gutscher, H., Scholz, R.W., 2011. Psychological determinants of fuel consumption of purchased new cars. Transportation Research Part F 14, 229–239.

Potoglou, D., Kanaroglou, P.S., 2007. Household demand and willingness to pay for clean vehicles. Transportation Research Part D 12, 264–274.

Punj, G.N., Stewart, D.W., 1983. An interaction framework of consumer decision making. Journal of Consumer Research 10, 181–196.

Schwartz, S.H., 1977. Normative influences on altruism. In: Berkowitz, L. (Ed.), Advances in Experimental Social Psychology, vol. 10. Academic Press, New York, pp. 221–279.

Schwartz, S.H., 1994. Are there universal aspects in the structure and contents of human values?. Journal of Social Issues 50 (4), 19–46.

Schwartz, S.H., Howard, J.A., 1981. A normative decision-making model of altruism. In: Rushton, J.P., Sorrentino, R.M. (Eds.), Altruism and Helping Behavior. Erlbaum, Hillsdale, NJ, pp. 189–211.
Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part A 39, 147–162.
Stern, P.C., 2000a. New environmental theories: toward a coherent theory of environmentally significant behaviour. Journal of Social Issues 56 (3), 407–424.
Stern, P.C., 2000b. Psychology and the science of human–environment interactions. American Psychologist 55, 523–530.
Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: the case of environmental concern. Human Ecology Review 6, 81–97.
Stern, P.C., Dietz, T., Kalof, L., 1993. Value orientations, gender, and environmental concern. Environment and Behavior 25, 322–348.
Sterner, T., Dahl, C., Franzen, M., 1992. Gasoline tax policy, carbon emissions and the global environment. Journal of Transport Economics and Policy 26, 109–119.
Tanner, J.C., 1958. An Analysis of Increases in Motor Vehicles in Great Britain and the United States. Internal Research Note RN3340. Road Research Laboratory, Harmondsworth.
Tanner, J.C., 1978. Long-term forecasting of vehicle ownership and road traffic. Journal of the Royal Statistical Society 141, 14–63.
Thøgersen, J., 2006. Norm for environmentally responsible behavior: an extended taxonomy. Journal of Environmental Psychology 26, 247–261.
Whelan, G., 2007. Modeling car ownership in Great Britain. Transportation Research Part A 41, 205–219.
World Health Organization, 2004. Health Aspects of Air Pollution: Results from the WHO Project "Systematic Review of Health Aspects of Air Pollution in Europe". World Health Organization, Geneva.

Paper II

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Comparison of socio-psychological characteristics of conventional and battery electric car buyers

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ABSTRACT

Knowledge about consumer groups is important for effective measures to encourage consumers to adopt fuel-efficient or alternative fuel cars. In this study, a latent class cluster analysis was conducted to differentiate consumer groups among conventional car buyers based on the latest purchased car's features. Consequently, a series of analysis of variance and a partial least square path modelling were performed to compare five conventional car buyer groups and a group of battery electric car buyers on a range of socio-psychological variables. The results indicated that battery electric car buyers had a significantly different socio-psychological profile from any group of conventional car buyers. In general, conventional car buyers evaluated convenience and performance attributes of the car more important than battery electric car buyers. All groups, however, generally held positive attitude and a high level of perceived behavioural control over buying fuel-efficient cars. Meanwhile, they exhibited weak social and personal norms to choose such cars. Implications for design of effective measures are discussed.

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1. Introduction

Road transportation is a major contributor to depletion of natural resources and environmental problems at a global scale (Hertwich and Peters, 2009; U.S. Energy Information Administration, 2013). Among measures to combat the problems, increasing the amount of cars with emergent technologies (i.e., cars equipped with improved internal combustion engine, hybrid or electric powertrain) in the total car fleet is identified as one of the most significant pathways in the transport sector (Bleijenberg et al., 2013). To achieve this goal, governing bodies generally seek to implement policies, which often heavily rely on monetary costs or benefits, aimed at encouraging consumers to adopt such cars (European Commission, 2009; Norwegian Ministry of the Environment, 2012).

Although the impact of financial benefits and other policy-related advantages in general, and cost of purchase and ownership in particular, is the paramount attribute governing consumers' uptake of cars with emergent technologies (Coad et al., 2009; Graham-Rowe et al., 2012; Mannberg et al., 2014; Turcksin et al., 2013), it has also been suggested that their effects may rely on consumer's general and behaviour-specific predisposition and beliefs (Stern, 2000). For the design of effective measures to promote cars with emergent technologies, socio-psychological characteristics of different target groups therefore need to be addressed alongside economic factors.

1.1. Economic approach to car purchase and todays' car market

In the consumer research literature from the 1980s and 1990s, the purchase and ownership of cars have often been explained by aggregated models, cohort models and disaggregated micro-economic models (see de Jong et al., 2004). Choice modelling studies carried out then reveal that the cost of purchase and use, socio-demographics, income, household characteristics and location strongly affect consumers' purchase decisions (Dargay, 2001, 2002; Liu et al., 2014; Whelan, 2007).

While economic influences on the acquisition of cars with emergent technologies remain strong (Green et al., 2011; Mau et al., 2008), the existence of large variation in engine size, engine power, fuel type, gear type, and drive system through and within all car size segments in todays' car market (de Haan et al., 2009) needs to be reflected in consumers' purchase decisions as well. Put it another way, in order to reflect the current process of consumers' car purchase decision, it seems helpful to use car features like the ones mentioned above to cluster cars. Consequently, close examination of characteristics of consumer segments, which are

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based on the car clusters, may add new material to the body of existing knowledge.

1.2. Socio-psychological approach to car purchase

Notwithstanding the contribution of the economic models being widely acknowledged in surging research on the purchase of cars with emergent technologies (Axsen et al., 2009; Mannberg et al., 2014), empirical evidence has also revealed the importance of various socio-psychological variables in consumers' uptake of such cars (Heffner et al., 2007; Jansson et al., 2010; Kahn, 2007; Ozaki and Sevastyanova, 2011; Peters et al., 2011; Turrentine and Kurani, 2007). In this regard, Stern's (2000) categorization of determinants of environmentally significant behaviour provides a general framework, which addresses a range of variables that the economic approach and the socio-psychological approach have emphasized in the research on consumers' purchase of cars with emergent technologies.

Contextual forces (e.g., interpersonal influences, community expectations, government regulations or policies, monetary factors, and various features of the broad social, economic, and political context) are one of the categories of determinants suggested by Stern (2000) as having huge impact on private sphere environmental behaviours. According to the attitude-behaviour-context theory (Guagnano et al., 1995; Stern, 2000), when the contextual forces are strongly positive or negative, they effectively compel or prohibit consumers' acquisition of cars with emergent technologies. This assumption is in line with economic preferences for acquisition of cars put forward by the economic approach and choice modelling studies.

Stern (2000) proposes that contextual forces and personal capabilities (e.g., knowledge and skills for particular actions, the availability of time to act, and general capabilities and resources indicated by sociodemographics), which is the other category of determinants, shape an individual' general and behaviour-specific predisposition and beliefs to act. This individual sphere predisposition and beliefs are then categorized by Stern (2000) as attitudinal factors. Cognitive behavioural theories like the theory of planned behaviour (TPB, Ajzen, 1991; Fishbein and Ajzen, 2010), and normative behavioural theories like Schwartz' (1977) norm-activation model (NAM) and Stern's (2000) value-belief-norm theory (VBN), provide good theoretical accounts of the attitudinal factors.

The TPB identifies behaviour specific predisposition like a person's overall evaluation of performing the particular behaviour (i.e., attitude toward behaviour), and behaviour specific beliefs like a person's perception of the ease or difficulty of performing the particular behaviour (perceived behavioural control) as factors affecting the behaviour. In addition, a person's beliefs about if other important persons approve or disapprove the particular behaviour (i.e., subjective norms) are also suggested to affect the performance of the behaviour. The subjective norms in the TPB resemble interpersonal influences and community expectations mentioned in contextual forces by Stern (2000). The TPB further suggest that a person's inclination to perform the particular behaviour (i.e., behavioural intention), which is generated by weighing the importance of each of the above three factors, is a direct antecedent of the behaviour. The TPB thus emphasizes expectancy-value assessment of individuals (Ajzen, 1991; Fishbein and Ajzen, 2010), and therefore views individuals as "utility maximizing actors" (Bamberg and Schmidt, 2003, p. 267).

Meanwhile, the NAM identifies behaviour specific predispositions like specific personal norms (i.e., strong intrinsic feeling of obligation to engage in the particular behaviour) and behaviour specific beliefs like awareness of need (i.e., the need to protect natural resources, the environment etc.), awareness of consequences (i.e., the particular behaviour's consequences for self, others, or the environment), and ascription of responsibility (i.e., accepting responsibility that the person holds for these consequences) to affect the behaviour. Besides, the NAM acknowledges the importance of the perception of the own ability to execute the behaviour (Schwartz and Howard, 1981), which is a construct comparable to perceived behavioural control in the TPB. The VBN theory extends the NAM, and adds a person's general predisposition to act according to value orientations and environmental beliefs as having an effect on environmentally significant behaviours. Both the NAM and VBN propose personal norms as direct determinant of the behaviour.

While the cognitive behavioural theories, such as the TPB, emphasize utility maximization or self-interest of individuals, normative behaviour theories shift the view toward moral obligation to help others or environment. However, neither of them comprehensively addresses the multifaceted attitudinal bases of environmentally significant behaviour. Considering environmentally significant behaviour as a mixture of self-interest and concern for others or environment, researchers have suggested an integration of the theories (Bamberg and Möser, 2007; Klöckner and Blöbaum, 2010). Studies employing the integrated approach have then found empirical evidence for the role of the above-mentioned attitudinal factors in uptake of cars with emergent technologies (Nayum et al., 2013; Peters et al., 2011).

In addition to the attitudinal factors mentioned above, Stern (2000) also suggest that attitudes about attributes of consumer products (e.g., drive wheel, colour, comfort, energy label in cars) can affect environmentally significant behaviour. This notion is supported by empirical research, in which consumers' attitudes toward a car's environmental attributes (i.e., the overall evaluation of environmentally friendly aspects of a car), attitudes toward the car's performance attributes (i.e., the overall evaluation of aspects of a car that enhance driving performance and the image of a car), and attitudes toward a car's convenience attributes (i.e., the overall evaluation of aspects of a car that enhance the practicality and comfort of a car) have been found to relate with behaviour (van Rijnsoever et al., 2009). A recent review of research on purchase of cars on alternative fuels and drive trains shows that the purchase decision is mainly driven by price characteristics, performance and convenience attributes (Turcksin et al., 2013).

To summarize, environmentally significant behaviour like consumers' acquisition of cars with emergent technologies, is determined by multiple variables, often in interaction (Stern, 2000). As a result, approaches based solely on financial benefits and other policy-related advantages hardly produce much change on their own in longer term. On the other hand, neither moral approaches (i.e., appealing values to change broad world views and beliefs) nor educational approaches (i.e., providing information to change specific attitudes and beliefs) alone result in satisfying track records (Gardner and Stern, 1996). There is, however, strong evidence that significant governmental incentives and regulations combined with information or moral appeals are much more effective (Gardner and Stern, 1996; Stern, 1999).

1.3. The present study

The Norwegian government's progressive tax policy has been in favour of cars that have low emissions. The study coincided with recent policy from the Norwegian government recognizing a wide range of benefits and advantage (e.g., exemption from one-off registration tax, no road and ferry tolls, free parking and charging in municipal parking areas, access to collective transport lane etc.) for buying and using battery electric cars. Although the important role of a facilitating context requires no refute, the recognition of a multifaceted motivation base of consumer behaviour poses a

question – how policy measures can effectively address different target groups? Thus, exploring socio-psychological profiles of different car buyers seems to be necessary.

2. Method

2.1. Sampling and procedure

Using a web survey, the data set for this study was collected from Norwegian car owners (a) who had bought a new conventional car (i.e. car with internal combustion engine) for private use between November and December 2011, and (b) who bought a new battery electric car for private use in 2011. In April 2012, an invitation letter, which asked the person who had the main responsibility for the purchase of the household's most recently acquired car to participate in a web survey, was sent by postal mail to 12,000 conventional car owners and 1362 battery electric car owners. Names and addresses were obtained from the Norwegian Public Roads Administrations Head Office. The battery electric car owners were sampled for a whole year to achieve a substantial group in the total sample. The car owners were informed that all participants who finished the web survey would be included in a lottery to win an Apple iPad 3, and a total of three iPads were given away.

1421 conventional car owners (response rate = 11.84%) and 372 battery electric car owners (response rate = 27.31%) filled out the questionnaire. The final sample consisted predominantly of men (77.72%), and 74.07% of the participants had a higher education (see Table 2 for a summary of the sample statistics). The median annual household income before tax was NOK[3] 850000–999,900 on a categorical scale. Information about gender, education level and household income were not available for the Norwegian population of new passenger car buyers. However, a comparison of the sample of this study with the general Norwegian population revealed that individuals with higher education and higher household income were overrepresented (Statistics Norway, 2012, 2013).

2.2. Web survey

Based on an extensive review of the literature, a self-administrated questionnaire was developed for the web survey. The questionnaire was tested among a smaller independent sample in 2011 (see Nayum et al., 2013). Subsequently, the questionnaire items were revised to improve clarity and reliability. The web survey consisted of several parts, and the following describes those parts used in this study.

2.2.1. Information on the latest purchases car

Respondents were first asked to provide detailed information on their latest purchased car (i.e., make, year of purchase, model, model year, purchase price, engine size, engine power, fuel type, gear type, body type, and drive wheel). The last seven features were used as indicators in the latent class cluster analysis performed in the study.

2.2.2. Attitudinal factors

In the second part of the survey, a range of items and statements, which were formulated to tap various attitudinal factors, were presented. The items and statements were based on previous studies on pro-environmental consumer behaviour, and in some cases modified with specific regard to car purchase.

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[3] 1 NOK is approximately equal to 0.1355 Euro.

2.2.2.1. Attitudes about attributes of car. 28 car attributes (see Appendix A) were randomly presented as a starting block of attitudinal factors. Respondents were asked to rate how important each of them was when they made the latest car purchase decision, on a seven-point ordinal scale ranging from 'not important at all' to 'extremely important'. These 28 items were adapted from van Rijnsoever et al.'s (2009) study on consumer car preferences in the car-purchasing process. A WLSMV factor extraction and oblique rotation with Geomin on these items was conducted in MPLUS (Muthén and Muthén, 2013). The results of this exploratory factor analysis showed that six eigenvalues for sample correlation matrix were larger than 1. However, a close inspection revealed there was no substantial drop in the magnitude of the eigenvalues after third eigenvalue. Consequently, a three-factor structure were retained, and the factors were labelled as attitude toward environmental attributes (Att.E), attitude toward performance attributes (Att.P), and attitude toward convenience attributes (Att.C) (see Appendix A).

2.2.2.2. Attitudinal factors from the cognitive and normative behavioural theories. Following Thøgersen's (2006) extended taxonomy of norms, norms were operationalized as descriptive norm (DN, i.e., whether other important persons own or consider buying a car that is more fuel-efficient and environmentally friendly), subjective social norm (SN, i.e., whether other important persons approve or disapprove the person's purchase of such a car), introjected norm (INJ, i.e., the person's feelings of guilt resulting from not owning or buying such a car), and integrated norm (IGN, i.e., the person's intrinsic feelings of obligation to own or buy such a car). Together with awareness of need (AN, i.e., realization of something needed to be done to protect natural resources and environment in relation to car ownership and sales), awareness of consequences (AC, i.e., the recognition of relationship between one's own car purchase and resource depletion, environmental pollution), ascription of responsibility (AR, i.e., the responsibility attribution to self as car buyer and owner for these consequences), perceived behavioural control (PBC, i.e., the person's perception of the ease or difficulty of buying a car that is more fuel-efficient and environmentally friendly), and behavioural intention (INT, i.e., the person's inclination to buy such a car), each of the above constructs was measured with three statements. These statements were formulated according to Fishbein and Ajzen's (2010) general recommendations and previous studies on pro-environmental behaviour (Fielding et al., 2008; Hunecke et al., 2007; Kaiser, 2006; Klöckner and Matthies, 2004; Matthies et al., 2006; Nayum et al., 2013). In addition, 10 statements from the New Ecological Paradigm scale (Dunlap et al., 2000) were adopted to tap general environmental beliefs (GEB). Respondents were asked to indicate the degree of agreement to these statements on 7-point Likert-type scale from 'strongly disagree' to 'strongly agree'.

Attitudes toward purchasing a car that is fuel-efficient and environmentally friendly (ATT) were assessed by asking respondents to rate on a seven-point scale, ranging from 'very bad/ harmful/unfavourable/foolish/unsatisfying/unpleasant' to 'very good/beneficial/favourable/wise/satisfying/pleasant'. Furthermore, 12 items from a brief inventory of values scale (Stern et al., 1998) were used to measure self-transcendence (STV), self-enhancement (SEV), openness to change (OCV), and conservation-tradition (CTV) value orientations. Respondents were asked to rate the importance of the values as guiding principles in their lives on a 7-point scale, ranging from 'opposed to my values' to 'extremely important'. This method of measuring values builds on Schwartz's (1992) universal value system, and it has been validated in a number of papers on pro-environmental

behaviour across different cultures (De Groot and Steg, 2008; Nordlund and Garvill, 2002).

2.2.3. Socio-demographic and household characteristics

Finally, questions about socio-demographic and household characteristics of the person, who had the main responsibility for the purchase of the household's most recently acquired car, were included.

2.3. Data analysis

A latent class cluster analysis using LatentGOLD 4.5 (Vermunt and Magidson, 2010) was conducted to identify conventional car clusters, which were then used to differentiate consumer groups among buyers of conventional cars. Price, engine size, engine power, fuel type (categorical), gear type (categorical), body type (categorical), and drive wheel (categorical) of the latest purchased conventional car were used as clustering indicators. Compared to traditional cluster analysis approaches such as hierarchical or k-means cluster analysis, which group cases together that are "near" each other according to an ad hoc definition of "distance", latent class cluster analysis provides a probability based classification through a posterior probability of membership. In addition, a variety of model selection tools, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), bootstrapped – 2 Log-likelihood (2LL) difference tests, entropy R-squared, Wald statistic and p-value for the contribution of each predictor variable are available to assess the cluster solutions (Haughton et al., 2009).

Afterwards, a series of analysis of variance (ANOVA) were performed to compare consumer groups (i.e., groups of conventional car buyers and one group of battery electric car buyers) on continuous socio-demographic variables.

In order to examine psychological profiles of these groups, a partial least squares path-modelling (PLS-PM) approach was conducted using the XLSTAT software package (Addinsoft, 2012). Measurement models for the latent psychological constructs were defined, and each of them was regressed on the consumer groups (dummy coded). The analysis was controlled for respondents' gender, age, household income, and education level. The reliability of measurement models was assessed at the construct level using Dillon-Goldstein's rho (D.G. rho), and at the indicator level by examining the factor loadings. For the reliability at the construct level, a D.G. rho value of 0.7 or higher is required (Hair et al., 2011). The validity of measurement models was assessed referring to convergent and discriminant validity of the psychological constructs. An average variance extracted (AVE) value larger than 0.5 was considered satisfactory convergent validity. Discriminant validity could be stated if the AVE value of a psychological construct was larger than the construct's highest squared correlation with any other construct (Fornell and Larcker, 1981). The results of the path model, i.e. the significant difference between unstandardized regression coefficients from groups to a psychological construct and their 95 % confidence intervals, were then used to reveal differences between consumer groups on that psychological construct. There were several reasons to use the PLS-PM approach to conduct the analyses. First, it generates robust estimators that do not rely on a specific distributional hypothesis (Jöreskog and Wold, 1982). Second, it manages data with large number of variables well, and presents a very flexible alternative approach to multi-block analysis by means of the confirmatory partial least squares path model (Tenenhaus and Hanafi, 2010). Third, it is also

Table 1
Profiles of the conventional car clusters ($N = 1421$).

Indicators	Cluster 1 (mid-size family cars) $N = 373$	Cluster 2 (large family cars & compact SUVs) $N = 330$	Cluster 3 (compact cars) $N = 307$	Cluster 4 (compact crossovers) $N = 216$	Cluster 5 (crossover SUVs & powerful cars) $N = 195$
Average engine size (l)	1.58	1.98	1.41	1.77	2.27
Average engine power (hp)	108.65	141.08	103.36	113.76	164.23
Average price (NOK[a])	328,970	464,565	268,762	344,796	647,965
Fuel type (%)					
Petrol	0.03	3.80	62.65	2.87	5.12
Diesel	99.97	96.20	26.92	97.13	94.88
Hybrid			10.43		
Gearbox type (%)					
Manual	77.23	47.72	66.91	99.94	21.69
Automatic	0.99	33.22	28.00	0.04	78.30
EMG[*]	13.41			0.01	
DSG[**]	8.37	19.06	5.08	0.01	0.01
Body type (%)					
3-Door kombi	3.09	0.87	3.18		
5-Door kombi	20.63	9.39	56.16	0.69	2.08
Fastback	1.63	0.71	1.00		0.83
Station wagon	48.58	35.11	18.59	12.55	31.65
SUV	4.35	31.81	3.53	86.74	54.36
Multivan	17.52	17.58	16.24	0.02	0.92
Sedan	4.19	4.52	0.97		9.65
Convertible			0.32		0.51
Drive system (%)					
Front wheel	96.23	46.51	91.76	66.78	6.09
Back wheel		4.18	1.91	0.01	11.73
Four wheel	3.77	49.30	6.33	33.22	82.18
Typical examples	VW Golf	VW Sharan	Toyota Auris	Mitsubishi ASX	Mitsubishi-Outlander
	Ford Focus	VW Tiguan	Skoda Fabia	Hyundai i40	BMW X3
	Peugeot 508	Ford Kuga	VW Polo		Volvo XC70

[a] 1 NOK ≈ 0.1355 Euro.
[*] EMG = electronic manuel gearbox.
[**] DSG = direct shift gearbox.

known to be robust to multicollinearity (Haenlein and Kaplan, 2004) and suitable for highly complex models with a large number of indicators or constructs, or both (Chin, 2010).

3. Results

3.1. Clustering conventional cars

Models between 1 and 13 clusters were estimated by a latent class cluster analysis approach. Though model fit indices (log-likelihood, AIC, and BIC) become better and better up to 12 clusters, the entropy R-squared was second best with a 5-cluster model. The increase in model fit flattened out considerably after 5 clusters. Furthermore, solutions with more than five clusters resulted in clusters with small cluster sizes (e.g., less than 100 cases). Thus we decided to proceed with a 5-cluster model in favour of a better model-parsimony and better interpretability. All of the clustering predictors contributed significantly to the 5-cluster solution as indicated by the Wald statistic and p-value for the contribution of each predictor. Table 1 displays the profiles for the resulting conventional car clusters. We named the clusters for illustrative purposes as 'mid-size family cars', 'large family cars & compact SUVs', 'compact cars', 'compact crossovers', and 'crossover SUVs & powerful cars'. However, there was overlap between clusters,

and some rather similar car models might appear in different clusters.

3.2. Socio-demographic and household characteristics of car buyer groups

Table 2 displays selected socio-demographic and household characteristics for the five conventional car buyer groups, which correspond to the five conventional car clusters, and one battery electric car buyer group. The results of a series of ANOVA using post hoc Bonferroni or Games-Howell tests indicated that there were significant differences between consumer groups on age (Welch F (5,641.77) = 11.21, $p \leqslant .001$), household size (F (5,1502) = 16.50, $p \leqslant .001$), children in household (Welch F (5,654.54) = 18.90, $p \leqslant .001$), and cars in household (Welch F (5,654.31) = 34.41, $p \leqslant .001$). Post hoc Games-Howell tests and Bonferroni test showed that battery electric car buyers were significantly younger, had significantly more cars and children per household, and had significantly larger household size than any conventional car buyer groups at the $p < .001$ levels. All other comparisons were insignificant.

For categorical variables, large differences existed mainly between the battery electric car buyers and conventional car buyers. A very high percentage of battery electric car buyers were

Table 2
Socio-demographic and household characteristics of the car buyer groups (N* = 1508).

	Total sample	Groups of conventional car buyers					Electric car buyers
		Cl. 1	Cl. 2	Cl. 3	Cl. 4	Cl. 5	
Group size	1508	321	266	246	188	170	317
Male (%)	77.72	76.32	86.84	63.82	78.19	85.88	77.60
Age (mean)	49.50	49.15	50.77	51.59	50.93	50.69	45.69
Nr. of household members (mean)	2.98	2.94	2.92	2.66	2.74	2.91	3.51
Nr. of children in household (mean)	0.89	0.87	0.81	0.67	0.61	0.73	1.38
Nr. of cars in household (mean)	1.70	1.61	1.58	1.52	1.55	1.69	2.11
Living status (%)							
Single	5.83	4.98	7.14	12.20	4.79	3.53	2.52
Married/registered	71.42	66.67	74.44	63.41	71.28	82.35	74.13
Cohabiting	17.64	21.50	13.91	16.67	20.21	10.59	19.87
Separated/divorced	3.78	5.92	2.63	4.47	2.66	2.94	3.16
Widow/widower	1.33	0.93	1.88	3.25	1.06	0.59	0.32
Education level (%)							
No education	0.07		0.38				
Elementary school	2.06	2.49	1.13	2.44	3.72	2.35	0.95
Upper secondary[a]	15.45	17.76	16.16	17.07	20.75	12.94	9.46
Upper secondary[b]	8.35	7.48	13.53	9.76	9.04	7.06	4.10
University (⩽4 years)	35.08	35.82	36.47	28.86	37.23	40.00	34.07
University (>4 years)	36.80	34.58	30.83	39.84	27.66	35.30	47.95
Doctor grade	2.19	1.87	1.50	2.03	1.60	2.35	3.47
Employment (%)							
Working	84.42	84.42	82.70	71.54	82.45	88.82	94.64
Student	0.33			0.41			1.26
Retired	12.60	13.40	15.04	21.95	14.89	10.00	2.52
Social benefit	1.99	1.56	1.50	4.47	2.66	1.18	0.95
Housework	0.53	0.62	0.38	1.22			0.63
Unemployed	0.13		0.38	0.41			
Household income: NOK/year (%)							
Under 150,000	0.40	0.94		0.41	0.53	0.59	
150,000–249,000	0.60		0.38	1.62		1.18	0.63
250,000–349,000	1.99	2.50	2.26	5.28	1.06		0.32
350,000–449,000	4.84	6.54	3.38	7.32	4.79	4.70	2.52
450,000–549,000	6.77	8.41	6.77	10.16	11.70	3.53	1.26
550,000–649,000	6.43	8.41	4.13	12.60	6.92	4.70	2.21
650,000–749,000	5.90	8.72	6.39	6.10	8.51	2.35	2.84
750,000–849,000	11.47	12.77	11.65	14.23	14.89	7.06	8.20
850,000–999,000	17.77	18.69	16.54	14.23	18.62	14.12	22.08
Over 1,000,000	43.83	33.02	48.50	28.05	32.98	61.77	59.94

* Respondents who had incomplete answers on socio-psychological variables were excluded.
[a] Vocational.
[b] General.

Table 3
Measurement models for the latent psychological variables (N = 1508).

Latent psychological variables and indicators	D.G. rho	AVE	β
Self-enhancement value (SEV)	.83	.66	
1. Wealth (material possession, money)			.97
2. Authority (the right to lead or command)			.62
Self-transcendence value (STV)	.85	.63	
1. A world at peace (free of war and conflict)			.87
2. Social justice (correcting injustice, care for the weak)			.82
3. Protecting the environment (preserving nature)			.67
Openness to change value (OCV)	.87	.68	
1. A varied life (filled with challenge, novelty and change)			.90
2. An exciting life (stimulating experiences)			.85
3. Curious (interested in everything, exploring)			.72
Conservation-tradition value (CTV)	.81	.67	
1. Honouring of parents and elders (showing respect)			.93
2. Self-discipline (self-restraint, resistance to temptation)			.68
General environmental belief (GEB)	.83	.50	
1. The so-called "ecological crisis" facing humankind has been greatly exaggerated*			.84
2. If things continue on their present course, we will soon experience a major ecological catastrophe			.78
3. The balance of nature is strong enough to cope with the impacts of modern industrial nations*			.76
4. The balance of nature is very delicate and easily upset			.59
5. Human ingenuity will insure that we do NOT make the earth unliveable*			.51
Awareness of need (AN)	.91	.77	
1. There is an urgent need for something to be done about the environmental pollution caused by people owning big cars			.90
2. Concerning the environment, I am particularly worried that many large and powerful cars are sold			.89
3. There is an urgent need for something to be done about the fuel consumption of powerful cars			.85
Awareness of consequences (AC)	.91	.77	
1. My own decision on what type of car I was going to buy has a relevant impact upon the environment			.89
2. My own decision on what type of car I was going to buy has a relevant impact upon the quality of life for future generations			.89
3. My own decision on what type of car I was going to buy has a relevant impact upon the consumption of energy resources			.85
Ascription of responsibility (AR)	.86	.67	
1. As a car owner, I have the responsibility to conserve energy resources and to ensure quality of life for future generations			.88
2. As a customer, I have the responsibility to influence the car industry towards more environmentally friendly solutions			.83
3. I feel personally responsible for environmental problems resulting from the type of car I own			.75
Introjected norm (IJN)	.94	.83	
1. I (would) have bad conscience sometime (if) because I own a powerful and large car			.92
2. Owning a car that is not fuel efficient and environmentally friendly (would) give me bad conscience sometime			.91
3. Owning a powerful and large car (would) give me bad conscience			.90
Integrated norm (IGN)	.91	.78	
1. When I bought my new car, I felt a strong personal obligation to choose a fuel efficient and environmentally friendly car			.89
2. I felt a strong personal obligation to protect the environment when I bought my new car			.89
3. Based on my values it was/would be the right thing for me to buy a fuel efficient and environmentally friendly car			.88
Descriptive norm (DN)	.87	.69	
1. Many of the people who are important to me own fuel efficient and environmentally friendly cars			.87
2. Many of the people who are important to me are replacing their powerful and large cars with fuel efficient and environmentally friendly cars			.83
3. Many of the people who are important to me are considering to buy fuel efficient and environmentally friendly cars			.79
Subjective social norm (SN)	.87	.65	
1. I believe many of the people who are important to me expected me to choose a fuel efficient and environmentally friendly car			.90
2. I believe many of the people who are important to me expected me to buy a fuel efficient and environmentally friendly car			.90
3. Many of the people who are important to me suggested that I should replace my car with a fuel efficient and environmentally friendly car			.59
Perceived behavioural control (PBC)	.73	.57	
1. There are many problems and difficulties associated with environmentally friendly cars*			.87
2. It was mostly up to me whether I would buy a fuel efficient and environmentally friendly car			.63
Attitude (ATT)	.94	.71	
[Buying a fuel-efficient car is...]			
1. Very unsatisfying.................Very satisfying			.90
2. Very foolish.....................Very wise			.89
3. Very unfavourable...............Very favourable			.86
4. Very unpleasant..................Very pleasant			.85
5. Very harmful....................Very beneficial			.82
6. Very bad........................Very good			.74
Intention (INT)	.82	.59	
1. When I bought my new car, I wanted to buy a fuel efficient and environmentally friendly car			.80
2. When I bought my new car, I intended to buy a powerful and large car*			.77
3. When I bought my new car, I planned to replace the car I'd had with a fuel efficient and environmentally friendly car			.75
Attitude toward environmental attributes of car (Att.E)	.92	.70	
1. Emission of polluting chemicals			.90
2. Greenhouse gas emission			.88
3. Environmentally friendly materials			.82
4. The energy label of the car			.81

Table 3 (continued)

Latent psychological variables and indicators	D.G. rho	AVE	β
5. CO_2 reducing tyres			.77
Attitude toward performance attributes of car (Att.P)	.89	.52	
1. Appearance			.81
2. Car class			.78
3. Extra accessories (e.g., metallic paint, heated seating etc.)			.77
4. Colour			.73
5. Comfort			.72
6. The "feeling" you get from the car			.68
7. Leather interior			.64
8. Make and model variant			.61
Attitude toward convenience attributes of car (Att.C)	.86	.53	
1. Cruise control			.78
2. Power steering			.77
3. Anti-lock breaking system (ABS)			.76
4. Drive wheel			.72
5. Airbag			.59

D.G. rho = Dillon-Goldstein's rho; AVE = average variance extracted; β = standardized factor loadings.
 * Reverse coded.

working, had higher education and very high household income compared to any of the conventional car buyer groups. Among groups of conventional car buyers, cluster 2 (i.e., buyers of 'large family cars & compact SUVs') and cluster 5 (i.e., buyers of 'cross-over SUVs & powerful cars') had higher household income than the other groups. Cluster 3 (i.e., buyers of 'compact cars'), meanwhile, included a significantly higher percentage of retired people. Besides, the household income level was on average lower in this group than in the other groups.

3.3. Measurement models of the psychological variables

The preliminary PLS-PM analysis, which was conducted to verify the reliability and validity of the measurement models, indicated that the following items had to be removed because of low factor loadings (<.50) and cross loadings: five items of attitude toward convenience attributes (i.e., price, winter tyres, reliability, length of the car, and volume of the car); four items of attitude toward performance attributes (i.e., speed, image, horsepower, and transmission); one item of attitude toward environmental attributes (i.e., fuel economy); one item of perceived behavioural control (i.e., If I wanted I could have bought a fuel efficient and environmentally friendly car); five items of general environmental belief (i.e., We are approaching the limit of the number of people the earth can support; Plants and animals have as much right as humans to exist; Despite our special abilities humans are still subject to the laws of nature; The Earth is like a spaceship with very limited room and resources; Humans were meant to rule over the rest of nature [reverse coded]); one item of self-enhancement value (i.e., influential); and one item of conservation-tradition value (i.e., family security). As shown in Table 3, the modified measurement models exhibited evidence of satisfactory reliability (at both indicator and construct level) and validity (both convergent and discriminant validity), which are prerequisites for assessing the path model of the study.

3.4. PLS-PM path analysis

Table 4 provides the details of the path model results showing mean differences on the latent psychological variables between the reference group (i.e., cluster 3 – buyers of 'compact cars') and all other groups. More specifically, the intercepts (i.e., a) represent the mean values of the latent psychological variables for the reference group. The unstandardized regression coefficient (i.e., b) of each groups (dummy coded) on a latent psychological variable

show the mean difference between the reference group and the respective group. A positive b shows that the reference group had a lower mean on the latent psychological variables and vice versa. The p values show if the difference is significant. Overlapping confidence intervals (i.e., 95% CI) between unstandardized regression coefficients (b) for any two groups would indicate a statistically non-significant mean difference on a latent psychological variable.

3.5. Psychological characteristics of car buyer groups

The following sections describes the psychological characteristics of car buyer groups based on all possible paired comparisons based on the PLS-PM path analysis.

3.5.1. Buyers of 'compact cars' (cluster 3) – the reference group

This group was used as a reference group in the partial least squares path-modelling. As indicated by the intercepts (a) in Table 4, they evaluated car's convenience and performance attributes as important, but environmental attributes as of little importance. They reported a favourable attitude, a rather high level of perceived behavioural control, and a rather strong intention to buy a car that is more fuel-efficient and environmentally friendly. Meanwhile, the perceived social pressure (descriptive norm and subjective social norm) to buy such a car was reported to be low. Although members of this group scored high on self-transcendence values, openness to change values, conservation-tradition values, and general environmental belief, the values on awareness of need, awareness of consequences, ascription of responsibility, and personal norms (introjected norm and integrated norm) were rather low.

3.5.2. Buyers of 'mid-size family cars' (cluster 1)

These buyers had very similar psychological characteristics to the reference group, but evaluated the car's convenience and performance significantly more important than the reference group. 95% confidence intervals of the unstandardized regression coefficients (see Table 4) indicated there were no significant differences between this group and the buyers of 'compact crossovers' (cluster 4) on any of the psychological variables. The comparison also showed that this group exhibited a psychological profile closer to buyers of 'battery electric cars' than to the profile of buyers of 'crossover SUVs & powerful cars' (cluster 5).

Table 4
PLS-PM parameters, buyers of compact cars (cluster 3) as reference group (*N* = 1508).

	a	*b*	*p* (⩽.05)	95% CI
SEV	4.12			−0.18 to 0.28
← Cluster 1		0.05	n.s.	−0.14 to 0.31
← Cluster 2		0.09	n.s.	−0.23 to 0.32
← Cluster 4		0.04	n.s.	0.07 to 0.54
← Cluster 5		0.28	sig.	−0.17 to 0.37
← Electric		0.12	n.s.	
STV	5.34			
← Cluster 1		−0.05	n.s.	−0.25 to 0.16
← Cluster 2		−0.26	sig.	−0.46 to −0.04
← Cluster 4		−0.06	n.s.	−0.33 to 0.18
← Cluster 5		−0.22	sig.	−0.44 to 0.01
← Electric		−0.11	n.s.	−0.26 to 0.19
OCV	5.51			
← Cluster 1		−0.13	n.s.	−0.33 to 0.07
← Cluster 2		−0.16	n.s.	−0.37 to 0.09
← Cluster 4		−0.27	sig.	−0.46 to −0.06
← Cluster 5		−0.01	n.s.	−0.30 to 0.18
← Electric		0.01	n.s.	−0.25 to 0.24
CTV	5.86			
← Cluster 1		0.00	n.s.	−0.22 to 0.21
← Cluster 2		−0.07	n.s.	−0.31 to 0.14
← Cluster 4		0.07	n.s.	−0.24 to 0.32
← Cluster 5		0.10	n.s.	−0.12 to 0.37
← Electric		−0.20	sig.	−0.41 to −0.03
GEB	4.72			
← Cluster 1		−0.13	n.s.	−0.46 to 0.08
← Cluster 2		−0.43	sig.	−0.63 to −0.23
← Cluster 4		−0.14	n.s.	−0.40 to 0.10
← Cluster 5		−0.41	sig.	−0.68 to −0.21
← Electric		0.09	n.s.	−0.16 to 0.31
AN	3.63			
← Cluster 1		−0.06	n.s.	−0.37 to 0.25
← Cluster 2		−0.51	sig.	−0.85 to −0.18
← Cluster 4		−0.26	n.s.	−0.49 to 0.10
← Cluster 5		−0.95	sig.	−1.21 to −0.61
← Electric		0.12	n.s.	−0.12 to 0.50
AC	3.55			
← Cluster 1		−0.02	n.s.	−0.29 to 0.23
← Cluster 2		−0.48	sig.	−0.79 to −0.17
← Cluster 4		−0.23	n.s.	−0.48 to 0.06
← Cluster 5		−0.84	sig.	−1.16 to −0.46
← Electric		0.48	sig.	0.21 to 0.83
AR	3.26			
← Cluster 1		−0.06	n.s.	−0.32 to 0.19
← Cluster 2		−0.43	sig.	−0.71 to −0.11
← Cluster 4		−0.20	n.s.	−0.41 to 0.08
← Cluster 5		−0.58	sig.	−0.88 to −0.24
← Electric		0.32	sig.	0.01 to 0.67
IJN	2.57			
← Cluster 1		−0.11	n.s.	−0.37 to 0.14
← Cluster 2		−0.61	sig.	−0.99 to −0.30
← Cluster 4		−0.22	n.s.	−0.48 to 0.13
← Cluster 5		−0.83	sig.	−1.10 to −0.48
← Electric		−0.05	n.s.	−0.34 to 0.25
IGN	2.92			
← Cluster 1		−0.14	n.s.	−0.47 to 0.13
← Cluster 2		−0.77	sig.	−1.09 to −0.49
← Cluster 4		−0.39	sig.	−0.69 to −0.06
← Cluster 5		−1.08	sig.	−1.37 to −0.74
← Electric		0.23	n.s.	−0.07 to 0.55
DN	2.63			
← Cluster 1		0.12	n.s.	−0.07 to −0.32
← Cluster 2		−0.21	n.s.	−0.53 to −0.05
← Cluster 4		0.11	n.s.	−0.09 to 0.34
← Cluster 5		−0.31	sig.	−0.63 to −0.11
← Electric		−0.34	sig.	−0.61 to −0.12
SN	2.05			
← Cluster 1		−0.07	n.s.	−0.29 to 0.15
← Cluster 2		−0.46	sig.	−0.72 to −0.24
← Cluster 4		−0.08	n.s.	−0.35 to 0.14

Table 4 (continued)

	a	b	p (⩽.05)	95% CI
← Cluster 5		−0.57	sig.	−0.84 to −0.32
← Electric		−0.50	sig.	−0.70 to −0.28
PBC	4.73			
← Cluster 1		−0.02	n.s.	−0.26 to 0.27
← Cluster 2		−0.30	sig.	−0.54 to 0.02
← Cluster 4		−0.16	n.s.	−0.35 to 0.13
← Cluster 5		−0.41	sig.	−0.68 to −0.14
← Electric		0.56	sig.	0.25 to 0.81
ATT	5.57			
← Cluster 1		0.12	n.s.	−0.11 to 0.35
← Cluster 2		−0.40	sig.	−0.60 to −0.14
← Cluster 4		−0.12	n.s.	−0.45 to 0.17
← Cluster 5		−0.59	sig.	−0.95 to −0.25
← Electric		0.43	sig.	0.20 to −0.68
INT	4.65			
← Cluster 1		−0.19	n.s.	−0.43 to 0.02
← Cluster 2		−1.10	sig.	−1.37 to −0.87
← Cluster 4		−0.49	sig.	−0.71 to −0.30
← Cluster 5		−1.87	sig.	−2.20 to −1.59
← Electric		0.36	sig.	0.13 to 0.60
Att.E	3.11			
← Cluster 1		0.06	n.s.	−0.20 to 0.36
← Cluster 2		−0.33	sig.	−0.66 to −0.09
← Cluster 4		−0.24	n.s.	−0.55 to 0.08
← Cluster 5		−0.61	sig.	−1.00 to −0.31
← Electric		0.43	sig.	0.13 to 0.79
Att.C	4.60			
← Cluster 1		0.30	sig.	0.07 to 0.47
← Cluster 2		0.73	sig.	0.48 to 0.91
← Cluster 4		0.25	sig.	0.02 to 0.48
← Cluster 5		1.00	sig.	0.81 to 1.19
← Electric		−1.16	sig.	−1.37 to −0.98
Att.P	5.21			
← Cluster 1		0.32	sig.	0.10 to 0.50
← Cluster 2		0.58	sig.	0.38 to 0.85
← Cluster 4		0.24	sig.	−0.05 to 0.52
← Cluster 5		0.96	sig.	0.77 to 1.21
← Electric		−0.91	sig.	−1.14 to −0.68

a = intercept, representing mean of the latent psychological variable for the reference group.
b = unstandardized regression coefficient, showing the difference from the reference group.
95% CI = 95% confidence interval for the unstandardized regression coefficient, used to compare remaining groups.
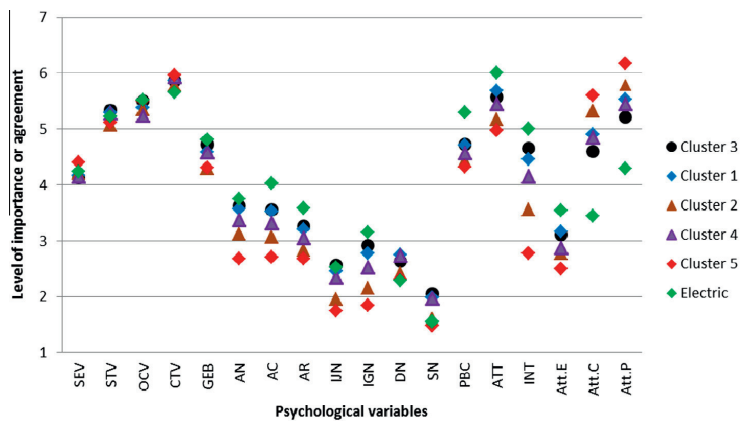
Fig. 1. Differences between car buyer groups on psychological variables.

3.5.3. Buyers of 'large family cars and compact SUVs' (cluster 2)

As shown in Fig. 1, this group differed significantly from the reference group on most of the psychological variables. As indicated by the 95% confidence intervals of the unstandardized regression coefficients, this group has an almost identical psychological profile to the buyers of 'crossover SUVs & powerful cars'

(cluster 5). The comparison also revealed that the group was significantly different from buyers of 'battery electric cars' on most of the psychological variables examined.

3.5.4. Buyers of 'compact crossovers' (cluster 4)

Members of this group had an almost identical psychological profile to buyers of 'mid-size family cars' (cluster 1). Compared to the reference group, they evaluated a car's convenience and performance attributes significantly more important. In addition, they had a significantly weaker intention and integrated norm to buy a car that is more fuel-efficient and environmentally friendly. Further comparisons of the 95% confidence intervals of the unstandardized regression coefficients indicated that this group exhibited more favourable attitude, stronger intention and personal norm to buy than the buyers of 'crossover SUVs & powerful cars' (cluster 5).

3.5.5. Buyers of 'crossover SUVs & powerful cars' (cluster 5)

The group was almost identical to the buyers of 'large family cars & compact SUVs' (cluster 2) as mentioned above, but differed significantly from other car buyer groups on most of the psychological variables. In general, the group evaluated the car's convenience and performance attributes the most important, and had the lowest values on most of the other psychological variables.

3.5.6. Buyers of 'battery electric cars'

They generally evaluated car attributes as of little importance. Although members of this group scored still low on awareness of consequences, ascription of responsibility, and subjective social norm, they differed significantly from the reference group in a more environmentally friendly direction. In addition, perceived behavioural control, attitude, and intention to buy a car that is fuel-efficient and environmentally friendly were the highest in this group. As indicated by 95% confidence intervals of the unstandardized regression coefficients, the group differed significantly from buyers of 'large family cars & compact SUVs' and buyers of 'crossover SUVs & powerful cars' on most of the psychological variables.

To summarize, a general pattern emerged among all car buyer groups in relation to psychological characteristics. The car's performance attributes were of high importance while environmental attributes were evaluated as less important. The social norms

and personal norms were weak, while high levels of general environmental beliefs and self-transcendence value were exhibited in all groups. All car buyer groups held positive attitudes and a rather high level of perceived behavioural control over purchasing a car that is fuel-efficient and environmentally friendly. However, the intention to purchase varied substantially between groups. In general, the main discriminators between the groups were attitude toward convenience and performance attributes of car, attitude and intention toward purchasing a car that is fuel-efficient and environmentally friendly, awareness of consequences, and integrated norm.

Fig. 2 summarizes the main structure of the findings. The highest level of distinction existed between the buyers of 'battery electric cars' and the groups of conventional car buyers. Among the five groups of conventional car buyers, the difference was larger between buyers of big/powerful cars (i.e., Cluster 2 and Cluster 5) and buyers of small to medium size cars (i.e., Cluster 1, Cluster 3 and Cluster 4) than within these sections.

4. Discussion

Knowledge about characteristics of car buyers is important for the design of effective policy measures to promote cars with emergent technologies. This study examined a wide range of socio-psychological variables that have been identified as relevant in previous research on car purchase and ownership. To reflect consumers' options of changing to more efficient versions of car models, an approach of clustering conventional car buyers based on their latest purchased car's features as suggested by Nayum et al. (2013) was used to identify segments of car buyers. The following section discusses the results of the analyses, and implications for consumer research, marketing pro-environmental innovations and policy measures. The limitations of the study are acknowledged as well.

4.1. Main findings of the study

For all groups of car buyers, the results revealed that awareness of need, awareness of consequence, ascription of responsibility, and personal norms with specific regard to buying a car, which is more fuel-efficient and environmentally friendly, were low.
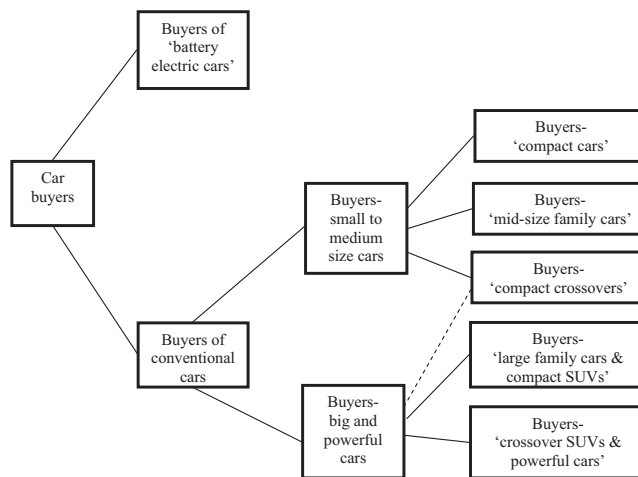

Fig. 2. Structure of car buyers based on the psycho-social car profiles.

Meanwhile, high levels of environmental concern and self-transcendence value were observed among all car buyers. The apparent mismatch between the high level of environmental consciousness and the low level of normative concerns (or intrinsic motivation) might result from a defensive denial strategy. According to the defensive denial hypothesis (Schwartz and Howard, 1980), car buyers probably redefined the high-costs involving car purchase situation in such a way that the activation of personal norms did not seem appropriate. Nevertheless, as relatively stable elements of the personal belief structure, environmental beliefs and value orientations are rarely affected by situational circumstances.

Moreover, the extrinsic incentives provided by the Norwegian government and its regulations might have resulted in crowding-out of consumers' "intrinsic motivation" (Frey and Oberholzer-Gee, 1997; Frey and Stutzer, 2006), hence reducing the likelihood of activated personal norms. At the same time, those incentives and regulations might at as well have caused changes in general public attitudes and perceived behavioural control over purchasing more fuel-efficient cars. However, the high level of positive attitude and perceived behavioural control did not necessarily translate into behavioural intention.

The results showed that the behavioural intention was significantly lower among buyers of big/powerful cars (i.e., Cluster 2 and Cluster 5). Convenience and performance attributes of a car were significantly more important for these two groups than others. These imply that these two groups might have doubts about convenience and performance attributes of a car that is more fuel-efficient and environmentally friendly, therefore they had lower behavioural intention to purchase such a car. On the other hand, the results indicated that buyers of battery electric cars were less occupied with evaluating different car attributes while making purchase decision. An explanation would be that battery electric cars were mostly bought as second cars, and overall evaluation of the car attributes are less important for the purchase of second cars than main cars (Schuitema et al., 2013).

4.2. Implications

The findings presented in this paper have several implications. For research in sustainable consumer behaviour, this study verified the manifold motivations of consumers in high cost situations (Cleveland et al., 2005; Stern, 2000). The examination of a wide range of socio-psychological variables in relation to purchase of a car could help the understanding of consumer behaviour for a high-cost high-involvement product, which has been called for in previous research (Thøgersen, 1999).

The results of the study indicate that marketing campaigns should be diversified according to the heterogeneous target audience (e.g., based on their demographic and household characteristics together with their inserts and attitudes). Given the low intrinsic motivation (e.g., awareness, responsibility, and social and personal norm) found among all car buyers, the adoption of cars with emergent technologies is likely to be limited without strong government policy (Turcksin et al., 2013). Nevertheless, those incentives and regulation from the government are probably the reason for the low intrinsic motivations among car buyers. This implies awareness raising programme is needed in addition to the current extrinsic incentives and regulations. Stakeholders (e.g., government, industry, marketers and environmental groups) therefore need to provide information about environmental impacts, and encourage consumers to set their own rewards for cutting their carbon footprint from private transportation.

Moreover, the results of the study showed that buyers of battery electric cars were better educated, and had a higher level of awareness and acceptance of the problem than others. This is in line with previous research on knowledge and pro-environmental

consumer behaviour (Fraj-Andrés and Martínez-Salinas, 2007; Laroche et al., 1996), and it implies that promotion of pro-environmental products may benefit from contributing to the consumers' knowledge and associated learning. Therefore, car buyers should be supported with a pro-environmental culture to form their own goals, and boost their own knowledge.

Furthermore, the results also indicated attitudes toward convenience and performance attributes of car seem to have large influence on intention to buy a car that are more fuel-efficient and environmentally friendly. Hence, marketing cars that are more fuel-efficient might well benefit from reducing general public concerns about the convenience and performance attributes of such cars.

5. Limitations

Although this study contributes to a nuanced picture of car buyer groups and carries several implications, there are also limitations. Perhaps one of the most obvious is the retrospective design. As a result, it is possible that the responses might have been reconstructed post hoc. If some of the purchase related variables had been measured at the time of purchase, the responses might have been different. The reason may be that post-purchase experience might have affected respondents' view about the car. Respondents might also have adjusted their answers to what they thought we wanted them to respond. Particularly, the questionnaire measures were biased in a pro-environmental direction. As a result, social conformity bias might have occurred. Additionally, the questionnaire was answered by a person in household who had main responsibility for the latest car purchase. Nevertheless, his or her response might not reflect whole process of car purchase decision, which is usually household-based.

Another major shortcoming of the study is that the buyers of battery electric cars in this study represent what Rogers (2003) calls the early majority of the adopters. This means our findings about socio-psychological characteristics of battery electric car buyers have limited generalizability (at least in the Norwegian market which is now much further developed). Further studies could investigate a larger sample of battery electric car buyers when a clear majority is developed. The decision to purchase a battery electric car might also be influenced by other variables that were not included in the survey. For example, usage type, range, recharging time, operating cost, and benefits or advantage provided by government have been identified as important factors for adoption of electric cars (Beggs and Cardell, 1980; Diamond, 2009).

Moreover, the latent class cluster analysis approach, which was used to cluster buyers of conventional cars, has important limitations. The latent class cluster analysis procedure is very sensitive to initial estimates, and thus promotes a strategy of obtaining multiple solutions from different starting points (Thompson, 2007). This was compensated by running a high number of analyses from different starting values and only solutions were accepted that were replicated several times. However, a risk remains, that an even better solution could have been found from different starting values. Furthermore, car buyers were assigned to groups based on the highest probability of belonging to a group. In this sense, the groups in our study were not strictly distinct and for some cars probabilities for several groups were on almost the same level. Besides, reported purchase price of the car was used as one of the clustering indicators. Nevertheless, purchase prices often vary as a function of time of the year and place of residence. This might have added error in the clustering process.

Furthermore, the requirements of the PLS-PM approach regarding reliability and validity of the measurement models resulted in exclusion of substantial items from measures of attitude toward convenience and performance attributes of car, and from measures

of general environmental belief. The excluded car attributes, such as price, reliability, car length and volume, speed, and horsepower, might have constituted another dimension of car attributes, on which car buyers would make evaluations. The exclusion of half of the items from the short version of the New Ecological Paradigm scale might as well raise concerns when interpreting environmental concern among participants of the study. However, Dunlap et al. (2000) acknowledge multidimensionality of their scale. Therefore, the excluded five items likely represent other dimensions of environmental concern.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.tbs.2015.03.005.

References

Addinsoft, 2012. XLSTAT software (Version 12). Addinsoft, Paris.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.

Axsen, J., Mountain, D.C., Jaccard, M., 2009. Combining stated and revealed choice research to simulate the neighbor effect: the case of hybrid-electric vehicles. Resour. Energy Econo. 31 (3), 221–238.

Bamberg, S., Schmidt, P., 2003. Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. Environ. Behav. 35 (2), 264–285.

Bamberg, S., Möser, G., 2007. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. J. Environ. Psychol. 27 (1), 14–25.

Beggs, S.D., Cardell, N.S., 1980. Choice of smallest car by multi-vehicle households and the demand for electric vehicles. Transp. Res. Part A 14 (5), 389–404.

Bleijenberg, A., Egenhofer, C., Behrens, A., Rizos, V., & Alessi, M. (2013). Pathways to low carbon transport in the EU – From possibility to reality. Climate Change, CEPS Task Force Reports. Brussels: Centre for European policy studies.

Chin, W.W., 2010. How to write up and report PLS analyses. In: Vinzi, V.E., Chin, W.W., Henseler, J., Wang, H. (Eds.), Handbook of Partial Least Squares. Springer, Heidelberg, pp. 655–690.

Cleveland, M., Kalamas, M., Laroche, M., 2005. Shades of green: linking environmental locus of control and pro-environmental behaviours. J. Consum. Market. 22 (4), 198–212.

Coad, A., De Haan, P., Woersdorfer, J.S., 2009. Consumer support for environmental policies: an application to purchases of green cars. Ecol. Econ. 68 (7), 2078–2086.

Dargay, J.M., 2001. The effect of income on car ownership: evidence of asymmetry. Transp. Res. Part A 35 (9), 807–821.

Dargay, J.M., 2002. Determinants of car ownership in rural and urban areas: a pseudo-panel analysis. Transp. Res. Part E 38 (5), 351–366.

De Groot, J.I., Steg, L., 2008. Value orientations to explain beliefs related to environmental significant behavior: How to measure egoistic, altruistic, and biospheric value orientations. Environ. Behav. 40 (3), 330–354.

de Haan, P., Mueller, M.G., Scholz, R.W., 2009. How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars – Part II: forecasting effects of feebates based on energy-efficiency. Energy Policy 37 (3), 1083–1094.

de Jong, G., Fox, J., Daly, A., Pieters, M., Smit, R., 2004. Comparison of car ownership models. Transp. Rev. 24 (4), 379–408.

Diamond, D., 2009. The impact of government incentives for hybrid-electric vehicles: evidence from US states. Energy Policy 37 (3), 972–983.

Dunlap, R.E., Van Liere, K.D., Mertig, A.G., Jones, R.E., 2000. Measuring endorsement of the new ecological paradigm: a revised NEP scale. J. Social Issues 56 (3), 425–442.

Commission, European., 2009. Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles (Text with EEA relevance). Off. J. Eur. Union L120, 5–12.

Fielding, K.S., McDonald, R., Louis, W.R., 2008. Theory of planned behaviour, identity and intentions to engage in environmental activism. J. Environ. Psychol. 28 (4), 318–326.

Fishbein, M., Ajzen, I., 2010. Predicting and Changing Behavior: The Reasoned Action Approach. Psychology Press, New York.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Market. Res. 18 (1), 39–50.

Fraj-Andrés, E., Martínez-Salinas, E., 2007. Impact of environmental knowledge on ecological consumer behaviour: an empirical analysis. J. Int. Consum. Market. 19 (3), 73–102.

Frey, B.S., Oberholzer-Gee, F., 1997. The cost of price incentives: an empirical analysis of motivation crowding-out. Am. Econ. Rev. 87 (4), 746–755.

Frey, B.S., Stutzer, A., 2006. Environmental Morale and Motivation. Institute for Empirical Research in Economics, University of Zurich.

Gardner, G.T., Stern, P.C., 1996. Environmental Problems and Human Behavior. Allyn & Bacon.

Graham-Rowe, E., Gardner, B., Abraham, C., Skippon, S., Dittmar, H., Hutchins, R., Stannard, J., 2012. Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: a qualitative analysis of responses and evaluations. Transp. Res. Part A 46 (1), 140–153.

Green, R.C., Wang, L., Alam, M., 2011. The impact of plug-in hybrid electric vehicles on distribution networks: a review and outlook. Renew. Sustain. Energy Rev. 15 (1), 544–553.

Guagnano, G.A., Stern, P.C., Dietz, T., 1995. Influences on attitude-behavior relationships a natural experiment with curbside recycling. Environ. Behav. 27 (5), 699–718.

Haenlein, M., Kaplan, A.M., 2004. A beginner's guide to partial least squares analysis. Understanding Stat. 3 (4), 283–297.

Hair, J.F., Ringle, C.M., Sarstedt, M., 2011. PLS-SEM: indeed a silver bullet. J. Market. Theory Pract. 19 (2), 139–152.

Haughton, D., Legrand, P., Woolford, S., 2009. Review of three latent class cluster analysis packages: latent Gold, poLCA, and MCLUST. Am. Stat. 63 (1), 81–91.

Heffner, R.R., Kurani, K.S., Turrentine, T.S., 2007. Symbolism in California's early market for hybrid electric vehicles. Transp. Res. Part D 12 (6), 396–413.

Hertwich, E.G., Peters, G.P., 2009. Carbon footprint of nations: a global, trade-linked analysis. Environ. Sci. Technol. 43 (16), 6414–6420.

Hunecke, M., Haustein, S., Grischkat, S., Böhler, S., 2007. Psychological, sociodemographic, and infrastructural factors as determinants of ecological impact caused by mobility behavior. J. Environ. Psychol. 27 (4), 277–292.

Jansson, J., Marell, A., Nordlund, A., 2010. Green consumer behavior: determinants of curtailment and eco-innovation adoption. J. Consum. Market. 27 (4), 358–370.

Jöreskog, K.G., Wold, H., 1982. The ML and PLS techniques for modeling with latent variables: historical and comparative aspects. In: Jöreskog, K.G., Wold, H. (Eds.), Systems Under Indirect Observation: Causality, Structure, Prediction. North-Holland, Amsterdam, pp. 263–270.

Kahn, M.E., 2007. Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. J. Environ. Econ. Manage. 54 (2), 129–145.

Kaiser, F.G., 2006. A moral extension of the theory of planned behavior: norms and anticipated feelings of regret in conservationism. Personality Individ. Differ. 41 (1), 71–81.

Klöckner, C.A., Blöbaum, A., 2010. A comprehensive action determination model: toward a broader understanding of ecological behaviour using the example of travel mode choice. J. Environ. Psychol. 30 (4), 574–586.

Klöckner, C.A., Matthies, E., 2004. How habits interfere with norm-directed behaviour: a normative decision-making model for travel mode choice. J. Environ. Psychol. 24 (3), 319–327.

Laroche, M., Toffoli, R., Kim, C., Muller, T.E., 1996. The influence of culture on pro-environmental knowledge, attitudes, and behavior: a Canadian perspective. Adv. Consum. Res. 23, 196–202.

Liu, Y., Tremblay, J.M., Cirillo, C., 2014. An integrated model for discrete and continuous decisions with application to vehicle ownership, type and usage choices. Transp. Res. Part A 69, 315–328.

Mannberg, A., Jansson, J., Pettersson, T., Brännlund, R., Lindgren, U., 2014. Do tax incentives affect households' adoption of 'green'cars? A panel study of the Stockholm congestion tax. Energy Policy 74, 286–299.

Matthies, E., Klöckner, C.A., Preißner, C.L., 2006. Applying a modified moral decision making model to change habitual car use: how can commitment be effective? Appl. Psychol. 55 (1), 91–106.

Mau, P., Eyzaguirre, J., Jaccard, M., Collins-Dodd, C., Tiedemann, K., 2008. The 'neighbor effect': simulating dynamics in consumer preferences for new vehicle technologies. Ecol. Econ. 68 (1), 504–516.

Muthén, B., Muthén, L., 2013. Mplus 7.1. Muthen & Muthen, Los Angeles, CA.

Nayum, A., Klöckner, C.A., Prugsamatz, S., 2013. Influences of car type class and carbon dioxide emission levels on purchases of new cars: a retrospective analysis of car purchases in Norway. Transp. Res. Part A 48, 96–108.

Nordlund, A.M., Garvill, J., 2002. Value structures behind proenvironmental behavior. Environ. Behav. 34 (6), 740–756.

Norwegian Ministry of the Environment. (2012). Norwegian climate policy 2011-2012 – The Storting (white paper) summary (Report No. 21). Retrieved from <https://www.regjeringen.no/contentassets/aa70cfe177d2433192570893d72b 117a/en-gb/pdfs/stm201120120021000en_pdfs.pdf>.

Ozaki, R., Sevastyanova, K., 2011. Going hybrid: an analysis of consumer purchase motivations. Energy Policy 39 (5), 2217–2227.

Peters, A., Gutscher, H., Scholz, R.W., 2011. Psychological determinants of fuel consumption of purchased new cars. Transp. Res. Part F 14 (3), 229–239.

Rogers, E.M., 2003. Diffusion of Innovations. Free Press, New York.

Schuitema, G., Anable, J., Skippon, S., Kinnear, N., 2013. The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transp. Res. Part A 48(C), 39–49.

Schwartz, S.H., 1977. Normative influences on altruism. Adv. Exp. Soc. Psychol. 10, 221–279.

Schwartz, S.H., 1992. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. Adv. Exp. Soc. Psychol. 25 (1), 1–65.

Schwartz, S.H., Howard, J.A., 1980. Explanations of the moderating effect of responsibility denial on the personal norm-behavior relationship. Soc. Psychol. Q. 43 (4), 441–446.

Schwartz, S.H., Howard, J.A., 1981. A normative decision-making model of altruism. In: Rushton, J.P., Sorrentine, R.M. (Eds.), Altruism and Helping Behavior: Social, Personality, and Developmental Perspectives. Lawrence Erlbaum, Hillsdale, NJ, pp. 189–211.

Statistics Norway. (2012). Registered income for households after household types – Average for all. 2011. Retrieved July 29, 2013, from <http://www.ssb.no/a/kortnavn/ifhus/tab-2012-12-18-02.html>.

Statistics Norway. (2013). Education level of the population, 1 October 2012. Retrieved July 29, 2013, from <http://www.ssb.no/utdanning/statistikker/utniv>.

Stern, P.C., 1999. Information, incentives, and proenvironmental consumer behavior. J. Consum. Policy 22 (4), 461–478.

Stern, P.C., 2000. Toward a coherent theory of environmentally significant behavior. J. Soc. Issues 56 (3), 407–424.

Stern, P.C., Dietz, T., Guagnano, G.A., 1998. A brief inventory of values. Educ. Psychol. Measur. 58 (6), 984–1001.

Tenenhaus, M., Hanafi, M., 2010. A bridge between PLS path modeling and multi-block data analysis. In: Vinzi, V.E., Chin, W.W., Henseler, J., Wang, H. (Eds.), Handbook of Partial Least Squares. Springer, Heidelberg, pp. 99–123.

Thompson, D.M., 2007. Latent Class Analysis in SAS: Promise, Problems and Programming. SAS Global Forum, Statistics and Data Analysis Section, Orlando, Florida.

Thøgersen, J., 1999. The ethical consumer. Moral norms and packaging choice. J. Consum. Policy 22 (4), 439–460.

Thøgersen, J., 2006. Norms for environmentally responsible behaviour: an extended taxonomy. J. Environ. Psychol. 26 (4), 247–261.

Turcksin, L., Mairesse, O., Macharis, C., 2013. Private household demand for vehicles on alternative fuels and drive trains: a review. Eur. Transp. Res. Rev. 5 (3), 149–164.

Turrentine, T.S., Kurani, K.S., 2007. Car buyers and fuel economy? Energy Policy 35 (2), 1213–1223.

U.S. Energy Information Administration. (2013). International energy outlook 2013 (Report No. DOE/EIA-0484). Retrieved from <http://www.eia.gov/forecasts/archive/ieo13/pdf/0484%282013%29.pdf>.

van Rijnsoever, F., Farla, J., Dijst, M.J., 2009. Consumer car preferences and information search channels. Transp. Res. Part D 14 (5), 334–342.

Vermunt, J., Magidson, J., 2010. Latent GOLD (Version 4.5). Statistical Innovations Inc., Belmont.

Whelan, G., 2007. Modelling car ownership in Great Britain. Transp. Res. Part A 41 (3), 205–219.

Paper III

Nayum, A., & Klöckner, C. A. (2014). A comprehensive socio-psychological approach to car type choice. *Journal of Environmental Psychology*, *40*, 401-411.

A comprehensive socio-psychological approach to car type choice

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ABSTRACT

Data from a web survey, which was conducted in 2012 among 1421 owners of a new internal combustion engine car and 372 new battery electric car owners in Norway, were used to test an adapted version of the comprehensive action determination model to explain private consumers' purchase of fuel-efficient cars. It was first examined whether the average fuel efficiency differs among internal combustion engine car classes. Consequently, with battery electric cars being regarded as the most fuel-efficient group, five car groups ordered by fuel efficiency were retained. The results of subsequent structural equation modelling show that intention to buy a fuel-efficient car, brand loyalty, number of cars and driver's license holders in the household, household size, and household income had significant direct effects on choosing a more fuel-efficient car. Normative processes had a mediated impact on behaviour. Implications for design and implementation of interventions are discussed.

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1. Introduction

Taking into consideration that road transportation is the largest energy consumption sector (European Environment Agency, 2007), one of the most significant options identified to further reduce energy consumption is increasing fuel efficiency of new cars (Metz, Davidson, Bosch, Dave, & Meyer, 2007). While internal combustion engine cars with increased fuel efficiency will lead the market for the coming years (MacLean & Lave, 2003), battery electric cars present another significant path for cutting the carbon intensity of road transport in the near future (Scown, Taptich, Horvath, McKone, & Nazaroff, 2013). It has been shown that energy consumption of battery electric cars[2] is well below most fuel-efficient internal combustion engine cars available today (Organisation for Economic Co-operation and Development & International Energy Agency, 2010).

Therefore, a substantial reduction of energy consumption in transportation requires increasing the number of consumers adopting fuel-efficient cars. The most prominent measures are usually introduced as a set of coordinated economic incentives to facilitate consumer adoption (European Commission, 2007), and

the effects of such measures are well documented (de Haan, Peters, & Scholz, 2007; Peters, Mueller, de Haan, & Scholz, 2008; Ryan, Ferreira, & Convery, 2009). Nonetheless, empirical research has also indicated that for buyers of fuel-efficient cars, symbolic values dominate over purely monetary cost-savings (de Haan, Mueller, & Peters, 2006; Kahn, 2007). Moreover, it is suggested that consumer behaviour is determined by a multitude of factors (Jansson, Marell, & Nordlund, 2010; Nayum, Klöckner, & Prugsamatz, 2013; Ozaki & Sevastyanova, 2011; Peters, Gutscher, & Scholz, 2011), and financial incentives can lead to a reduction of intrinsic motivation of consumers (Deci & Ryan, 2000; Frey & Osterloh, 2002). For the choice and design of interventions, it is, therefore, crucial to understand the mechanisms behind car purchase.

This paper seeks to examine consumer motivations in relation to choice of more fuel-efficient cars. Specifically, how a combination of psychological, situational, and demographic factors affect consumers' car choice is in focus. An adapted version of the comprehensive action determination model (Klöckner, 2013; Klöckner & Blöbaum, 2010), which integrates both psychological and socio-demographic variables to explain consumers' choice of fuel-efficient cars, was tested using a sample of internal combustion engine passenger car and battery electric car owners in Norway.

2. Determinants of environmentally significant private sphere behaviours with special regard to purchasing fuel-efficient cars

The adoption of fuel-efficient cars has received increasing attention from many disciplines. Within research focussing on

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   [2] Depending on a country's electricity grid mix system, it may vary. For example, as Norway's electricity is mostly from renewable sources (Hawkins, Singh, Majeau-Bettez, & Strømman, 2013), energy consumption of battery electric cars in Norway is far below that of most fuel-efficient internal combustion engine cars.

environmentally significant behaviours, several theoretical developments have emerged to explain private sphere behaviour. One such theories put forward by Stern (2000b) is the attitude-behaviour-context theory, which identifies four categories of determinants of environmental behaviours, as introduced in the following sections.

2.1. Contextual forces

According to Stern (2000b), high-cost behaviours such as purchasing a fuel-efficient car are likely to be strongly influenced by contextual forces (e.g. interpersonal influences, monetary factors, and government regulations). This notion is supported by empirical research, in which some adopters of fuel-efficient cars were reported to consider financial benefits and other policy-related advantages important (Diamond, 2009; Graham-Rowe et al., 2012; de Haan, Mueller, & Scholz, 2009; Ozaki & Sevastyanova, 2011), while others were influenced by the their community's ideology (Kahn, 2007; Kahn & Vaughn, 2009). Though the contextual forces are important, the relationship between contextual forces and actual consumer behaviour is heavily mediated by personal variables (Black, Stern, & Elworth, 1985). Thus, "the perception of contextual forces and how these perceptions influence actual behaviour might be more relevant than an objective measure of the contextual factors" (Jansson, Marell, & Nordlund, 2009, p. 248).

2.2. Attitudinal factors

Attitudinal factors such as the general disposition to act with pro-environmental intent, behaviour-specific predispositions, behaviour-specific beliefs, and non-environmental attitudes are another category of determinants suggested by Stern (2000b). Cognitive behavioural theories such as the theory of planned behaviour (Ajzen, 2005) focus on the consumer's behaviour-specific predispositions and beliefs. The theory of planned behaviour postulates that a rational choice process by weighting attitudes towards behaviour, subjective norms, and perceived behavioural control produce intentions which, together with actual control, determine performance of behaviour. The theory of planned behaviour posits consumers to carry out elaborate decision processes based on their expectancy value assessments, and therefore they are "… utility-maximizing actors" (Bamberg & Schmidt, 2003, p. 267).

In contrast to the theory of planned behaviour, normative models for pro-environmental behaviour such as the norm activation model (Schwartz, 1977; Schwartz & Howard, 1981) and the value-belief-norm theory (Stern, 2000b) highlight explicit normative and moral motivations of individuals as opposed to self-interest. The norm activation model postulates that the driving force of environmentally significant behaviour is a personal norm. This personal norm, which denotes a strong intrinsic feeling of obligation to perform the specific behaviour, has to be activated. Prerequisites and activators of this personal norm are awareness of consequences of certain behaviour, ascription of responsibility for one's actions, and recognition of one's own ability to engage in actions. Besides personal norm, the norm activation model also acknowledges that social implications (i.e. perceived social norm), as well as non-moral implications of action, influence behaviour. The value-belief-norm theory integrates the value theory (Schwartz, 1994), the new ecological paradigm (Dunlap, Van Liere, Mertig, & Jones, 2000), and the norm activation model perspective through a hierarchical chain of variables leading to behaviour. The relevance of the above-mentioned cognitive and normative constructs for consumer adoption of fuel-efficient cars has been demonstrated in various studies (Flamm, 2009; Jansson et al., 2010; Ozaki & Sevastyanova, 2011; Peters et al., 2011).

Non-environmental attitudes are also suggested to affect consumers' pro-environmental behaviour (Stern, 2000b). More specifically, researchers (e.g. Heffner, Turrentine, & Kurani, 2006; Kurani, Turrentine, & Heffner, 2006) suggest that the adoption and use of fuel-efficient cars are influenced by the perception of (1) instrumental attributes of the car, which refer to the functionality or utility that can be derived from functions performed by the car (Dittmar, 1992; Voss, Spangenberg, & Grohmann, 2003); (2) hedonic attributes of the car, which refers to the emotional experience derived from using the car (Dittmar, 1992; Roehrich, 2004; Voss et al., 2003); and (3) symbolic attributes of the car, which is related to a sense of self or social identity that is reflected by, or built from the possession of the fuel-efficient car (Dittmar, 1992; Roehrich, 2004). These arguments are supported by recent research showing a close association between car use/ownership and instrumental, hedonic, and symbolic attributes of the car (Bergstad et al., 2011; Caulfield, Farrell, & McMahon, 2010; Schuitema, Anable, Skippon, & Kinnear, 2013; Skippon & Garwood, 2011).

2.3. Personal capabilities

Personal capabilities such as knowledge and skills for particular actions, general capabilities and resources including socio-demographic variables, are the third category of determinants suggested by Stern (2000b). Although these variables are suggested to have very limited explanatory power for most environmental behaviours (Dietz, Stern, & Guagnano, 1998), they may exert significant influence for high-cost and high-involvement behaviours such as buying fuel-efficient cars (Stern, 2000b). In fact, the traditional car type choice approach by economists and market researchers (see de Jong, Fox, Daly, Pieters, & Smit, 2004) identifies household characteristics (such as number of household members, number of cars, number of driver license holders, and household income) and principal driver characteristics (such as gender, age, and education) as explanatory variables of car ownership. Recent empirical research evidence also confirms the relevance of personal capabilities in adopting fuel-efficient cars (Flamm, 2009; Jansson et al., 2010).

2.4. Habit or routine

The last category of determinants suggested by Stern (2000b) is habit/routine, which is the automatic performance of behavioural patterns triggered by context cues (Triandis, 1979). For behaviours performed daily or weekly under stable circumstances it is found that past behaviour has a stronger influence than intentions; for behaviours performed only annually or biannually it is found that the relationship was reversed (Ouellette & Wood, 1998). Arguably, car purchase occurs less frequently and involves rather deliberate decision-making. Therefore, it might appear that the influence of past behaviour or habit is trivial for car purchase. Nonetheless, empirical evidence indicates that brand loyalty, which is observed in terms of repetitive same-brand or same-brand-set purchasing (Oliver, 1999), has significant influences on car purchase (Chandrasekharan, McCarthy, & Wright, 1994; Mannering & Winston, 1985, 1991). This suggests that brand loyalty may serve a similar function as habit strength in car purchase behaviour by short cutting or simplifying the decision-making process. Even though habits, which are generally understood as context-cued automatic responses (Verplanken & Wood, 2006), are structurally different from brand loyalty, the function in the decision-making process appears to be comparable to a certain degree.

To summarize, private sphere environmentally significant consumer behaviour, such as purchasing fuel-efficient cars, is determined by different types of variables that may interact (Stern, 2000b). However, the lack of a comprehensive approach that incorporates variables from more than one of the above categories has seriously hampered understanding consumers' motivations in relation to purchasing fuel-efficient and environmentally friendly cars.

2.5. An integrated approach: a comprehensive action determination model

In an attempt to integrate the above-mentioned variables, Klöckner and Blöbaum (2010) proposed 'a comprehensive action determination model'. Their model represents a general framework, which avoids the weakness of the single models and could be applied in a large variety of situations including high-cost high-involvement purchase behaviours. The model is supported by a recent meta-analysis based on a pool of 56 different data sets with a variety of target behaviours (Klöckner, 2013).

According to the comprehensive action determination model, individual behaviour is influenced by four possible sources: habitual processes, intentional processes, situational influences, and normative processes. It further postulates that the first three sources have a direct impact upon behaviour. The effect of normative processes on individual behaviour, however, is to be mediated by intentional and habitual processes. More specifically, the model postulates that individual behaviour is directly determined by habit strength, intentions, and objective and perceived situational constraints. Intentions are to be generated by referring to attitudes, norms (both social and personal norms), and perceived situational constraints (perceived behavioural control). While attitudes reflect the results of expectancy value assessments on behaviour in question, personal norms provide the effect of moral motivations in the decision-making process. Personal norms are, in line with the normative theories, to be influenced by awareness of the need for help, awareness of consequences of one's actions,

social norms, and perceived behavioural control (see Klöckner & Blöbaum, 2010).

Fig. 1 depicts how the model of Klöckner and Blöbaum (2010) has been adapted, taking into account factors specific to car purchase. There are similarities and differences between the original comprehensive action determination model and the adapted model, which have been described below. The adapted model predicts that consumers' brand loyalty (serves a similar function as habit strength by short cutting the decision-making process even if the underlying cognitive mechanisms might be different), demographic characteristics (gender, age, and education level), household characteristics (number of cars in the household, number of licence holders in the household, number of household members, and household income), perceived behavioural control, and intention to buy a fuel-efficient and environmentally friendly car directly affect the purchase of a more fuel-efficient car. It is further assumed that household characteristics (as a measure of objective situational constraints) influence perceived behavioural control (as a measure of perceived situational constraints). Corresponding to the theory of planned behaviour (Ajzen, 2005), attitude towards the purchase of fuel-efficient and environmentally friendly cars, perceived behavioural control, and social norm are conceptualized as having a direct influence on intention. The perceived instrumental, hedonic, and symbolic attributes of a car are added as new components that directly affect the intention, as their role in forming an intention to adopt fuel-efficient cars has been demonstrated before (Schuitema et al., 2013). It might be argued that the impact of symbolic attributes should be mediated by attitudes, but the attitudes measured in this paper were very specific towards fuel efficient cars. Therefore, we decided to model the impact of the attributes directly rather than indirectly. In line with the value-belief-norm theory (Stern, 2000b), an ecological worldview, awareness of need, and awareness of the consequences of one's own car purchase are assumed as a causal chain, which leads to the activation of personal norm. Likewise, another assumption of the norm activation model (Schwartz & Howard, 1981), which is perceived behavioural control and social norm as preconditions of
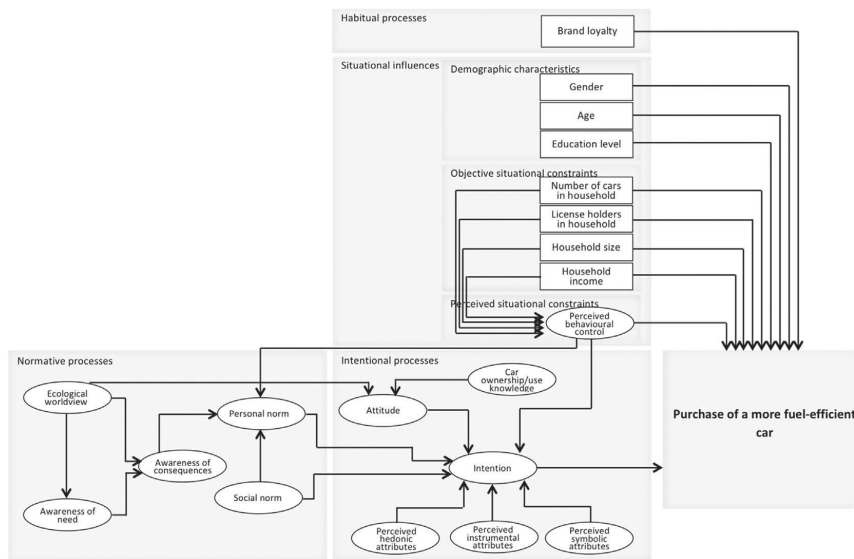

Fig. 1. The theoretical integrated model to explain purchase of fuel-efficient car, adapted from Klöckner and Blöbaum (2010).

personal norm activation, is also applied in the adapted model. However, in contrast to the normative theories, the influence of personal norm on behaviour in the adapted model is not direct, but rather mediated by intention as suggested by Bamberg and Möser (2007). The adapted model also assumes that the ecological worldview and knowledge of the environmental impacts of car ownership and use influence consumer attitude towards the purchase of a fuel-efficient and environmentally friendly car.

Therefore, the adapted model incorporates variables from all four categories of determinants of environmentally significant behaviour (Stern, 2000b), and postulates relationships among them according to widely applied socio-psychological theories and empirical evidences. The adapted model addresses the role of contextual forces by applying interpersonal influences (i.e. social norm). However, it does not include variables from broad social, economic, and political contexts. Not incorporating government regulations, monetary incentives, and legal factors into the adapted model does not mean that the important role of these contextual variables is overlooked. Instead, it is suggested that the impact of broad social, economic, and political factors is mediated through the individual level variables (Alwitt & Berger, 1993; Black et al., 1985) identified in the model.

Based on the presented model, this paper aims to identify the most relevant subset of socio-demographic and psychological factors affecting consumers' purchase of fuel-efficient cars. Fig. 1 displays the expected relationships. Specifically, the following hypotheses will be tested in this paper:

H1. Brand loyalty, demographic and household characteristics, perceived behavioural control, and intention to buy a fuel-efficient car directly influence the purchase of a more fuel-efficient car.
H1.1. The impact of the intention to buy a fuel-efficient car and perceived behavioural control on the purchase of a more fuel-efficient car are positive.
H1.2. Since fuel-efficient cars, particularly battery electric cars, are not yet the priority of the big producers, brand loyalty exerts a negative direct effect on purchase of a more fuel-efficient car.[3]
H1.3. Among the variables having direct influence on purchase of a more fuel-efficient car, intention has the strongest impact.
H1.4. Effects of demographic and household characteristics (objective situational constraints) on purchase of a more fuel-efficient car have a small effect size when brand loyalty and intention are accounted for.
H2. Intention to buy a fuel-efficient car mediates the influences of variables from intentional and normative processes, and also partly the influences of variables from situational constraints.
H2.1. Personal norm, social norm, positive attitudes toward purchasing fuel-efficient car, and perceived behavioural control have positive indirect influence on purchase of a more fuel-efficient car mediated through intentions.
H2.2. The car's symbolic attributes contribute positively to the intention to buy a fuel-efficient car while hedonistic and instrumental attributes negatively contribute to this intention.
H3: Personal norm integrates the influence of norm activation variables.
H3.1: Social norm, awareness of consequences, and perceived behavioural control have a positive impact on activated personal norm.

H3.2: An ecological worldview and awareness of need trigger the awareness of consequences.
H4: Knowledge of the environmental impact of car ownership/ use and ecological worldview have positive impacts on the attitudes to buy a fuel-efficient car.

3. Method

3.1. Sampling and procedure

The data set for this study was collected using a web survey. In April 2012, an invitation letter to participate in a web survey was sent to 12,000 car owners across Norway, who had purchased a new passenger car with an internal combustion engine for private use between November and December 2011. In addition, a sample of 1362 battery electric car owners across Norway, who purchased a new battery electric car in 2011 for private use, was also contacted. Names and addresses were obtained from the Norwegian Public Roads Administrations Head Office. The battery electric car owners

Table 1
Sample characteristics.

	Total sample (N = 1540)	Internal combustion engine car owners (N = 1216)	Battery electric car owners (N = 324)
Average age (S.D.)	49.61 (12.58)	50.63 (13.01)	45.80 (9.93)
Average household size (S.D.)	2.97 (1.24)	2.82 (1.22)	3.52 (1.17)
Average number of cars in household (S.D.)	1.69 (0.64)	1.58 (0.63)	2.09 (0.54)
Average number of driver's license holders in household (S.D.)	1.95 (0.55)	1.93 (0.58)	2.02 (0.43)
Male (%)	77.73%	77.88%	77.16%
Education level (%)			
No education	0.06%	0.08%	0.00%
Elementary school	2.01%	2.22%	1.24%
Upper secondary (vocational)	15.58%	17.35%	8.95%
Upper secondary (general)	8.38%	9.54%	4.01%
University (≤4 years)	35.00%	35.20%	34.26%
University (>4 years)	36.69%	33.72%	47.84%
Doctor grade	2.27%	1.89%	3.70%
Household income/year (%)			
Under 150000 NOK[a]	0.39%	0.49%	0.00%
150000−249000 NOK	0.58%	0.58%	0.62%
250000−349000 NOK	1.95%	2.38%	0.31%
350000−449000 NOK	4.87%	5.51%	2.47%
450000−549000 NOK	7.21%	8.63%	1.85%
550000−649000 NOK	6.49%	7.57%	2.47%
650000−749000 NOK	6.04%	6.91%	2.78%
750000−849000 NOK	11.49%	12.25%	8.64%
850000−999000 NOK	17.73%	16.61%	21.91%
Over 1 000000 NOK	43.25%	39.06%	58.95%
Residence location (%)			
Area with less than 200 inhabitants	2.08%	2.22%	1.54%
Area with 200−499 inhabitants	1.82%	1.89%	1.54%
Area with 500−999 inhabitants	1.88%	2.14%	0.93%
Area with 1000−1999 inhabitants	3.31%	3.13%	4.01%
Area with 2000−19999 inhabitants	31.88%	32.24%	30.56%
Area with 20000−99999 inhabitants	30.32%	30.35%	30.25%
Area with more than 100000 inhabitants	28.70%	28.04%	31.17%

[a] 1 NOK ≃ 0.1355 Euro.

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[3] Since the time of data collection, several of the big producers have introduced their own electric vehicles into the Norwegian market. It would be interesting to analyse how the impact of brand loyalty has changed.

were sampled for the whole calendar year to achieve a substantial group in the total sample. The car owners were informed that all participants who finished the web survey would be included in a lottery to win an Apple iPad 3, and a total of three iPads were given away.

A total of 1793 respondents filled out the questionnaire, which gave a response rate of 13.42%. Of these, 1421 (response rate = 11.84%) were owners of new cars with internal combustion engine, and 372 (response rate = 27.31%) were battery electric car owners. Due to non-response on single items crucial for the model, the final sample consisted of 1540 car owners. The sample characteristics are shown in Table 1. Information on characteristics of the Norwegian new car owner population in 2011 was not available. Nevertheless, comparison of the whole survey sample with the general Norwegian population revealed that men and persons with higher education and higher household income were over-represented (Statistisk sentralbyrå, 2012, 2013).

3.2. Cars

Only the most recently purchased passenger car with internal combustion engine (purchased between November and December 2011) or battery electric cars (purchased in 2011) were considered. Make, model, fuel type, CO_2 emissions, and fuel consumption of the car were obtained from the database of the Norwegian Public Roads Administrations Head Office. The resulting final sample of $N = 1540$ cars contained 12.00% petrol-fuelled cars, 64.90% diesel-fuelled cars, 21.10% battery electric cars, and 2.00% hybrid cars. The average CO_2 emission and fuel efficiency of the cars with internal combustion engines were 136.86 g/km (min. = 89 g/km, max. = 253 g/km, SD = 23.96) and 5.33 l/100 km (min. = 3.40 l/ 100 km, max. = 9.40 l/100 km, SD = 0.93) respectively.

3.3. Web survey

The web survey consisted of the following parts.

3.3.1. Passenger car ownership

Participants were first asked to give detailed information about their most recently purchased car. The information included make, year of purchase, model, model year, price, engine size, engine power, CO_2 emissions, fuel type, transmission, body type (i.e. car size classes), and drive system. These attributes of the latest purchased car were used to match the car with data on make, model year, CO_2 emissions, and fuel efficiency of the car registered in the database of the Norwegian Public Roads Administrations Head Office. Registered fuel efficiency was used as a control variable for the validity of the car class types, which were identified in Nayum, Klöckner, and Mehmetoglu's (under review) study. Furthermore, participants were requested to give information (at least the make and model) on up to nine cars they had purchased, starting with the latest. Using the make of the latest purchased car as reference, brand loyalty was calculated by the following formula[4]: Brand loyalty = (number of times car of the same make was

purchased − 0.99999)/(total number of cars bought − 0.99). The brand loyalty ranged from close to zero to close to one, and a higher score represented higher brand loyalty.

3.3.2. Measures

In the second part of the questionnaire, participants were asked to indicate agreement to statements that were formulated to tap various psychological constructs in the theoretical model (see Appendix). Unless otherwise stated, seven-point ordinal scales ranging from strongly disagree (1) to strongly agree (7) was provided. Negatively framed statements were reversed in coding.

3.3.2.1. Importance of car attributes. As a first block, a list of instrumental (10 items), hedonic (12 items), and symbolic (6 items) attributes of a car (e.g. top speed, energy label, and anti-lock braking system) was randomly presented to participants. The items were adopted from van Rijnsoever, Farla, and Dijst's (2009) study on consumer car preferences. Participants were asked to rate how important these attributes were when they purchased their most recent passenger car. They responded on a seven-point ordinal scale ranging from not important at all (1) to extremely important (7).

3.3.2.2. Norm activation constructs (awareness of need, awareness of consequences, and perceived behavioural control). Perception of need for action regarding environmental and energy problems associated with car ownership and use (awareness of need), awareness of consequences of one's own car purchase (awareness of consequences), and perceived behavioural control were then assessed by three statements each. The items were adapted from Nayum et al.'s (2013) study.

3.3.2.3. Norm-related items (social and personal norms). With regard to operationalization of social norm, Ajzen (2005) suggests that subjective (or social) norms are determined by beliefs about the expectations and behaviours of others. Hence, social norm encompasses subjective social norm, which describes whether significant others approve or disapprove of the specific behaviour in question, and descriptive social norm, which refers to whether the significant others themselves perform this specific behaviour. Of six statements to measure social norm, three were formulated in terms of a subjective social norm and the other three, in terms of a descriptive social norm. Thøgersen (2006) postulates two types of personal norms (i.e. introjected norms and integrated norms) that differ in the degree of internalization and integration into the self. It is suggested that anticipated guilt or pride enforce introjected norms, which are only superficially internalized; whereas integrated norms are generated from one's own internalized values and goals. Among six statements that measure personal norm, three were formulated in terms of an introjected norm and another three, in terms of an integrated norm. A preliminary analysis showed that the two sub-dimensions of social norms (subjective and descriptive norms) and personal norms (introjected and integrated norms) could not be differentiated.

3.3.2.4. Ecological worldview (NEP). Ten statements from the new ecological paradigm scale (Dunlap et al., 2000) were used to measure the ecological worldview.

3.3.2.5. Attitudes and intention. Intention to purchase an environmentally friendly and fuel-efficient car was measured using three items, which were formulated in line with Fishbein and Ajzen's (2010) general recommendations. General attitudes toward purchasing a fuel-efficient and environmentally friendly car were assessed by asking participants to rate on a seven-point ordinal

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[4] There is no accepted formula for calculating brand loyalty. For this study, brand loyalty was assumed to be higher if more cars of the last nine purchased cars were of the same make. The formula we used included also a correction for short purchase histories. Consider for example a person who bought the first car; if not correcting for the short car purchase history, this person would have received the highest possible brand loyalty (since *all* cars bought by this person would be of the same make). Therefore, a correction needed to be applied. Subtracting 1 from both the numerator and denominator would have resulted in missing values, because dividing by zero is not possible. Thus, numbers close to 1 were subtracted. The number in the numerator is closer to 1 so that the resulting ratio is very small.

scale from bad/harmful/unfavourable/foolish/unsatisfying/un-pleasant (1) to good/beneficial/favourable/wise/satisfying/pleasant (7). This measurement also followed Fishbein and Ajzen's (2010) general recommendations.

3.3.2.6. Knowledge on environmental impacts of the car. Eight true and seven false statements were developed to assess the partici-pants' knowledge on environmental impacts of car ownership and use, and five options - 'absolutely true', 'probably true', 'probably not true', 'absolutely not true', or 'do not know' were provided. For true statements, the following coding was applied: 5 'absolutely true' = 5; 'probably true' = 4; 'do not know' = 3; 'probably not true' = 2; 'absolutely not true' = 1. For the false statements, the reverse coding was applied.

3.3.2.7. Extended socio-demographics. Finally, questions for several socio-demographic (gender, age, and education level) and house-hold (number of cars in household, number of driver's license holders in household, number of household members, household income, and residence location) characteristics of the participant were included in the questionnaire.

3.4. Analyses

Data were analysed in the following steps. First, a one-way be-tween subjects analysis of variance (ANOVA) was performed to examine whether the five car class types among internal combus-tion engine cars, which were identified by a latent class cluster analysis using the last purchased internal combustion engine pas-senger car's features in Nayum et al.'s (under review) study, differed in their average fuel efficiency. The results indicated that two car class types did not differ significantly in their average fuel effi-ciency. Therefore, it was decided to combine those two car class types into one, and to retain four groups among internal combus-tion engine passenger cars in order of increasing fuel efficiency. Consequently, the final dependent variable—fuel efficiency of the purchased car—consisted of five ordered categories with battery electric cars being the most fuel-efficient, placed at the top of the four combustion engine classes.

The measurement models of the latent variables in the adapted model were then specified (a two-parameter logistic item response theory model was specified for the knowledge construct) and tested using confirmatory factor analysis by applying WLSMV[5] estimation. Based on the results of the confirmatory factor anal-ysis, several items were excluded (see below). Finally, the combined measurement and structural model (the model hypothesized in Fig. 1) was tested using WLSMV estimation. Mplus 7.0 was used for the multivariate data analyses.

4. Results

4.1. One-way between subjects analysis of variance (ANOVA)

Table 2 displays the average fuel efficiency of internal combus-tion engine car class types, which were identified in Nayum et al.'s (under review) study. Due to violation of the assumptions of ho-mogeneity of variance (Levene's test (4, 1211) = 79.55, $p < .001$), robust tests were used. The results show that the average fuel ef-ficiency differed significantly across the five internal combustion engine car class types (Welch's F (4, 540.29) = 360.87, $p < .001$). Dunnett's T3 post-hoc comparisons of the five car class types

Table 2
Average fuel-efficiency of internal combustion engine car class types.

Car class types	N	Mean (l/100 km)	S.D.	S.E.
Mid-size family cars	329	4.49	0.43	0.02
Compact cars	254	5.17	0.93	0.06
Compact crossovers	190	5.34	0.31	0.02
Large family cars & compact SUVs	273	5.76	0.68	0.04
Crossover SUVs & powerful cars	170	6.46	0.87	0.07
Total	1216	5.33	0.93	0.03

indicated that 'compact cars' and 'compact crossovers' were not statistically significantly different ($p > .05$). All other comparisons indicated significant differences between car class types ($p < .001$).

Consequently, four car class types among the internal combus-tion engine cars were retained. An ordered categorical variable labelled 'fuel efficiency of the purchased car' was created, with increasing average fuel efficiency for the combustion engine car classes and with battery electric cars being the most fuel-efficient group, which was used as the final dependent variable in the hy-pothesized model.

4.2. Test of the measurement models

The confirmatory factor analysis, which was performed to test the measurement model of the predictor variables in the hypoth-esized model, indicated that the three items developed to measure perceived behavioural control failed to reflect one common factor. Thus, based on face validity, a single item ('PBC3: It was mostly up to me whether I would buy a fuel-efficient and environmentally friendly car') was used to measure perceived behavioural control. Furthermore, the following items had rather low standardized loadings (<0.30) from the respective latent variables: (1) one item (PIA1) from perceived instrumental attributes of car; (2) two items (NEP2 and NEP8) from ecological worldview; and (3) four items (KN4, KN11, KN13, and KN14) from knowledge on car ownership and use. Another item (KN1) related to knowledge on car owner-ship and use and one item (INT2) of intention had cross-loadings from other latent variables. Therefore, these items were removed. The measurement models of the remaining constructs could be confirmed without modification. The statistical fit of the revised measurement models is acceptable ($\chi^2 = 10159.15$, $df = 2359$, $p < .001$; RMSEA = .05; CFI = .94; TLI = .94).

4.3. Structural equation modelling

In the last step, the combined measurement and structural model were tested. According to the model fit indices, the sug-gested structural model produced an acceptable fit to the data ($\chi^2 = 13863.60$, $df = 3097$, $p < .001$; RMSEA = .05; CFI = .92; TLI = .92). Table 3 displays the results of the model test, and Fig. 2 shows the standardized structural coefficients of the path model and explained variance (R^2) of the dependent variables.

Intention to buy a fuel-efficient car, brand loyalty, and situa-tional influences (except age) could be confirmed as having sig-nificant direct effects on purchasing a more fuel-efficient car. 23% of the variation in the fuel efficiency of the purchased car was explained by variations in these variables. The intention had the strongest and positive effect on purchasing a more fuel-efficient car, and 92% of the variation in the intention was explained by perceived instrumental, hedonic, and symbolic car attributes; personal norm; attitudes; perceived behavioural control; and social norm. While perceived symbolic attributes of the car had the strongest positive influence on the intention, the perceived instrumental and hedonic attributes of the car had negative

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[5] WLSMV estimates are more efficient and less biased regarding a model with many factors with categorical indicators (Asparouhov & Muthén, 2007).

Table 3
Estimated parameters of the model to explain car type choice ($N = 1517$).

	B	S.E.	p	β	R^2
Perceived instrumental attributes (PIA)					
→ PIA2	1.00	.00	–	.79	
→ PIA3	1.00	.02	<.001	.80	
→ PIA4	0.69	.03	<.001	.54	
→ PIA5	0.80	.03	<.001	.64	
→ PIA6	0.77	.03	<.001	.61	
→ PIA7	0.72	.03	<.001	.57	
→ PIA8	0.88	.02	<.001	.70	
→ PIA9	0.59	.03	<.001	.47	
→ PIA10	0.55	.03	<.001	.44	
Perceived symbolic attributes (PSA)					
→ PSA1	1.00	.00	–	.77	
→ PSA2	0.65	.03	<.001	.50	
→ PSA3	0.95	.02	<.001	.73	
→ PSA4	1.01	.02	<.001	.77	
→ PSA5	1.20	.02	<.001	.92	
→ PSA6	1.16	.02	<.001	.89	
Perceived hedonic attributes (PHA)					
→ PHA1	1.00	.00	–	.59	
→ PHA2	1.20	.04	<.001	.71	
→ PHA3	1.27	.05	<.001	.75	
→ PHA4	1.10	.04	<.001	.65	
→ PHA5	0.83	.04	<.001	.49	
→ PHA6	0.98	.04	<.001	.58	
→ PHA7	1.01	.04	<.001	60	
→ PHA8	1.37	.05	<.001	.81	
→ PHA9	1.14	.05	<.001	.67	
→ PHA10	1.04	.04	<.001	.62	
→ PHA11	1.34	.05	<.001	.80	
→ PHA12	0.92	.04	<.001	.55	
Social norm (SN)					
→ SN1	1.00	.00	–	.59	
→ SN2	1.24	.04	<.001	.73	
→ SN3	1.18	.04	<.001	.70	
→ SN4	1.43	.05	<.001	.84	
→ SN5	0.78	.05	<.001	.46	
→ SN6	1.51	.06	<.001	.89	
Awareness of need (AN)					
→ AN1	1.00	.00	–	.86	
→ AN2	0.97	.01	<.001	.84	
→ AN3	0.92	.01	<.001	.79	
Awareness of consequences (AC)					
→ AC1	1.00	.00	–	.81	
→ AC2	1.00	.02	<.001	.81	
→ AC3	1.00	.02	<.001	.81	
Personal norm (PN)					
→ PN1	1.00	.00	–	.78	
→ PN2	1.09	.02	<.001	.85	
→ PN3	1.11	.02	<.001	.86	
→ PN4	1.10	.02	<.001	.85	
→ PN5	1.09	.02	<.001	.85	
→ PN6	1.12	.02	<.001	.88	
Intention (INT)					
→ INT1	1.00	.00	–	.87	
→ INT3	0.84	.02	<.001	.73	
Attitude (ATT)					
→ ATT1	1.00	.00	–	.86	
→ ATT2	0.99	.01	<.001	.85	
→ ATT3	1.00	.02	<.001	.86	
→ ATT4	1.06	.01	<.001	.91	
→ ATT5	1.07	.01	<.001	.92	
→ ATT6	0.98	.02	<.001	.84	
Ecological worldview (NEP)					
→ NEP1	1.00	.00	–	.24	
→ NEP3	1.23	.15	<.001	.29	
→ NEP4	1.87	.19	<.001	.45	
→ NEP5	0.89	.13	<.001	.21	
→ NEP6	2.32	.23	<.001	.56	
→ NEP7	1.22	.13	<.001	.29	
→ NEP9	1.81	.18	<.001	.43	
→ NEP10	2.19	.21	<.001	.52	
Car ownership and use knowledge (KN)					
→ KN2	0.54	.04	<.001	.54	
→ KN3	0.36	.04	<.001	.36	

Table 3 (continued)

	B	S.E.	p	β	R^2
→ KN5	0.34	.04	<.001	.34	
→ KN6	0.54	.03	<.001	.54	
→ KN7	0.40	.04	<.001	.40	
→ KN8	0.56	.03	<.001	.56	
→ KN9	0.61	.03	<.001	.61	
→ KN10	0.29	.04	<.001	.29	
→ KN12	0.51	.03	<.001	.51	
→ KN15	0.58	.03	<.001	.58	
Awareness of need (AN)					.80
← Ecological worldview (NEP)	3.24	.32	<.001	.89	
Awareness of consequences (AC)					.94
← Awareness of need (AN)	0.35	.06	<.001	.38	
← Ecological worldview (NEP)	2.09	.31	<.001	.62	
Attitude (ATT)					.32
← Car ownership and use knowledge (KN)	0.07	.03	<.01	.09	
← Ecological worldview (NEP)	1.94	.20	<.001	.54	
Perceived behavioural control (PBC3)					
← Number of cars in household	0.21	.07	<.01	.09	
← Number of driver's license holders in household	−0.13	.10	n.s.	−.05	
← Household size	−0.02	.04	n.s.	−.01	
← Household income	−0.06	.03	<.05	−.09	
Personal norm (PN)					.91
← Awareness of consequences (AC)	0.75	.02	<.001	.78	
← Social norm (SN)	0.35	.03	<.001	.26	
← Perceived behavioural control (PBC3)	0.06	.01	<.001	.11	
Intention (INT)					.92
← Perceived instrumental attributes (PIA)	−0.14	.03	<.001	−.12	
← Perceived symbolic attributes (PSA)	0.63	.03	<.001	.55	
← Perceived hedonic attributes (PHA)	−0.19	.04	<.001	−.13	
← Attitude (ATT)	0.15	.02	<.001	.15	
← Social norm (SN)	−0.01	.04	n.s.	−.01	
← Perceived behavioural control (PBC3)	0.11	.01	<.001	.19	
← Personal norm (PN)	0.43	.04	<.001	.39	
Fuel efficiency of purchased car					.23
← Brand loyalty	−0.75	.13	<.001	−.16	
← Gender[a]	−0.18	.08	<.05	−.06	
← Age	−0.01	.00	n.s.	−.05	
← Education level	0.08	.03	≤.01	.07	
← Number of cars in household	0.42	.06	<.001	.21	
← Number of driver's license holders in household	−0.31	.07	<.001	−.13	
← Household size	0.13	.03	<.001	.13	
← Household income	−0.06	.02	<.01	−.09	
← Perceived behavioural control (PBC3)	0.04	.02	<.05	.05	
← Intention (INT)	0.48	.04	<.001	.33	
Perceived instrumental attributes (PIA)					
←→ Perceived symbolic attributes (PSA)	0.19	.02	<.001	.31	
←→ Perceived hedonic attributes (PHA)	0.34	.02	<.001	.72	
←→ Social norm (SN)	0.04	.01	≤.001	.09	
←→ Ecological worldview (NEP)	0.01	.01	n.s.	.03	
←→ Car ownership and use knowledge (KN)	0.17	.02	<.001	.21	
Perceived symbolic attributes (PSA)					
←→ Perceived hedonic attributes (PHA)	0.08	.01	<.001	.18	
←→ Social norm (SN)	0.23	.01	<.001	.51	
←→ Ecological worldview (NEP)	0.13	.01	<.001	.72	
←→ Car ownership and use knowledge (KN)	0.09	.02	<.001	.12	
Perceived hedonic attributes (PHA)					
←→ Social norm (SN)	0.01	.01	n.s.	.02	
←→ Ecological worldview (NEP)	−0.02	.00	<.001	−.11	
←→ Car ownership and use knowledge (KN)	0.07	.02	<.001	.11	
Social norm (SN)					
←→ Ecological worldview (NEP)	0.08	.01	<.001	.58	
←→ Car ownership and use knowledge (KN)	−0.02	.02	n.s.	−.04	
Ecological worldview (NEP)					
←→ Car ownership and use knowledge (KN)	0.04	.01	<.001	.17	

B = unstandardized coefficient; β = standardized coefficient; R^2 = explained variance.
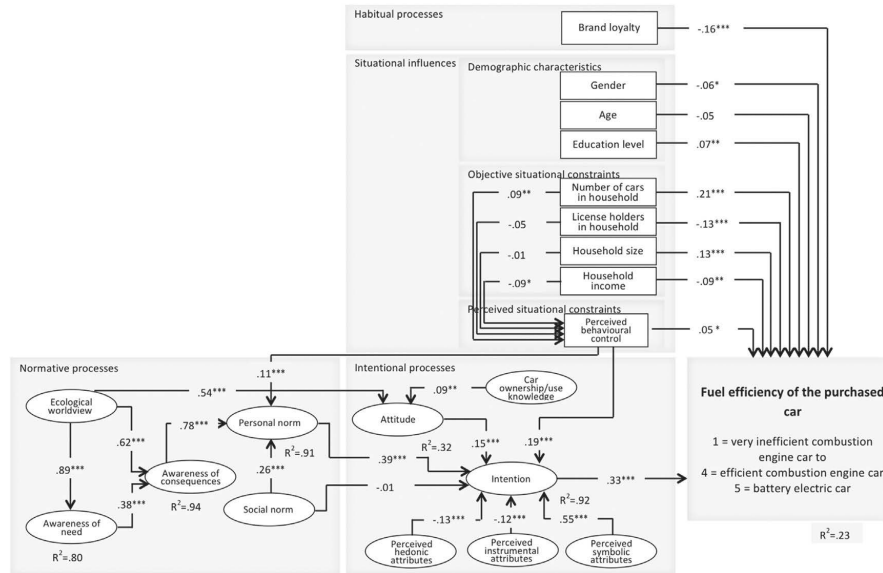[a] Gender: female = 0.

Fig. 2. Results of the estimated SEM: standardized structural coefficients ($^*p \le .05$; $^{**}p \le .01$; $^{***}p \le .001$), and explained variances ($N = 1517$).

impacts on the intention. The very high degree of explained variance in the intention resulted from the high number of variables included and high congruence between them. It also implies the intention is the variable integrating the influence of a comprehensive set of other variables.

Though the direct influence of the social norm on the intention was not significant, the social norm influenced the intention indirectly via personal norm as a mediator. It was found that 91% of the variation in the personal norm could be explained by awareness of consequences, social norm, and perceived behavioural control. Again, the personal norm integrates the norm-activating processes, as reflected in the high degree of explained variance. Awareness of need and ecological worldview were confirmed to be preconditions for awareness of consequences, and together explained 94% of the variation in the awareness of consequences. The influences of specific knowledge about car ownership and use, and ecological worldview on attitude were significant. Together, they explained 32% of variation in the attitude.

Brand loyalty turned out to have the third largest effect on purchasing a more fuel-efficient car. As hypothesized, the influence of brand loyalty was negative. It was observed that the influence of perceived situational constraints (i.e. perceived behavioural control) on fuel efficiency of the purchased car was mostly mediated through the intention and the personal norm. The assumption that variables from objective situational constraints affect perceived situational constraints (i.e. perceived behavioural control) was only observed for two of four objective situational variables (i.e. number of cars in household and household income). Meanwhile, the direct influence of objective situational constraints on purchasing a more fuel-efficient car varied from small to the second largest. More specifically, more cars in the household, larger household size, and higher education level positively influenced the purchase of a more fuel-efficient car, while more drivers license holders in a household and higher household income had negative effects on purchasing a fuel-efficient car.

5. Discussion

The aim of the present study was to test an integrated model of socio-psychological variables influencing the purchase of a more fuel-efficient car. The model was an application as well as an extension of the comprehensive action determination model (Klöckner & Blöbaum, 2010), which includes assumptions of the theory of planned behaviour, the norm activation model, the value-belief-norm theory, habits, and situational facilitators and constraints in order to predict behaviour. Extension meant that variables identified by traditional aggregated models of car purchase (see de Jong et al., 2004) such as socio-demographic variables as well as motivational dimensions of consumer innovativeness in the form of importance of car features (Vandecasteele & Geuens, 2010) were included in the adapted model.

At the same time, it was suggested that the purchase of a fuel-efficient car does not necessarily involve the choice of a smaller car. Evidence from previous studies indicated that variances in fuel efficiency and CO_2 emissions still remain large within and across all internal combustion engine car size classes (de Haan et al., 2009; Mueller & de Haan, 2009). Thus, forecasting fuel-efficient car choice based only on traditional car size classes was deemed unreliable. Instead, it was suggested to use car features such as price, engine size, engine power, fuel type, transmission, body type (i.e. car size classes), and drive system to classify internal combustion engine car class types, which in turn capture better the current behavioural options of changing to fuel-efficient cars (Nayum et al., 2013). The results of the present study indicated that car class types among internal combustion engine cars identified by this approach are distinct in relation to their average fuel efficiency. Moreover, the results showing 'mid-size family cars' having better average fuel efficiency than 'compact cars' confirmed that smallest internal combustion engine cars do not necessarily have the highest fuel efficiency.

The model structure analyses demonstrated almost all hypothesized variables from normative, intentional, and habitual processes; situational influences; and socio-demographic categories contributed to explaining the purchase of more fuel-efficient car either directly or indirectly. This indicated the comprehensive action determination model has promising potential in the domain of high-involvement purchase decisions for efficiency-increasing products like cars. From a psychological perspective, the findings that normative and intentional processes also influence consumers' purchase of more fuel-efficient cars imply that psychological factors are important in situations where consumer behaviour has been suggested to be more constrained by contextual forces such as taxes, incentives, and other social and political factors (Stern, 2000b).

As hypothesized, intention to buy a fuel-efficient car had a positive direct influence on purchasing more fuel-efficient cars, and it mediated the impacts of all normative and intentional variables. The hypothesized effects of perceived instrumental, hedonic, and symbolic attributes on the intention were also confirmed. The strong positive influence of perceived symbolic attributes indicated that the intention to adopt a fuel-efficient car was stronger if consumers perceived the car's symbolic attributes as more important. However, if consumers perceived instrumental and hedonic attributes more important, their intentions were weaker. This suggests consumers still hold the perception that choosing a fuel-efficient car involves sacrificing pleasure, comfort, safety, and performance to some extent (Kurani & Turrentine, 2004).

The low-to-medium impacts of most socio-demographic variables on consumers' purchase of more fuel-efficient cars indicate that these variables have relatively low explanatory ability if psychological variables are controlled for. Contrary to previous research on pro-environmental consumer behaviours (Stern, 2000a), it was not possible to confirm socio-demographics (as proxy for personal capabilities) as major factors in the purchase of major household goods and services, such as fuel-efficient new passenger cars. The difference between the findings in this study and previous research in terms of socio-demographics may be related to the focus of the research. In previous research, the focus was whether or not to purchase a major household good. Subsequently, the socio-demographics might be found useful in explaining consumer adoption of products irrespective of the type. In contrast, the specific focus on the consumer choice of a more fuel-efficient car in this study differed from the decision of whether or not to buy a car. Furthermore, the use of psychological variables to mediate the impacts of socio-demographics, together with the relatively high number of these variables, might have reduced their individual impacts and resulted in low estimates. Meanwhile, the Norwegian government's regulation (i.e. providing strong incentives to purchase cars with higher fuel efficiency and low emissions) might have a stronger influence than that of traditional socio-demographic variables.

Another significant finding of this study was the influence of brand loyalty on fuel efficiency of the purchased car. It seems that consumers are less occupied with brand and brand switching is presumably more common when fuel efficiency is a topic. The reason might be that brands among fuel-efficient cars carry less symbolic meaning, and differences between them are perceived to be smaller than the differences between powerful and prestigious cars. As manufacturers today are developing fuel-efficient cars in almost all car size classes and categories with similar features, it can be further speculated that the effect of loyalty will be reduced in the future. In addition, battery electric cars, which were regarded as the most fuel-efficient group in this study, have been adopted by Norwegian consumers only recently to a higher degree. Loyalty to certain battery electric cars had not yet developed when the study

was conducted. Nevertheless, the latest development in the battery electric car market, especially battery electric cars from the prestigious (e.g. Tesla) and well-known brands (e.g. BMW and Volkswagen), might affect the purchase of battery electric cars differently in the future.

5.1. Limitations of the study

A limitation of the present study is its retrospective design and its reliance on self-report measures. The web survey was distributed to car owners 6–12 months after they had purchased the car. It is possible, therefore, that responses might have been different if the survey was conducted at the time of purchase. Another limitation is the correlational design of the study, which would prevent establishing cause and effect. Moreover, a single item had to be used to measure perceived behavioural control. Single items are generally assumed to be less reliable measure than multiple-item measures, and this might be the reason for the relatively small effect of the construct on the final dependent variable. Likewise, the mediating effect of perceived behavioural control for objective situational constraints might not have been captured properly by the single item in the study.

Other methodological considerations concern the chosen high-impact product and the specific context. The purchase of a new passenger car is highly involving and has considerable symbolic and economic importance (Lambert-Pandraud, Laurent, & Lapersonne, 2005). In this sense, the results of this study are most likely generalizable to other highly involved purchase decisions on high-cost, high-impact products, which also convey some symbolism. Nevertheless, generalizability of the findings across different countries and cultural groups should be done with care because the study sample consisted of a Norwegian population. Norway has a very active policy to support purchases of fuel-efficient internal combustion engine cars and battery electric cars. This policy creates a political context that forms a cost structure pushing purchases away from high-emission and inefficient cars. Therefore, the research presented here, being explorative in nature, is likely more valuable as a reference point for further research in relation to other purchase situations, products, and contexts, than as a definitive generalizable conclusion across contexts.

5.2. Implications for research and policy-making

The present study provides an integrated, comprehensive approach to explaining consumer purchase of fuel-efficient car with the purpose of developing measures to change consumer behaviour. The main implication for consumer research is that future research would be more valuable if psychological factors are included in explaining the purchase of high-cost products. Focussing primarily on socio-demographic data when explaining consumer purchase of high-cost, high-impact product seems largely misguided and runs the risk of guiding industry and policy decisions in the wrong direction. It might be argued that the adoption of high-cost products involves a series of separate decisions with different predictors (Bamberg, 2012). At the initial stage, socio-demographics (as a proxy for personal capabilities) and the existence of a facilitating context (e.g. incentive structure) might be important for the purchase decision of a high-cost product. Once this stage is passed (i.e. a decision has been made to purchase the product), the decision regarding when and which product type to buy becomes salient. At a later stage, the psychological factors—mostly mediated through intention—likely come into play in the decision processes to a greater extent.

Although incentive structures likely help in increasing the sales of fuel-efficient cars, it can be debated how many more would be

sold due to incentives or tax relief alone. Uncertainty about how long highly debated financial incentives and other benefits will last cause further concern. Moreover, changes in government policy and incentive structure might negatively affect consumer attitudes and perceptions of both regulations and environmental impact of cars. Research evidence has indicated that a substantial proportion of consumers question the impacts of promoted environmentally friendly cars and call for more communication and debate on the subject (Egbue & Long, 2012). Possible changes in government policy may thus further fuel public resentment and widen the gap in the understanding of the impact of promoted fuel-efficient cars. Therefore, it seems necessary to underpin the high willingness to purchase fuel-efficient cars caused by policy incentives with matching psychological motive structures to make them robust.

Taken together, incentive structures and policy decisions that consider consumers' multi-layered motivations will have a high level of success in the long run. With proper design, management, and communication strategies, packages that contain messages to elicit pro-environmental norms, and attitudes towards adopting more fuel-efficient and environmentally friendly cars will further increase the diffusion rate of such cars under the incentive structure. From a business and marketing perspective, the results that consumers held the perception of owning a fuel-efficient car as a trade-off against instrumental and hedonic attributes provide several insights for targeting potential adopters of fuel-efficient cars. First, it seems necessary to offer consumers both information and personal experience highlighting that fuel-efficient cars do not necessarily need to be smaller (at least in the same car class), unreliable, or less pleasant in most everyday situations. This information would help consumers overcome fears or doubts about the technical performance and practical aspects of such cars. Second, symbolic attributes such as an energy label and fuel efficiency should be promoted as popular features. As the environmental effects of cars and traffic are widely known, highlighting the link between fuel consumption and environmental problems would likely be effective.

Acknowledgements

Appendix A. Supplementary data

Supplementary data related to this article can be found at http:// dx.doi.org/10.1016/j.jenvp.2014.10.001.

References

Ajzen, I. (2005). *Attitudes, personality, and behaviour.* Maidenhead: Open University Press.
Alwitt, L. F., & Berger, I. E. (1993). Understanding the link between environmental attitudes and consumer product usage: Measuring the moderating role of attitude strength. *Advances in Consumer Research, 20*(1), 189–194.
Asparouhov, T., & Muthén, B. (2007, July/August). Computationally efficient estimation of multilevel high-dimensional latent variable models. In *Proceedings of the 2007 Joint Statistical Meetings of the American Statistical Association, Salt Lake City, Utah* (pp. 2531–2535). Section on Statistics in Epidemiology.
Bamberg, S. (2012). Processes of change. In L. Steg, A. E. van den Berg, & J. I. M. de Groot (Eds.), *Environmental psychology: An introduction* (pp. 267–280). New York: Wiley & Sons.
Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14–25.
Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behaviour, 35*(2), 264–285.

Bergstad, C. J., Gamble, A., Hagman, O., Polk, M., Gärling, T., & Olsson, L. E. (2011). Affective–symbolic and instrumental–independence psychological motives mediating effects of socio-demographic variables on daily car use. *Journal of Transport Geography, 19*(1), 33–38.
Black, J. S., Stern, P. C., & Elworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology, 70*(1), 3–21.
Caulfield, B., Farrell, S., & McMahon, B. (2010). Examining individuals preferences for hybrid electric and alternatively fuelled vehicles. *Transport Policy, 17*(6), 381–387.
Chandrasekharan, R., McCarthy, P. S., & Wright, G. P. (1994). Structural models of brand loyalty with an application to the automobile market. *Transportation Research Part B: Methodological, 28*(6), 445–462.
Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry, 11*(4), 227–268.
Diamond, D. (2009). The impact of government incentives for hybrid-electric vehicles: Evidence from US states. *Energy Policy, 37*(3), 972–983.
Dietz, T., Stern, P. C., & Guagnano, G. A. (1998). Social structural and social psychological bases of environmental concern. *Environment and Behaviour, 30*(4), 450–471.
Dittmar, H. (1992). *The social psychology of material possessions: To have is to be.* Hemel Hempstead: Harvester Wheatsheaf.
Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*(3), 425–442.
Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy, 48*(C), 717–729.
European Commission. (2007). *Communication from the Commission to the European Council and the European Parliament: An energy policy for Europe.* COM(2007) 1 Final. Brussels: European Commission.
European Environment Agency. (2007). *EN16 Final energy consumption by sector: Assessment made on 01 April 2007.* Retrieved July 7, 2013, from http://www.eea.europa.eu/data-and-maps/indicators/en16-final-energy-consumption-by-sector.
Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behaviour: The reasoned action approach.* New York: Psychology Press.
Flamm, B. (2009). The impacts of environmental knowledge and attitudes on vehicle ownership and use. *Transportation Research Part D: Transport and Environment, 14*(4), 272–279.
Frey, B. S., & Osterloh, M. (2002). *Successful management by motivation: Balancing intrinsic and extrinsic incentives.* New York: Springer.
Graham-Rowe, E., Gardner, B., Abraham, C., Skippon, S., Dittmar, H., Hutchins, R., et al. (2012). Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations. *Transportation Research Part A: Policy and Practice, 46*(1), 140–153.
de Haan, P., Mueller, M. G., & Peters, A. (2006). Does the hybrid Toyota Prius lead to rebound effects? Analysis of size and number of cars previously owned by Swiss prius buyers. *Ecological Economics, 58*(3), 592–605.
de Haan, P., Mueller, M. G., & Scholz, R. W. (2009). How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars - Part II: Forecasting effects of feebates based on energy-efficiency. *Energy Policy, 37*(3), 1083–1094.
de Haan, P., Peters, A., & Scholz, R. W. (2007). Reducing energy consumption in road transport through hybrid vehicles: Investigation of rebound effects, and possible effects of tax rebates. *Journal of Cleaner Production, 15*(11), 1076–1084.
Hawkins, T. R., Singh, B., Majeau-Bettez, G., & Strømman, A. H. (2013). Comparative environmental life cycle assessment of conventional and electric vehicles. *Journal of Industrial Ecology, 17*(1), 53–64.
Heffner, R. R., Turrentine, T., & Kurani, K. (2006). *A Primer on automobile semiotics.* UC Davis: Institute of Transportation Studies (UCD). Retrieved from http://escholarship.org/uc/item/3577d04p.
Metz, B., Davidson, O., Bosch, P., Dave, R., & Meyer, L. (Eds.). (2007), *Contribution of working group III to the fourth assessment report of the intergovernmental panel on climate changeClimate change 2007: Mitigation.* Cambridge: Cambridge University Press.
Jansson, J., Marell, A., & Nordlund, A. (2009). Elucidating green consumers: A cluster analytic approach on proenvironmental purchase and curtailment behaviours. *Journal of Euromarketing, 18*(4), 245–267.
Jansson, J., Marell, A., & Nordlund, A. (2010). Green consumer behaviour: Determinants of curtailment and eco-innovation adoption. *Journal of Consumer Marketing, 27*(4), 358–370.
de Jong, G., Fox, J., Daly, A., Pieters, M., & Smit, R. (2004). Comparison of car ownership models. *Transport Reviews, 24*(4), 379–408.
Kahn, M. E. (2007). Do greens drive Hummers or hybrids? Environmental ideology as a determinant of consumer choice. *Journal of Environmental Economics and Management, 54*(2), 129–145.
Kahn, M. E., & Vaughn, R. K. (2009). Green market geography: The spatial clustering of hybrid vehicles and LEED registered buildings. *The BE Journal of Economic Analysis & Policy, 9*(2), 1–24.
Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour – A meta-analysis. *Global Environmental Change, 23*(5), 1028–1038.
Klöckner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology, 30*(4), 574–586.

Kurani, K. S., & Turrentine, T. S. (2004). *Automobile buyer decisions about fuel economy and fuel efficiency*. UC Davis: Institute of Transportation Studies (UCD). Retrieved from http://escholarship.org/uc/item/6zq891d1.

Kurani, K. S., Turrentine, T. S., & Heffner, R. R. (2006). Narrative self-identity and societal goals: Automotive fuel economy and global warming policy. In D. Sperling, & J. S. Cannon (Eds.), *Driving climate change: Cutting carbon from transportation* (pp. 217–238). Boston: Academic Press.

Lambert-Pandraud, R., Laurent, G., & Lapersonne, E. (2005). Repeat purchasing of new automobiles by older consumers: Empirical evidence and interpretations. *Journal of Marketing, 69*(2), 97–113.

MacLean, H. L., & Lave, L. B. (2003). Evaluating automobile fuel/propulsion system technologies. *Progress in Energy and Combustion Science, 29*(1), 1–69.

Mannering, F., & Winston, C. (1985). A dynamic empirical analysis of household vehicle ownership and utilization. *Rand Journal of Economics, 16*(2), 215–236.

Mannering, F., & Winston, C. (1991). Brand loyalty and the decline of American automobile firms. In *Brookings papers on economic activity: Microeconomics* (pp. 67–114).

Mueller, M. G., & de Haan, P. (2009). How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars - Part I: Model structure, simulation of bounded rationality, and model validation. *Energy Policy, 37*(3), 1072–1082.

Nayum, A., Klöckner, C. A., & Mehmetoglu, M. (2014). Comparison of socio-psychological characteristics of conventional and electric car buyers. *Transportation Research Part F: Traffic Psychology and Behaviour* (under review).

Nayum, A., Klöckner, C. A., & Prugsamatz, S. (2013). Influences of car type class and carbon dioxide emission levels on purchases of new cars: A retrospective analysis of car purchases in Norway. *Transportation Research Part A: Policy and Practice, 48*(C), 96–108.

Oliver, R. L. (1999). Whence consumer loyalty? *Journal of Marketing, 63*, 33–44.

Organisation for Economic Co-operation and Development, & International Energy Agency. (2010). *Energy technology perspectives 2010: Scenarios and strategies to 2050*. Organisation for Economic Co-operation and Development.

Ouellette, J., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behaviour predicts future behaviour. *Psychological Bulletin, 124*(1), 54–74.

Ozaki, R., & Sevastyanova, K. (2011). Going hybrid: An analysis of consumer purchase motivations. *Energy Policy, 39*(5), 2217–2227.

Peters, A., Gutscher, H., & Scholz, R. W. (2011). Psychological determinants of fuel consumption of purchased new cars. *Transportation Research Part F: Traffic Psychology and Behaviour, 14*(3), 229–239.

Peters, A., Mueller, M. G., de Haan, P., & Scholz, R. W. (2008). Feebates promoting energy-efficient cars: Design options to address more consumers and possible counteracting effects. *Energy Policy, 36*(4), 1355–1365.

van Rijnsoever, F., Farla, J., & Dijst, M. J. (2009). Consumer car preferences and information search channels. *Transportation Research Part D: Transport and Environment, 14*(5), 334–342.

Roehrich, G. (2004). Consumer innovativeness: Concepts and measurements. *Journal of Business Research, 57*(6), 671–677.

Ryan, L., Ferreira, S., & Convery, F. (2009). The impact of fiscal and other measures on new passenger car sales and CO2 emissions intensity: Evidence from Europe. *Energy Economics, 31*(3), 365–374.

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice, 48*(C), 39–49.

Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology, 10*, 221–279.

Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? *Journal of Social Issues, 50*(4), 19–45.

Schwartz, S. H., & Howard, J. A. (1981). A normative decision-making model of altruism. In J. P. Rushton, & R. M. Sorrentine (Eds.), *Altruism and helping behaviour: Social, personality, and developmental Perspectives* (pp. 189–211). Hillsdale, NJ: Lawrence Erlbaum.

Scown, C. D., Taptich, M., Horvath, A., McKone, T. E., & Nazaroff, W. W. (2013). Achieving deep cuts in the carbon intensity of US automobile transportation by 2050: Complementary roles for electricity and biofuels. *Environmental Science & Technology, 47*(16), 9044–9052.

Skippon, S., & Garwood, M. (2011). Responses to battery electric vehicles: U.K. consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. *Transportation Research Part D: Transport and Environment, 16*(7), 525–531.

Statistisk sentralbyrå. (2012). *Registrerte inntekter for hushald, etter hushaldstype. Gjennomsnitt for alle. 2011* [*Registered income for households after household types. Average for all. 2011*]. Retrieved July 29, 2013, from http://www.ssb.no/a/kortnavn/ifhus/tab-2012-12-18-02.html.

Statistisk sentralbyrå. (2013). *Befolkningens utdanningsnivå, 1. oktober 2012* [*Education level of the population, 1 October 2012*]. Retrieved July 29, 2013, from http://www.ssb.no/utdanning/statistikker/utniv.

Stern, P. C. (2000a). Psychology and the science of human-environment interactions. *American Psychologist, 55*(5), 523–530.

Stern, P. C. (2000b). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues, 56*(3), 407–424.

Thøgersen, J. (2006). Norms for environmentally responsible behaviour: An extended taxonomy. *Journal of Environmental Psychology, 26*(4), 247–261.

Triandis, H. C. (1979). Values, attitudes, and interpersonal behaviour. *Nebraska Symposium on Motivation, 27*, 195–259.

Vandecasteele, B., & Geuens, M. (2010). Motivated consumer innovativeness: Concept, measurement, and validation. *International Journal of Research in Marketing, 27*(4), 308–318.

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25*(1), 90–103.

Voss, K. E., Spangenberg, E. R., & Grohmann, B. (2003). Measuring the hedonic and utilitarian dimensions of consumer attitude. *Journal of Marketing Research, 40*(3), 310–320.

Klöckner, C. A., Nayum, A., & Mehmetoglu, M. (2013). Positive and negative spillover effects from electric car purchase to car use. *Transportation Research Part D: Transport and Environment*, *21*, 32-38.

Paper IV

Positive and negative spillover effects from electric car purchase to car use

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ARTICLE INFO

ABSTRACT

This study reports the results of two online surveys conducted on buyers of conventional combustion engine cars compared to those of electric vehicles in Norway. The results show that electric cars are generally purchased as additional cars, do not contribute to a decrease in annual mileage if the old car is not substituted, and that electric car buyers use the car more often for their everyday mobility. Psychological determinants derived from the theory of planned behavior and the norm-activation theory show a high correlation between the purchase and use stages. Electric car buyers, have lower scores on many determinants of car use, especially awareness of consequences and close determinants of car use.

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1. Introduction

To tackle the environmental problems associated with individual motorization, two paths are conventionally considered; improvements in the technical fuel efficiency of the car fleet or reducing the number of car trips. The first strategy began to be supported when several European countries started subsidizing electric cars; e.g. in Norway, there is no purchase or value added tax on electric cars, a reduced annual tax, free or cheap use of use toll roads, parking places, ferries, and bus lanes on the roads. In August 2012 Norway had the highest number of electric cars per capita (2.75%) and the highest percentage of electric cars among all passenger cars. In September 2012, 5.2% of all new cars sold in Norway were electric cars, an incremental increase of 143% over the same month in 2011. In some urban areas electric cars were the most widely purchased cars in 2012.

The environmental benefit of electric cars is still unclear (Hawkins et al., 2013). At the macro level, because of the ways electricity is generated, the global environmental impact may be worse with more electric cars than with modern, fuel efficient conventional combustion engine vehicles, but at the microlevel electric cars benefit the local environment because of their lack of local emissions and low noise levels.[1] Our main focus here, however, is the potential implications on traffic volumes of a greater use of electric cars. To this end we consider stated preference data collected as part of a large survey of car buyers in Norway.

2. Methodology

To consider the factors motivating the use of electric cars use is made of a sample based on data in the Norwegian Public Roads Administration (statens vegvesen) database. In April 2012 an invitation letter was sent to all private households that purchased a new passenger car in November or December 2011, and the same letter to all households who bought an electric
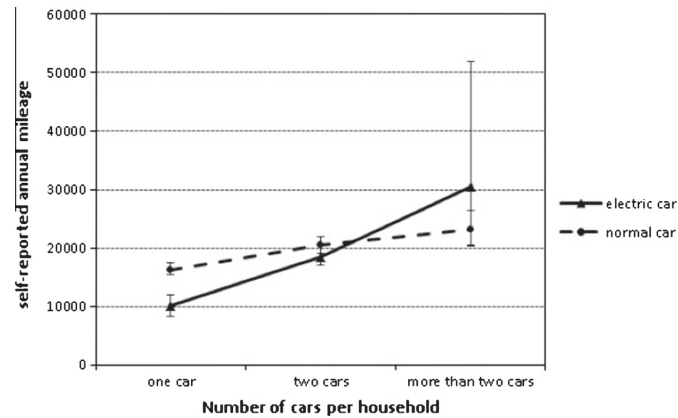

Fig. 1. Reported annual mileage in the previous year against number of cars per household and purchased car type including bootstrapped 95% confidence intervals.

car in 2011. Electric car buyers were over sampled to obtain a reasonable group size. The letter included information about the study that involved two online questionnaires. The first questionnaire included questions related to car purchase, and the second consisted of questions about car use. The same psychological constructs were measured in both questionnaires and the electric car buyers received the same questions as the normal car buyers.[2]

In all 13,362 letters were sent out; 12,000 to normal car buyers and 1362 to electric car buyers. This resulted in an overall response rate of 13.4% for the first questionnaire (11.8% for normal car buyers and 27.3% for electric car buyers), and of 11.69% for the second questionnaire (10.41% for normal car buyers and 22.98% for electric car buyers). The response rate for the normal car sample is within the range expected for an online study with long questionnaires (Deutskens et al., 2004); the response rate for electric car buyers is comparatively high.

Females constituted 23.5% of the sample, with no difference between the subsamples. The total respondents had a mean age of 49.9 years. The mean age among the normal car buyers was 51.0 years which is significantly different from 45.9 years for electric car purchases. The regional distribution of participants in the normal car group corresponds well with that for the country's regional distribution. In the electric car buying group, the regional distribution matches that of electric cars sold. The average household size was 2.9 people, with a significantly higher number in the electric car group. Further, 70.1% of the sample were either married or living in registered partnerships, 17.5% co-habiting, 6.3% single, 4.2% separated or divorced and 1.9% widowed. In the electric car group the rate of married or co-habiting people was significantly larger. Overall, 73.5% of the sample had a university or college degree – 85.6% in the electric car group and 70.3% in the normal car group indicating a significant over-representative of well-educated people. Eighty-three percent of the sample were in the work-force; 93.9% in the electric and 80.1% in the normal car groups.

The following variables from both online questionnaires are used for our analysis: number of cars per household, estimated annual mileage irrespective of the used car, expected annual mileage for next year, self-reported percentage of car use for specific trips, attitudes (ATT), intentions (INT), perceived behavioral control (PBC), integrated personal norms (PN), introjected norms (IN), descriptive norms (DN), social norms (SN), awareness of responsibility (AR), awareness of need (AN) and ascription of responsibility (AR).

Cars per household and the estimated annual mileage in the previous year were recorded in the first questionnaire, while the expected annual mileage the following year was recorded in the second. The percentage of car use for specific trips was recorded separately for a number of trips (Fig. 1); an 11-point scale with 10% intervals beginning with 0% is used. Participants indicating that they never took such trips were excluded them from the analysis. For the analysis, 11-point scale was transformed into percentages assigning the middle of each category as the value. In addition electric car buyers were asked on how many of their car trips for the seven travel goals they use their electric car.

The psychological variables are measured with three items per variable and domain (buy/use) with two exceptions; the three items intended to measure perceived behavioral control were too different to be integrated into one latent variable so only the item with the highest face validity was selected and attitudes were measured with five items using a seven point agreement scale from −3 for totally disagree, to +3 for totally agree.[3] Examples and Cronbach's alpha for each scale can be found in Table 1.

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[2] As an incentive, all participants who answered both questionnaires were entered in a lottery of three iPads.
[3] For further descriptions of this approach see, Klöckner and Matthies (2004), Nayum et al. (2013), Thøgersen (2006).

Table 1
Overview of the measures used.

|	Definition	N	Parallel items	Sample item purchase	Sample item use	Cronbach's alpha purchase	Cronbach's alpha use
Attitude (ATT)	A global evaluation of how favorable a behavioral alternative is perceived	1715	5 of 5	"Do you think that buying a fuel efficient and environmentally friendly car would be very bad … very good?"	"Do you think that reducing your personal car use would be very bad … very good?"	0.91	0.88
Intention (INT)	Intention is the willingness to make an effort implement a behavior. Thereby it is a direct predictor of behavior and a result of ATT, PBC and SN	1774	2 of 3	"When I bought my car I planned to substitute my car with a fuel efficient and environmentally friendly car."	"I plan to substitute some of my car trips by other travel modes."	0.65	0.73
Perceived behavioral control (PBC)	Perceived behavioral control is a variable from the theory of planned behavior and captures to which degree a person feels capable to perform a certain behavior	1510	1 of 1	"If I wanted to I could have bought a fuel efficient and environmentally friendly car."	"If I want to I can easily reduce the number of car trips."	–	–
Integrated personal norm (PN)	An integrated personal norm is the feeling of moral obligation to act in a certain way. It is rooted in the personal value system of a person and triggered by AN, AC and AR	1774	2 of 3	"I felt obliged to save the environment when I bought my new car."	"I feel obliged to reduce the number of car trips."	0.86	0.77
Introjected norm (IN)	Introjected norms are the next to last step in the internalization process of social norms into integrated personal norms	1774	3 of 3	"To own a strong and big car gives/would give me sometimes a bad conscience."	"I get a bad conscience when I use my car unnecessarily."	0.89	0.83
Descriptive norm (DN)	The mental representation of what other people around a person do with respect to the behavior in question	1772	2 of 3	"Many people who are important to me own a fuel efficient and environmentally friendly car."	"Many people who are important to me reduce the number of their car trips."	0.79	0.60
Social norm (SN)	The mental representation of expectations relevant other people have about the behavior in question	1774	2 of 3	"I think that many people who are important to me expected that I should buy a fuel efficient and environmentally friendly car."	"I think that many people who are important to me expect that I should reduce the number of car trips."	0.74	0.70
Ascription of responsibility (AR)	The degree to which a person is willing to accept responsibility for the negative outcomes of a behavior and taking action against it	1774	2 of 3	"I feel responsible for the environmental problems that result from the type of car I own."	"I feel personally responsible for problems that result from car use."	0.76	0.57
Awareness of need (AN)	The perceived degree for need to act against a potentially negative outcome	1774	2 of 3	"There is an acute need to do something about environmental pollution resulting from that people own big cars."	"There is an acute need to do something about environmental pollution resulting from car use."	0.86	0.82
Awareness if consequences (AC)	The perceived amount of contribution of one's own behavior to the negative outcomes of a behavior	1774	3 of 3	"My own decision which car I should buy has a relevant impact in the environment."	"My personal car use contributes to environmental problems (e.g. air pollution, noise, global warming."	0.85	0.81
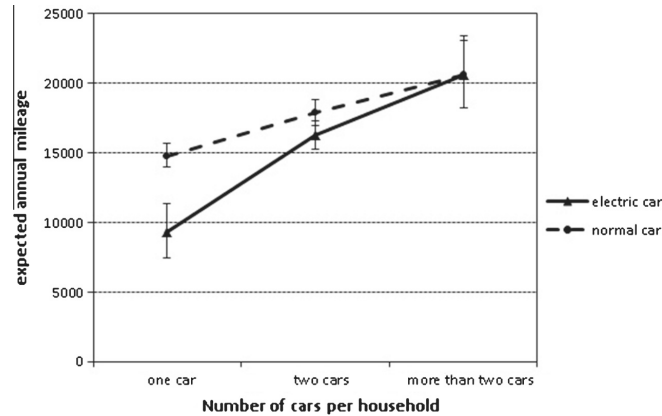
Fig. 2. Expected annual mileage in the following year against number of cars per household and purchased car type including bootstrapped 95% confidence intervals.

3. Results

An analysis of variance indicates that participants who purchased an electric car have on average a significantly larger number of vehicles per household than those who purchased a normal car. Nearly 50% of normal car buyers only have one car per household, 44.5% own two, with only 6.1% own more than two. For electric car buyers, only 9.5% have it as their only car, whereas 75.7% own two cars per household and 14.9% own more than two. This means that electric cars are generally bought as an additional vehicle and not as a substitute for a conventional car; a result that differs from De Haan et al. (2006) in Switzerland.

Self-reported annual mileage was analyzed depending whether the car is electric or "normal", whether a household has one, two, or more cars, and the interaction between the two (Fig. 1). While the main effect for car type is not significant, the annual mileage is increasing significantly with the number of cars per household in both groups. This increase, however, is even more pronounced in the electric car group resulting in a significant interaction term. In particular, the lower annual mileage for people that own an electric car as the only household car compared that who own only a normal car is noticeable. When the expected annual mileage for next year is compared, electric car and normal car buyers show no significant difference, unless the number of cars per household is controlled for when both the car type and the number of cars have a significant effect (Fig. 2). In summary, electric car buyers expect to drive less; the more cars per household are owned, the higher mileage is expected.

For people owning an electric car as a second or third vehicle there is no difference in annual mileage compared to combustion engine car owners, while individuals that only own an electric vehicle report lower annual mileage; a pattern also expected for future car use. One can only speculate on why this may be. It could be that only people that really substitute a traditional with an electric car reduce their driving and thus have a positive spillover and there are features of electric vehicles limiting this (e.g., range limits). People who become car owners by buying an electric vehicle, on the other hand may increase their personal mileage, although not by the same extent as conventional car users.[4] People that buy an electric car as an additional car show no positive spillover effect on their travel behavior.

We now turn to look at car trip by purpose; trips to work/school, transporting a child to school or kindergarten, shopping, visits of medical facilities, leisure activities, visits of friends, and holiday was compared for electric car buyers and normal car buyers (Fig. 3). We find that electric car owners use their vehicles significantly more often than conventional car owners for any kind of trip, however, for most of the trips they use the electric vehicle. The implication of this, given the electricity generation mix in Norway (Hawkins et al., 2013), just focusing on vehicular use, and excluding vacation trips, is that the electric car use substantially reduced emissions. Those differences are most pronounced for work/school related trips, but also large for shopping, visits of the doctor, leisure activities and transportation of children.

Finally we consider linkages between the decisions to buy a particular vehicle type and its use. The analysis involves a series of 10 structural equation model comparisons outlined in Fig. 4. Table 2 shows the results of the first model, where there is no interaction between purchase variables and car type, the Bayesian information criterion (BIC) for the second model and the relative improvement in model fit ΔBIC if the interaction is included. The results indicate that all models meet the

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[4] In the sample only four participants bought an electric car as their primary vehicle.
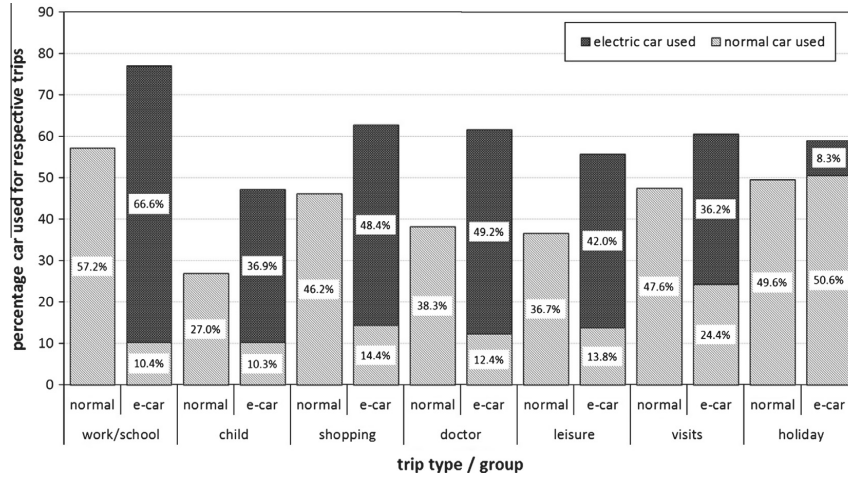
Fig. 3. Self-reported percentage of car use for different trip types against car type.
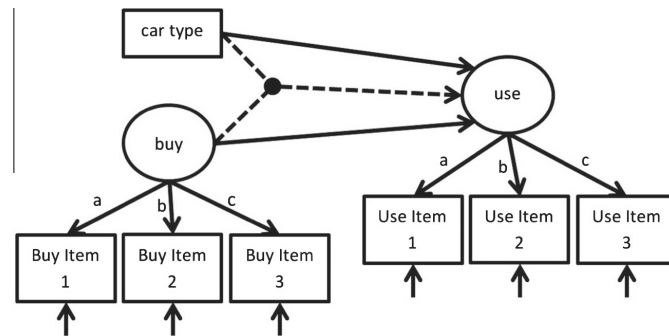

Fig. 4. The structure of the model tested. *Note*: Model test A without interaction, model test B with interaction.

Table 2
Unstandardized regression weights of Models A and B and selected model fit criteria.

	Model A				Model B				
	B_{use}	B_{type}	$BIC_{model\ A}$	RMSEA	B_{use}	B_{type}	$B_{interaction}$	$BIC_{model\ B}$	ΔBIC
ATT	0.340[*]	−0.276[*]	49314.13	0.086	0.374[*]	−0.232[*]	−0.173[*]	49314.79	0.660
INT	0.419[*]	−0.387[*]	35758.96	0.104	0.422[*]	−0.383[*]	−0.013	35766.41	7.452
PBC	0.142[*]	0.083			0.150[*]	0.199	−0.038		
PN	0.619[*]	−0.455[*]	34165.55	0.054	0.645[*]	−0.427[*]	−0.099	34168.48	2.926
IN	0.582[*]	−0.370[*]	33912.35	0.070	0.623[*]	−0.291[*]	−0.169[*]	33906.66	−5.691
DN	0.618[*]	−0.043	32224.39	0.062	0.620[*]	−0.045	−0.011	32231.85	7.456
SN	0.603[*]	0.031	32715.78	0.079	0.620[*]	0.015	−0.081	32721.52	5.743
AR	0.739[*]	0.051	34059.07	0.092	0.753[*]	0.063	−0.058	34065.04	5.970
AN	0.653[*]	0.151	32422.30	0.038	0.654[*]	0.152	−0.005	32429.77	7.468
AC	0.465[*]	−0.489[*]	32789.45	0.098	0.517[*]	−0.412[*]	−.233[*]	32780.96	−8.493

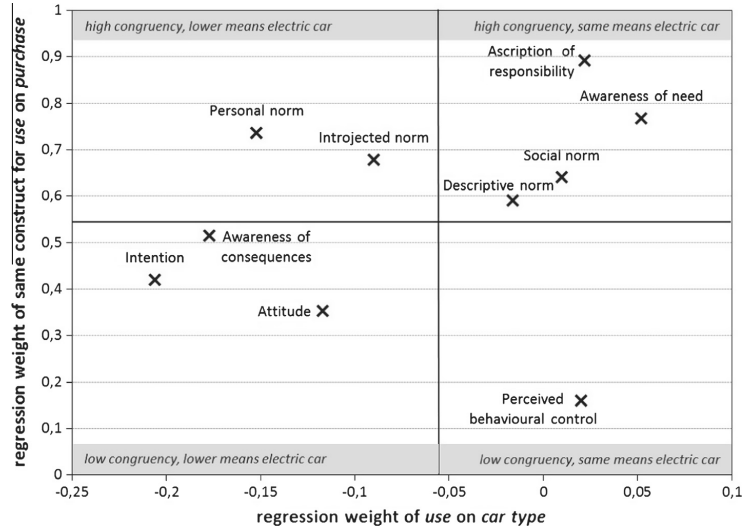[*] Significant at 5% (Bonferroni corrected).

Fig. 5. Standardized regression weights for "use" on "buy" and car type.

basic criteria for a reasonable fit (Hu and Bentler, 1999). Further, negative ΔBICs suggest the inclusion of the interaction improves the fit of the model for awareness of consequences and injunctive norms. The table also shows the unstandardized regression weights for "use" on "buy" and car type (Model A) and "use" on "buy", car type and the interaction between the two (Model B). It indicates that all relationships between the same variables for the "buy" and "use" stage are significant and positive. The grade of congruency between use and purchase varies considerably: while the ascription of responsibility (AR), basically the degree to which a person is willing to accept responsibility for the negative outcomes of an action and rectify it, is largely stable across the domains, is perceived behavioral control (PBC), the degree a person feels capable to perform a certain action, depending heavily on the domain. Additionally, attitudes and intentions are relatively specific to buying and usage, whereas the norm related constructs are more overarching. Electric car buyers put significantly lower values on car use attitude, intention, integrated personal norm, introjected norms and awareness of consequences than other car buyers. Findings indicate that three interactions terms are significant: The relation between attitudes to buy an environmentally friendly car to the attitude to reduce car use is significantly weaker for participants that bought an electric car. The same results are seen for introjected norms and awareness of consequences.

Fig. 5 shows the standardized regression weights of the two predictors. We see that the general norm related constructs (SN, DN, AN, AR) exhibit both a high congruency between the purchase and use stage and small impacts of the purchased car type on the mean. The more individual representations of norms are rather domain unspecific but weaker among electric car buyers. Awareness of consequences, intentions and attitudes are both relatively specific and weaker for electric car buyers. Finally, perceived behavioral control is very domain specific but not weaker for electric car buyers.

While the estimated annual mileages do not suggest any negative spillover effect, the analyses of the psychological determinants of car use behavior indication some. Although many variables have a high correlation between the purchase and use stage and thus point towards a positive spillover effect (Thøgersen, 2004; Thøgersen and Ölander, 2003; Thøgersen and Noblet, 2012), the significantly lower scores for electric car owners on all variables that are close to behavior (intention, integrated personal norms, attitudes, and introjected norms) indicate that electric car owners may feel they had already 'done their share' to reduce the negative impacts from car travel.[5] The notable results of awareness of consequences being reduced might also explain the other effects, for instance: If people own an electric car the consequences of their personal car use for the environment are reduced drastically. Even if they still think that car traffic is a problem for the environment (AN) and that they should take responsibility (AR) they feel that their behavior no longer has negative consequences, thus their integrated personal norms will not be activated. They will also have less bad conscience (IN), even if their perception of other people's expectations and other people's behavior remains constant. It is theoretically satisfying to note that perceived behavioral control is very specific to the two domains while all norm-related variables are strongly congruent between the two

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[5] This is in line with findings about recycling and reducing packaging Thøgersen (1999).

domains. Perceived control should be related to a specific behavior and feeling able to purchase an electric car may be totally different to feeling able to reduce car use.[6]

The significant negative interaction between the purchased car type and awareness of consequences as well as introjected norms indicates that the congruency is particularly impaired. The latter indicates that people that purchased electric cars possess a weaker relation between their bad conscience to buy a big car and their conscience to use the car, which again can be interpreted along the lines of Thøgersen and Noblet (2012), people that feel unable but have a conscience about their ability to reduce their car use may realize that by buying an electric car.

4. Conclusions

The Norwegian market for electric vehicles is developing quickly. In some regions an electric car is the most sold car type. This development may lead to changes in the traffic structure of Norwegian cities and this study analyzed how ownership of an electric car potentially impacts car use patterns. There are several conclusions that can be drawn based First, most Norwegians who buy an electric car buy it as an addition to their household's car fleet. Only few people substitute their conventional car, but once bought, an electric car is used for a large proportion of all trips. Those that own an electric car, only drive less than conventional car owners if it is their only vehicle. At the trip level, the data indicate that electric car owners use their car more, which is rational given the incentive structure in Norway, and that owning an electric car reduces attitudes, intentions and perceived moral obligation to reduce car use. Most psychological determinants also show a rather high correlation between car purchase and use indicating potential positive spillover effects.

Acknowledgements

References

Brand, S., Petri, M., Haas, P., Krettek, C., Haasper, C., in press. Hybrid and electric low-noise cars cause an increase in traffic accidents involving vulnerable road users in urban areas. International Journal of Injury Control and Safety Promotion.

De Haan, P., Mueller, M.G., Peters, A., 2006. Does the hybrid Toyota Prius lead to rebound effects? Analysis of size and number of cars previously owned by Swiss Prius buyers. Ecological Economics 58, 592–605.

Deutskens, E., De Ruyter, K., Wetzels, M., Oosterveld, P., 2004. Response rate and response quality of internet-based surveys: an experimental study. Marketing Letters 15, 21–36.

Hawkins, T.R., Singh, B., Majeau-Bettez, G., Strømman, A.H., 2013. Comparative environmental life cycle assessment of conventional and electric vehicles. Journal of Industrial Ecology 17, 53–64.

Hu, L., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal 6, 1–55.

Klöckner, C.A., Matthies, E., 2004. How habits interfere with norm-directed behaviour: a normative decision-making model for travel mode choice. Journal of Environmental Psychology 24, 319–327.

Nayum, A., Klöckner, C.A., Prugsamatz, S., 2013. Influences of car type class and carbon dioxide emission levels on purchases of new cars: a retrospective analysis of car purchases in Norway. Transportation Research Part A: Policy and Practice 48, 96–108.

Thøgersen, J., 1999. Spillover processes in the development of a sustainable consumption pattern. Journal of Economic Psychology 20, 53–81.

Thøgersen, J., 2004. A cognitive dissonance interpretation of consistencies and inconsistencies in environmentally responsible behavior. Journal of Environmental Psychology 24, 93–103.

Thøgersen, J., 2006. Norms for environmentally responsible behaviour: an extended taxonomy. Journal of Environmental Psychology 26, 247–261.

Thøgersen, J., Noblet, C., 2012. Does green consumerism increase the acceptance of wind power? Energy Policy 51, 854–862.

Thøgersen, J., Ölander, F., 2003. Spillover of environment-friendly consumer behaviour. Journal of Environmental Psychology 23, 225–236.

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[6] As Thøgersen and Noblet (2012) point out, people that buy electric cars might so because they feel unable to reduce car use.