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Sustainable development: *Our Common Future* revisited

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ABSTRACT

No clear definition of sustainable development exists to guide politicians in solving challenges at the global or regional levels. Rather, the concept's use has increasingly reflected socially desirable attributes of solutions to local- and project-level problems, but these ignore the global challenges that the concept was meant to address. We return to the original definition of sustainable development used in the Brundtland Report and suggest an assessment method to determine whether countries currently meet the threshold values of four equally important primary dimensions: safeguarding long-term ecological sustainability, satisfying basic needs, and promoting intragenerational and intergenerational equity. We also define indicators and threshold values for each of these dimensions; in addition, we show how 167 countries compare in meeting these threshold values. Currently, no country meets all four thresholds. Even so, we propose that, with the use of technology and behavioural changes, it will be possible to reach the threshold values by 2030.

1. Introduction

"Anything on which John Major, George Bush and Fidel Castro all agree can't really mean anything, can it?"

Whitelegg (1997, p. 101)

Sustainable development is increasingly being presented as a pathway to all that is good and desirable in society. Some of the proposed national indicators of sustainable development from the United States, the United Kingdom, and Finland illustrate this point. They include such factors as crime rate; participation of 14-year-olds in social organizational work; teacher capabilities; workforce skill level; the number of 19-year-olds in the UK with Level 2 qualifications, classes taught in a minority language, children in public care, daily smokers, and internet users; the manner in which children get to school; obesity rates; and R&D expenditures (Banister, 2008; Holden, 2007; Holden and Linnerud, 2007). And the list grows longer yearly.

Thus, the sustainable development concept has become so comprehensive and complex that it is no longer useful in guiding policymaking. Not surprisingly, a number of scholars have argued that the sustainable development concept is in danger of becoming irrelevant (e.g., Hopwood et al., 2005; Redclift, 2005).

Even though there is not yet any political or scientific agreement on a definition of sustainable development, it remains remarkably persistent as an ideal political concept, similar to democracy, justice, and liberty (Meadowcroft, 2007). Indeed, sustainable development "is now like 'democracy': it is universally desired, diversely understood, extremely difficult to achieve, and won't go away" (Lafferty, 2004, p. 26).

Unquestionably, sustainable development still is an important concept, which was clearly illustrated at the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro in June 2012. One of the conference's main outcomes was the agreement by member states to set up sustainable development goals, which could be useful tools in achieving sustainable development. Thus, achieving sustainable development is still high on the international and national agendas 25 year after the concept was launched with the publication of *Our Common Future*, commonly referred to as the Brundtland Report (WCED, 1987).

However, to become a useful tool, the concept must be clearly defined. This article attempts to do so by going back to its origin, the Brundtland Report. We suggest an assessment method that involves four equally important primary dimensions mentioned in the Brundtland Report, and then define suitable indicators and assign minimum/maximum thresholds for each indicator.

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Some scholars argue that there is a difference between "sustainable development" and "sustainability", for example: that sustainability refers to the environmental dimension of sustainable development, or that sustainability refers to a process whereas sustainable development refers to the product (end state). To us the two concepts entail the same dimensions and the same policy implications. Thus, we use them interchangeably.

2. Sustainable development's primary dimensions

Four primary dimensions have been derived from the Brundtland Report: safeguarding long-term ecological sustainability, satisfying basic human needs, and promoting intragenerational and intergenerational equity. These dimensions are what Daly (2007) refers to as "fundamental objective values, not subjective individual preferences." Thus, they are not negotiable.

In addition to the primary dimensions, Høyer (2000) presents a number of *secondary* dimensions, which include preserving nature's intrinsic value, promoting protection of the environment, promoting public participation, and satisfying aspirations for an improved standard of living (or quality of life). These secondary dimensions are subordinate to the primary dimensions. Thus, preserving nature's intrinsic value (a secondary dimension) must give way whenever basic human needs (a primary dimension) are threatened. Correspondingly, satisfying aspirations for a better life (a secondary dimension) should be subordinate to safeguarding long-term ecological sustainability (a primary dimension).

Following this logic, we contend that economic growth is not one of the primary dimensions of sustainable development. This argument runs contrary to the popular "triple bottom line" model focusing on the *balance* between environmental, social, and economic issues (Elkington, 1997, 2004; see also Holden, 2007:11), a model that presently dominates the political and to some extent the academic debate on sustainable development UN, 2012; Rogers et al., 2008). However, aspiring for economic growth may be equivalent to aspiring for an improved standard of living far beyond what can be considered ecologically sustainable in the long term. The Brundtland Report claims that: "Sustainable development clearly requires economic growth in places where such [human] needs are not being met. Elsewhere, it can be consistent with economic growth, provided the content of growth reflects the broad principles of sustainability and non-exploitation of others. But growth by itself is not enough" (WCED, 1987, p. 44). Thus, we argue, economic growth is a *potential means* to facilitate the fulfilment of the four primary dimensions and not a primary dimension in its own right (WCED, 1987; Daly, 2007; OECD, 2002).

Another possibly controversial aspect of our argument is that our four primary dimensions do not include the participation of or acceptance by stakeholders (though we regard it as a secondary dimension). This argument runs contrary to a number of recent studies, which consider participation and acceptance as crucial to achieving sustainability (Amekudzi et al., 2009; Castillo and Pitfield, 2010; Shiftan et al., 2003). Although we agree that stakeholder participation and acceptance are vital to ensure efficient implementation of sustainable policies and measures, we disagree that the choice of sustainable dimensions, indicators, and threshold values should be whatever a group of local stakeholders chooses to agree upon. Of course, there must be global agreement, and our basis for this agreement is the Brundtland Report and the extensive debates that have taken place as part of the subsequent UN processes (Biermann et al., 2012).

Finally, by setting explicit minimum and maximum threshold values, our approach runs contrary to those focusing on relative changes. For example, suggesting that sustainability can be achieved by demonstrating a positive "rate of change" (Amekudzi et al., 2009) for a country or region is not satisfactory. Changing an unsustainable state to a less unsustainable state is good, but the result cannot be considered sustainable.

2.1. Primary Dimension No. 1: safeguarding long-term ecological sustainability

The term "sustainability" has its origin in ecological science. It was developed to express the conditions that must be present for the ecosystem to sustain itself over the long term. In the Brundtland Report, there are several references to the necessity of ecological sustainability, such as: "At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings" (WCED, 1987, p. 44), and "There is still time to save species and their ecosystems. It is an indispensable prerequisite for sustainable development. Our failure to do so will not be forgiven by future generations" (WCED, 1987, p. 166).

The Brundtland Report gives two reasons for setting minimum requirements for ecological sustainability. First, if basic human needs are to be met on a sustainable basis, the Earth's natural base must be conserved. Human development tends to damage ecosystems, which reduces the number of species. The loss of plant and animal species can greatly limit the options of future generations. Therefore, the Brundtland Report argued that "sustainable development requires the conservation of plant and animal species" (WCED, 1987, p. 46). Second, the report argued that "the case for the conservation of nature should not rest only with the development goals. It is part of our moral obligation to other living beings and future generations" (WCED, 1987, p. 57).

2.2. Primary Dimension No. 2: satisfying basic human needs

Satisfying basic human needs is at the core of the development part of sustainable development. Indeed, the concept of need is embedded in the definition of sustainable development: "It [sustainable development] contains [...] the concept of 'needs,' in particular the essential needs of the world's poor, to which overriding priority should be given" (WCED, 1987, p. 43). Thus, satisfying basic human needs and assuring long-term ecological sustainability constitute necessary preconditions for sustainable development.

The Brundtland Report mentions employment, food, energy, housing, water supply, sanitation, and health care as basic human needs. The Brundtland Report does not, however, refer only to basic needs. People are, according to the report, entitled to aspire to more than just covering their basic needs: "Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life" (WCED, 1987, p. 44).

The Brundtland Report argues that living standards that provide for more than basic needs can be sustainable, but *only* if such living standards assure long-term ecological sustainability. Thus, not every aspiration for a better life is compatible with the goal of sustainable development. Accordingly, the aspiration for a better life is defined as a secondary dimension, whereas satisfying basic human needs is defined as a primary dimension.

2.3. Primary Dimension Nos. 3 and 4: promoting inter- and intragenerational equity

The minimum requirement to conserve the Earth's ecosystems has led several authors to conclude that the concept of sustainable development should be understood as pertaining exclusively to physical sustainability (Wetlesen, 1999). Lafferty and Langhelle (1999), however, claim that the Brundtland Report dismisses such a conclusion. They base their claim on a passage in the report that states that even physical sustainability "cannot be secured unless development policies pay attention to such considerations as changes in access to resources and in the distribution of costs and burdens" (WCED, 1987, p. 43).

Hence, in the opinion of Lafferty and Langhelle, even the narrowest definition of physical sustainability – as the minimum requirement for a sustainable development – must take into account social equity, which implies that the present generation must meet its needs without compromising the ability of future generations to meet theirs. The Brundtand Report puts it this way: "We act as we do because we can get away with it: future generations do not vote; they have no political or financial power; they cannot challenge our decisions" (WCED, 1987, p. 8).

Furthermore, the Brundtland Report claims that social equity *between* generations "must logically be extended to equity *within* each generation" (WCED, 1987, p. 43, our italics). Thus, social equity as an integral part of sustainable development has two dimensions, time and space (Lafferty and Langhelle, 1999). From this perspective, sustainable development has consequences for equity within and between generations both globally and nationally.

2.4. Broad and narrow sustainability

To what extent is there a hierarchy of the primary dimensions and what are we to do if conflicts arise between them? Like several authors, the Norwegian philosopher Arne Næss interprets the concept of sustainable development in the following way: "development is not sustainable if it is not ecologically sustainable" (Næss, 1991, p. 37). This approach, which also was dominant in the *World Conservation Strategy* (IUCN, 1980), places great emphasis on long-term ecological sustainability, and is often referred to as "narrow sustainability." The World Conservation Strategy coined the term "sustainability" in 1980. But it was only with the publication of *Our Common Future* (WCED, 1987) that sustainability, coupled to the notion of development, become known as sustainable development.

The Brundtland Report identifies a much broader spectrum of issues to be covered by sustainable development, including political, social, economic, and cultural issues. Thus, sustainability includes more than environmental sustainability, and this approach is therefore often called "broad sustainability."

As Lafferty and Langhelle (1999) point out, none of the above definitions says anything about how possible conflicts between the goals should be resolved. Consequently, there is no hierarchy among the primary dimensions. In fact, they argue that this is exactly the intention of the Brundtland Report: "Development is only sustainable when it takes into consideration *both* human needs and long-term ecological sustainability. The point then becomes specifically one of *not* establishing a hierarchy of values between the two dimensions [that is, our four dimensions], but one of excluding development paths which do not take both into consideration" (Lafferty and Langhelle, 1999, p. 13). This is in line with our understanding of the concept of sustainable development.

2.5. Strong vs. weak sustainability

In 1991, Victor (1991) remarked that one of the contributions that economists have made to the sustainable development debate has been the idea that the depletion of environmental resources in the pursuit of economic growth is similar to living off capital rather than profit. Victor defines sustainable development as the maximum development that can be achieved without running down the capital assets of a nation, which are its resource base. Included in the resource base are man-made capital, natural capital, human capital, and moral and cultural capital. There are, however, differing views regarding the relation between these types of capital (Neumayer, 2013). Turner (1993) argues that the spectrum of views ranges from "very weak sustainability" to "very strong sustainability." Turner traces these two opposing positions to the techno-optimists and their techno-centric perspective (very weak sustainability), and the deep ecologists and their eco-centric perspective (very strong sustainability), respectively.

The rule in very weak sustainability is that the overall stock of capital assets should remain constant over time. This rule allows for the reduction of an asset provided that another capital asset (or assets) is increased to compensate for such a reduction. Thus, every reduction of natural capital must be offset by an increase in some other form or forms of natural or man-made capital.

Weak sustainability represents a slight modification of very weak sustainability. The implication of this modified sustainability thinking seems to be that there is a need for the formulation of a sustainability constraint that will impose *some degree* of restriction on resource-using economic activities. Such restriction would not result from concern for the ecosystems themselves; rather, it would result from concern for the ecosystems' ability to meet human needs. Thus, even though there would be some restrictions, there would still be a high degree of substitutability between all forms of capital resources. Both the weak and very weak versions of sustainability are consistent with declining levels of natural capital as long as the losses are offset by gains in other forms of capital.

Those advocating strong sustainability claim that just protecting the overall amount of capital is insufficient; rather, they claim that natural capital must also be protected because some *critical* natural capital cannot be replaced by other forms of capital. The rationale for this strong view is based on a combination of factors: uncertainty about ecosystem functions, the irreversibility of some components of natural capital if damaged, and the aversion felt by many people about environmental degradation.

The very strong sustainability perspective concentrates on the scale of human development relative to global carrying capacity. According to this view, when human development reaches global carrying capacity, no forms of natural capital are substitutable. Thus, there are absolute limits to human development.

The approach we take is based on an understanding of sustainable development in the strong sustainability sense, which according to Daly (2005), is in line with most ecological economists who suggest that natural and man-made capital are more often complements to each other rather than substitutes for each other. Like Tengström (1999) suggests, good arguments exist to support claims that there is (critical) natural capital that cannot be replaced by other natural capital or by man-made capital. Certain ecosystems and the global climate are examples of such natural capital. We do not, however, advocate the very strong sustainability approach because it implies the primacy of safeguarding long-term ecological sustainability over the safeguarding of other primary dimensions, which is not consistent with our understanding of sustainable development.

3. The sustainable development space

For each of the four primary dimensions, we choose appropriate indicators and assign threshold values that need to be met for development to be deemed sustainable. All threshold values should be met as soon as possible. The four threshold values form a four-dimensional space, which we call the "Sustainable Development Space". Amekudzi et al. (2009) uses the concept "sustainability footprint", the *World Wide Fund for Nature* (WWF, 2010) uses the concept "sustainability box", and the *United Nations Development*

Programme uses the concept "sustainable human development" (UNDP, 2013) for similar constructions.

The sustainable development space is in accordance with the literature that develops and assesses sustainable indicators. However, we argue that the primary indicators (one for each dimension) and their threshold values represent *equally important* targets and that each must be fulfilled. This approach excludes the possibility of trading off under performance in one indicator against the over performance in another. Consequently, we argue against reducing sustainability to *one* composite index (e.g., the International Human Dimensions Programme on Global Environmental Change's Inclusive Wealth Index). On the other hand, we have not chosen the other extreme, namely specifying a very long list of indicators (e.g., the list of 96 indicators suggested by the UN Commission on Sustainable Development (UNCSD, 2007)), which contains a mix of primary and secondary dimensions). Thus, our approach adopts four distinct composite dimensions.

Ultimately, sustainability should be addressed globally. Humans are part of a single natural (global) system whose parts interact is complex ways. Still, although national territories, economies, and societies constitute only one level of system organization, it is perhaps the most significant level because governance is presently strongest at the national level (Dahl, 2012). Thus, the sustainable development space is presented at the national level, but is defined according to global challenges and limits. Assessing sustainability at a regional or local level could result in differences for the ecological footprint (and bio capacity) but not, in accordance with strong sustainability requirements, for irreversible damage to the natural environment.

3.1. Indicators and threshold values for the four primary dimensions

Dimension 1: We use the ecological footprint as an indicator for safeguarding long-term ecological sustainability. The ecological footprint tracks humanity's demands on the biosphere by comparing humanity's consumption against the Earth's regenerative capacity, or biocapacity. This comparison is carried out through calculating the area, measured in global hectares, required to produce the resources people consume, the area occupied by infrastructure, and the area of forest required for sequestering CO_2 not absorbed by the ocean (WWF, 2012).

Ecological footprint covers a wide range of current major environmental issues (UNDP, 2011; WWF, 2012; EEA, 2012). It compares consumption against the Earth's regenerative capacity and illustrates the extent to which we may be overusing natural resources (WWF, 2012). Ecological footprint fits well with the concept of strong sustainability (UNDP, 2011), thus reflecting our notion that there should be no trade-offs in meeting the thresholds of the four primary dimensions. The concept and methodology are well established, and ecological footprint is one of only two measures of long-term ecological sustainability available for a large number of countries over a reasonably long period (the World Bank's adjusted net savings is the other measure) (UNDP, 2011). Following the logic of Brundtland's low-energy scenario (WCED, 1987), we argue that the yearly per capita threshold value must be maximum 2.3 global hectares (see Table 1 for details).

Dimension 2: We use the United Nations Development Programme's (UNDP) Human Development Index as an indicator to measure whether basic human needs are satisfied. Human development index is a composite index measuring average achievement in three basic dimensions of human development – a long and healthy life, knowledge, and a decent standard of living (UNDP, 2011). We contend that the minimum human development index threshold value should be set at 0.630 (Table 1).

Dimension 3: We use the Gini coefficient as an indicator of intragenerational equity. The Gini coefficient is the most popular and widely used measure of inequality (UNDP, 2010). It measures the inequality among values of a frequency distribution in a country (for example, levels of income). A Gini coefficient of zero expresses perfect equality (for example, where everyone has an exactly equal income). A Gini coefficient of one hundred expresses maximal inequality (for example, where one person has all the income). Using the target level set by the United Nations Human Settlements Programme (UN, 2010), we set the threshold value to 40 (Table 1).

Equity (as required by the Brundtland Report) is not the same as equality (as measured by the Gini coefficient). Equity refers to the qualities of justness, fairness, and impartiality, whereas equality refers to equal sharing of something. Thus, equality represents quantity, whereas equity represents quality. Even so, according to Amartya Sen (2009, p. 291) "every normative theory [and 'sustainable development' is indeed a normative term] of social justice [or equity] demands equality of *something* – something that is regarded as particularly important in that theory." Hence, we consider the distribution of income (indeed an important something) as measured by the Gini coefficient, to be a good measure of equity in a society.

Dimension 4: We use the proportion of renewable energy to total primary energy production as an indicator of intergenerational equity. Intergenerational equity requires that future generations be able to meet their needs. Although we do not know these future needs, it is unlikely that future generations' needs can be met without access to some sort of energy. Expecting that fossil fuel will become more scarce and costly, the Brundtland

Table 1
Primary dimensions, indicators, and suggested 2030 threshold values for sustainable development.

Dimension	Indicator	2030 Threshold
(1) Safeguarding long-term ecological sustainability	Yearly per capita ecological footprint	Maximum 2.3 gha per capita[a]
(2) Satisfying basic human needs	Human Development Index	Minimum 0.630[b]
(3) Promoting intragenerational equity	Gini coefficient	Maximum 40[c]
(4) Promoting intergenerational equity	The proportion of renewable to total energy in primary energy production	Minimum 27%[d]

[a] Based on Brundtland's low-energy scenario: The 1985 global energy consumption of 9.9 TW is allowed to increase to 14.4 TW by 2030 (WCED, 1987). Adjusted for global population growth, this increase calls for a 15% per capita reduction in energy consumption by 2030. Because ecological footprint is strongly correlated with energy consumption, we use the same 15% rate of reduction to reduce its 1985 level of 2.7 global hectares (gha) per capita (WWF, 2008) to 2.3 gha per capita in 2030. Interestingly, Brundtland's low-energy scenario compares to the IPCC's low estimate for scenario group B1 in which global energy consumption in 2030 scenarios varies from 16 to 28 TW (IPCC, 2000).

[b] UNDP (2011) classifies countries into groups according to human development – very high, high, medium, and low – according to their levels on the human development index. Human development index classifications are relative and based on quartiles of human development index distribution across countries. We take the view that the measure of the medium group reflects the minimum requirement a country must meet to ensure its inhabitants' basic human needs. For 2009, the human development index of countries with a medium human development was 0.630 (UNDP, 2011).

[c] This threshold value equals the target level set by UN-HABITAT (UN, 2010). It is sometimes called the international alert line.

[d] This threshold reflects the proportion needed by 2035 to be consistent with a 450 ppm CO_2eq stabilization levelas recommended by the IPCC (2011); we apply this proportion for our 2030 threshold value. IPCC data are based on the IEA's "450 Policy Scenario" (IEA, 2010).

Report emphasizes that "every effort should be made to develop the potential for renewable energy, which should form the foundation of the global energy structure during the 21st Century" (WCED, 1987, p. 144). Thus, we argue that the proportion of renewable energy to total energy in primary energy production is a good indicator of intergenerational equity, and that the proportion of renewable energy to total energy in total primary energy production must be a minimum of 27% by 2030 (Table 1).

Using ecological footprint as an indicator for long-term ecological sustainability and the proportion of renewable energy as an indicator for intergenerational equity raises some concern (e.g., Sing et al., 2011; Gasparatos et al., 2009; Heink and Kowarik, 2010; van den Bergh and Grazi, 2010). The ecological footprint only includes consumption and emissions that require land areas, in some form or another. Important environmental issues relating to emissions of heavy metals, persistent organic and nonorganic materials, radioactive substances etc. are therefore not included. These issues should therefore be included within the secondary dimensions in our approach. Moreover, the idea of aggregating many different land categories into a single number is problematic. So far the answer is 'land productivities'; the productivity of different types of land can be determined by referring to the reported yields of various plant and animal produce. Even though this makes it possible to summarize the different land areas, it represents an inevitable methodological weakness. Finally, the ecological footprint depends heavily on GHG emissions and total energy use, which we thus could choose as alternative indicators. Nevertheless, the ecological footprint captures more environmental issues than other measures such as GHG emissions and energy use.

Using the proportion of renewable energy as an indicator to promoting intergenerational equity raises two concerns. First, renewable energy production is up to 1000 times more spatially demanding than fossil energy production is (Twidell and Weir, 2005), meaning that significant land areas must be reserved. Thus, a high proportion of renewable energy in a high-energy consumption society would almost certainly not be sustainable, because the potential loss of bio diversity could seriously threaten long-term ecological sustainability. However, a maximal threshold value on ecological footprint (as required by the first primary dimension) prevents this scenario from happening. Second, the ecological footprint already accounts for renewable energy use, which opens up for double counting of the ecological sustainability dimension. Still, we regard the proportion of renewable energy an important indicator for intergenerational equity, because it explicitly reflects a necessary long-term transition into a renewable-energy regime.

In spite of the methodological weaknesses, all four indicators and thresholds are based on high quality, scientifically based sources, and we regard them to be relevant and robust.

4. Country data

This section presents 167 countries' data on the suggested indicators for the four primary dimensions. The main sources are the World Wide Fund for Nature's Living Planet Report (WWF, 2012) and UNDP's Human Development Report (UNDP, 2011). Threshold values indicating the sustainable development space boundaries are shown in each of the six figures presented in this section. The shaded area in each figure represents the sustainable development space across the two dimensions shown.

4.1. Ecological sustainability and basic needs

Currently, 23 countries are in the sustainable development space on dimensions 1 (ecological footprint) and 2 (human development index) (Fig. 1). The figure lends little support for the Environmental Kuznets Curve (EKC) hypothesis, which states that as per capita income grows (income correlates strongly with

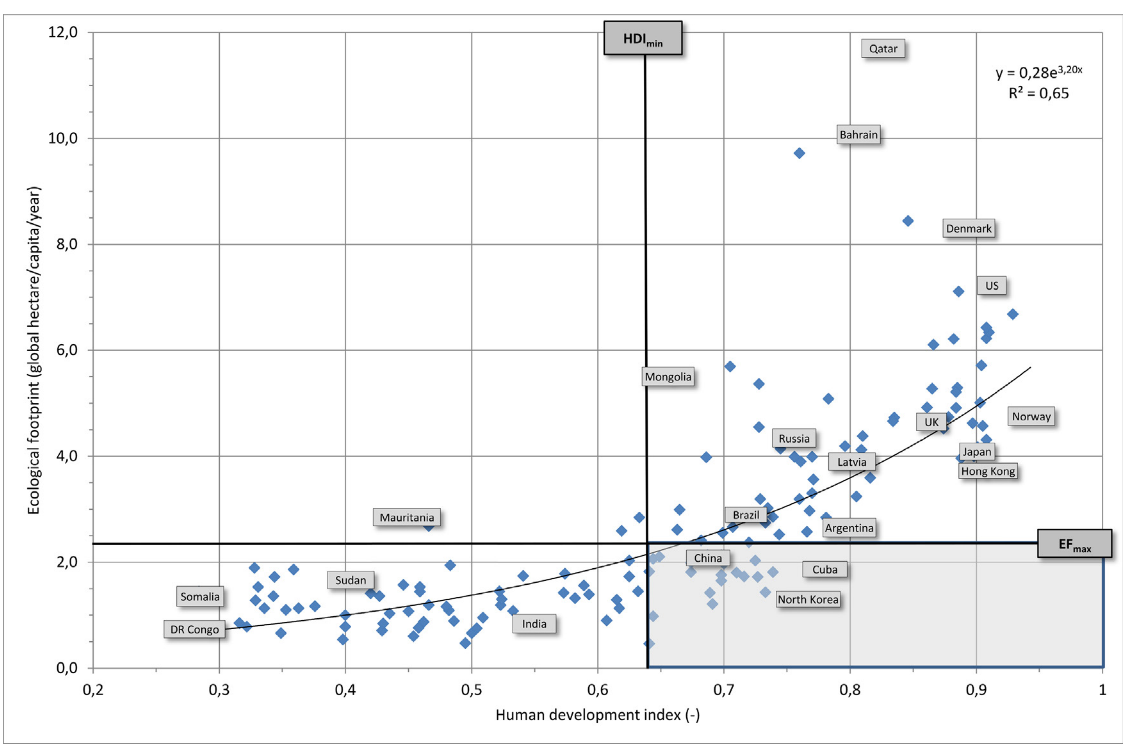

Fig. 1. The sustainable development space (SDS) for dimensions 1 (ecological footprint) and 2 (human development index). SDS is in the lower right quadrant (shaded). Country data are for 2008/2009 ($N = 154$).
Sources: UNDP (2011) and WWF (2012).

human development index), environmental impacts rise, hit a maximum, and then decline, implying an "inverted U-shape" (Hanley et al., 2001). The observed pattern does not resemble an inverted U-shape, and the regression line in Fig. 1 indicates that per capita ecological footprint increases exponentially as human development index increases.

4.2. Ecological sustainability and intragenerational equity

Currently, 38 countries are in the sustainable development space on dimensions 1 (ecological footprint) and 3 (Gini coefficient) (Fig. 2). The regression line in Fig. 2 indicates that there is a negative correlation between ecological footprint and the Gini coefficient. Thus, there seems to be a sort of mismatch between the two dimensions – countries have not succeeded in performing well on both dimensions. This result runs contrary to the finding of Wilkinson and Pickett (2009), who suggest that societies having low levels of inequality score better on a wide range of positive features, such as community life and social relations, mental health and drug use, and physical health and life expectancy. It is, however, hard to see any causal relationship between ecological footprint and the Gini coefficient; thus, it should be possible to reduce ecological footprint without causing an increase in inequity (i.e., increasing the Gini coefficient).

4.3. Ecological sustainability and intergenerational equity

Currently, 38 countries are in the sustainable development space on dimensions 1 (ecological footprint) and 4 (renewable energy) (Fig. 3). The regression line in Fig. 3 indicates that countries having a high proportion of renewable energy in their energy production have lower ecological footprints than do countries having a low proportion of renewable energy. This finding might not come as a surprise. Many developing countries rely heavily on bioenergy to fulfil their energy needs; thus, their low ecological footprint values could result from low levels of development rather than a high proportion of renewable energy in their total primary energy production. However, multivariate regression analyses show that the proportion of renewable energy has a significant negative effect on ecological footprint even when level of development is controlled for (data not shown).

4.4. Basic needs and intragenerational equity

Currently, 61 countries are in the sustainable development space on dimensions 2 (human development index) and 3 (Gini coefficient) (Fig. 4). The regression line in Fig. 4 suggests a negative relation between human development index and Gini coefficient. Thus, countries with low levels of inequality are better positioned to safeguard their inhabitants' basic needs. This finding is in accordance with Wilkinson and Pickett (2009), who found that health and social problems – which prevent societies from providing their inhabitants' basic needs – are more common in countries that have high levels of inequality. Moreover, Wilkinson and Pickett argue that the relationship between high levels of health and social problems on the one hand and high levels of inequality on the other is such that the latter causes the former. Thus, reducing a country's level of inequality (i.e., the Gini coefficient) would subsequently lead to fewer health and social problems, thereby improving the country's ability to meet its inhabitants' basic needs.

4.5. Basic needs and intergenerational equity

Currently, 15 countries are in the sustainable development space on dimensions 2 (human development index) and 4 (renewable energy) (Fig. 5). The regression line in Fig. 5 shows that as human development index increases, the proportion of

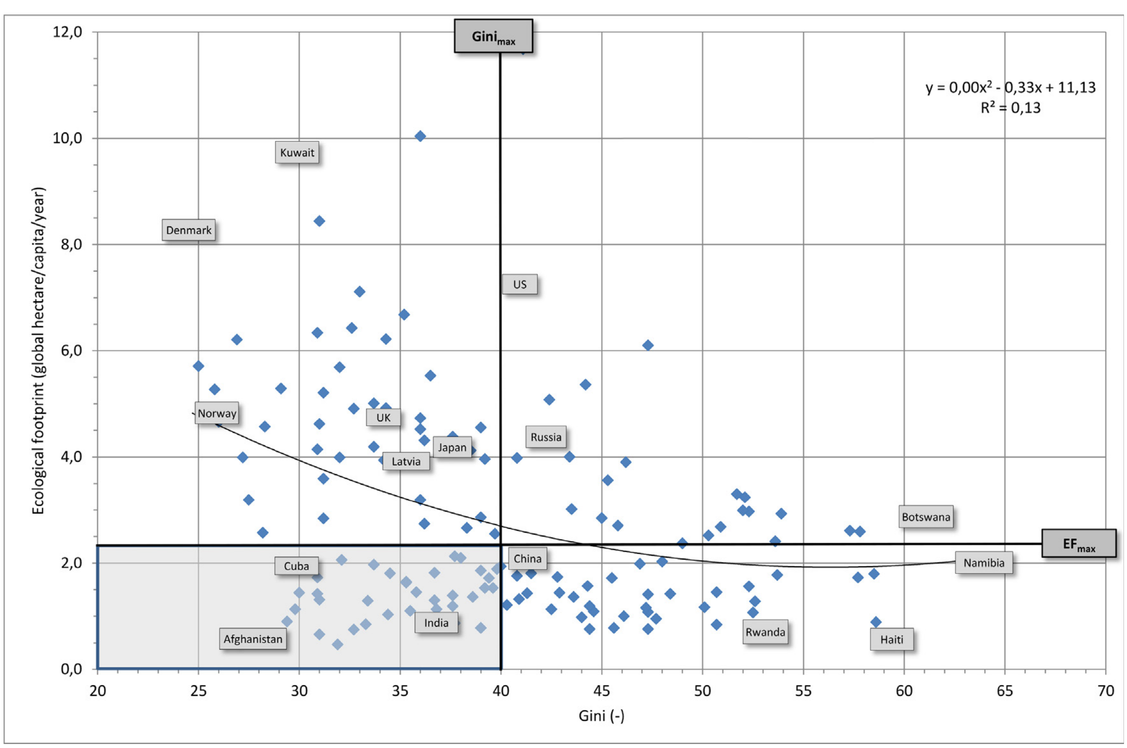

Fig. 2. The sustainable development space (SDS) for dimensions 1 (ecological footprint) and 3 (Gini coefficient). The SDS is in the lower left quadrant (shaded). Country data are for 2008/2009 ($N = 152$).
Sources: UNDP (2011) and WWF (2012).

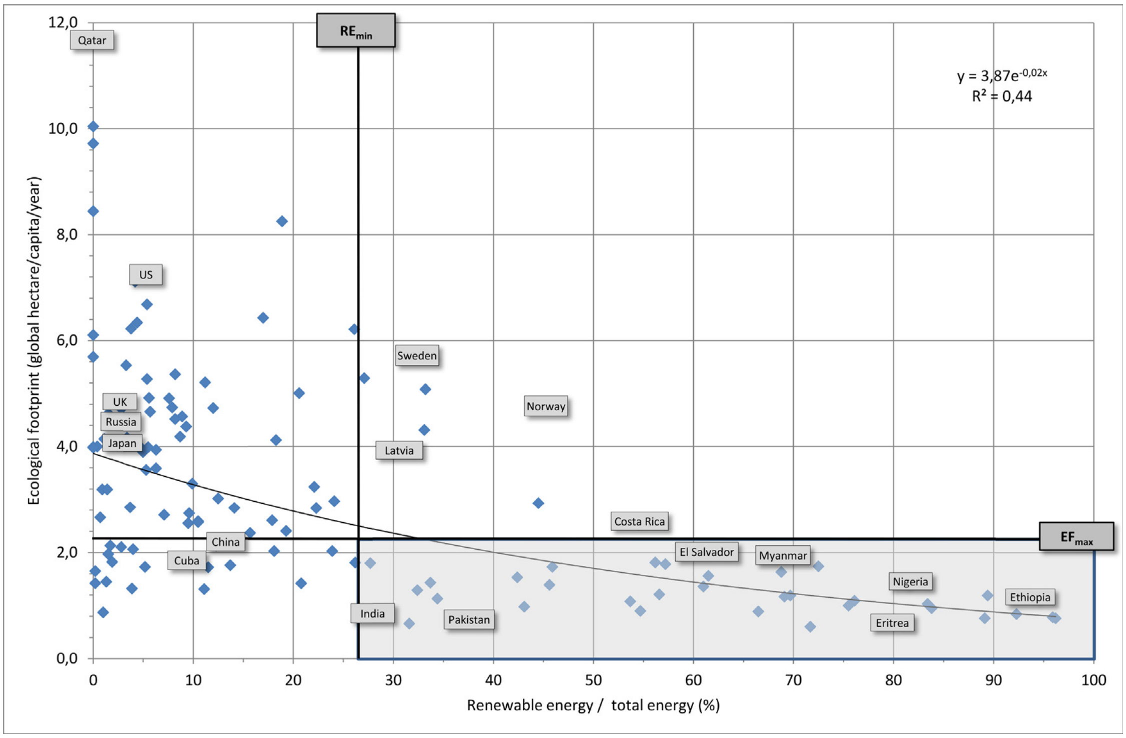

Fig. 3. The sustainable development space (SDS) for dimensions 1 (ecological footprint) and 4 (renewable energy/total energy). The SDS is in the lower right quadrant (shaded). The country data are for 2008/2009 ($N = 128$).
Source: UNDP (2011).

renewable energy in total primary energy production falls sharply. Thus, rich countries tend to have a low proportion of renewable energy, which is quite plausible because most developed countries have built their wealth on easy access to fossil energy sources such as coal, oil, and gas. There are a few notable exceptions though, where countries (e.g., Iceland and Norway) have managed to combine very high levels of human development and a high proportion of renewable energy use. In these cases, the higher

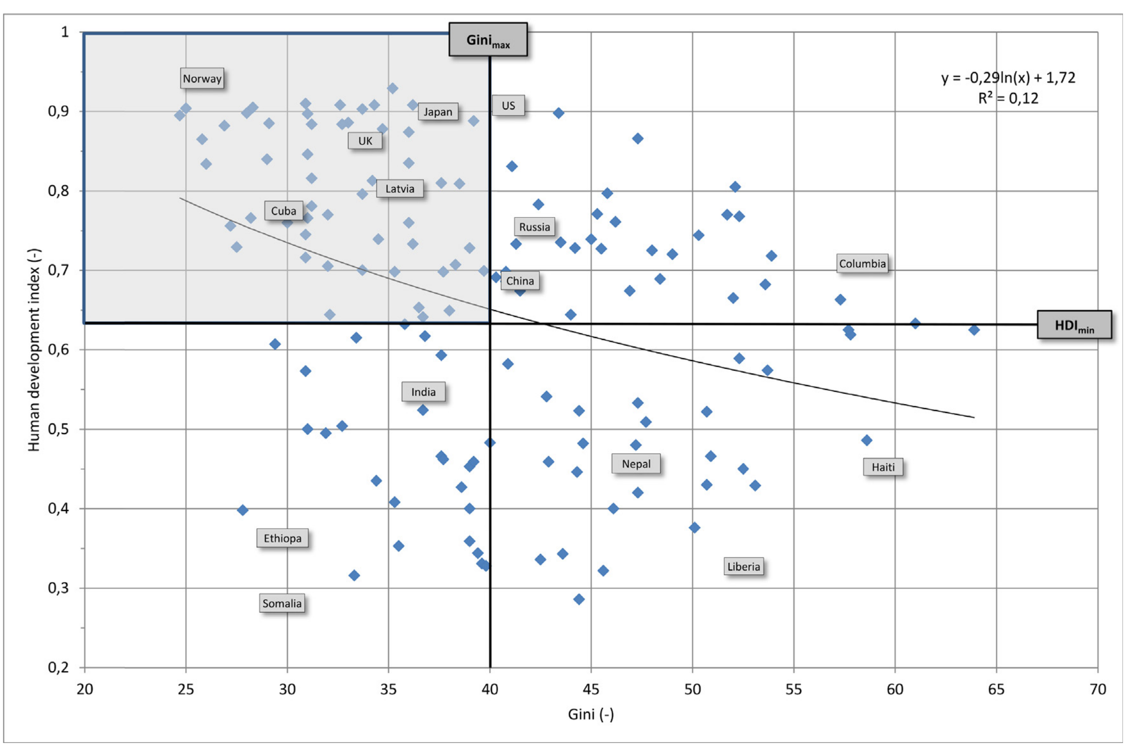

Fig. 4. The sustainable development space (SDS) for dimensions 2 (human development index) and 3 (Gini coefficient). The SDS is in upper left quadrant (shaded). Country data are for 2008/2009 ($N = 155$).

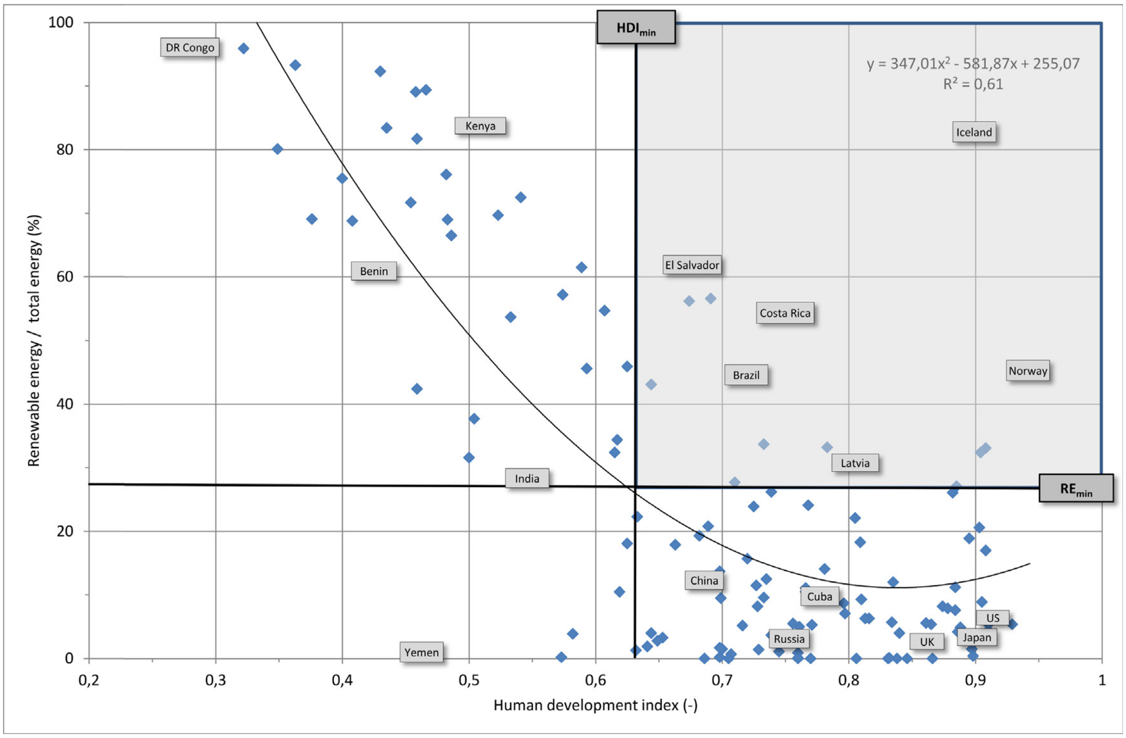

Fig. 5. The sustainable development space (SDS) for dimensions 2 (human development index) and 4 (renewable energy/total energy). The SDS is in the upper right quadrant (shaded). Country data are for 2008/2009 ($N = 132$).
Source: UNDP (2011).

renewable energies can be explained by these countries' abundant access to domestic renewable energy sources. Apart from these few exceptions, no country has yet managed to create a high human development index without having access to significant fossil energy sources.

4.6. Intragenerational equity and intergenerational equity

Currently, 20 countries are in the sustainable development space on dimensions 3 (the Gini coefficient) and 4 (renewable energy) (Fig. 6). The regression line in Fig. 6 shows a positive

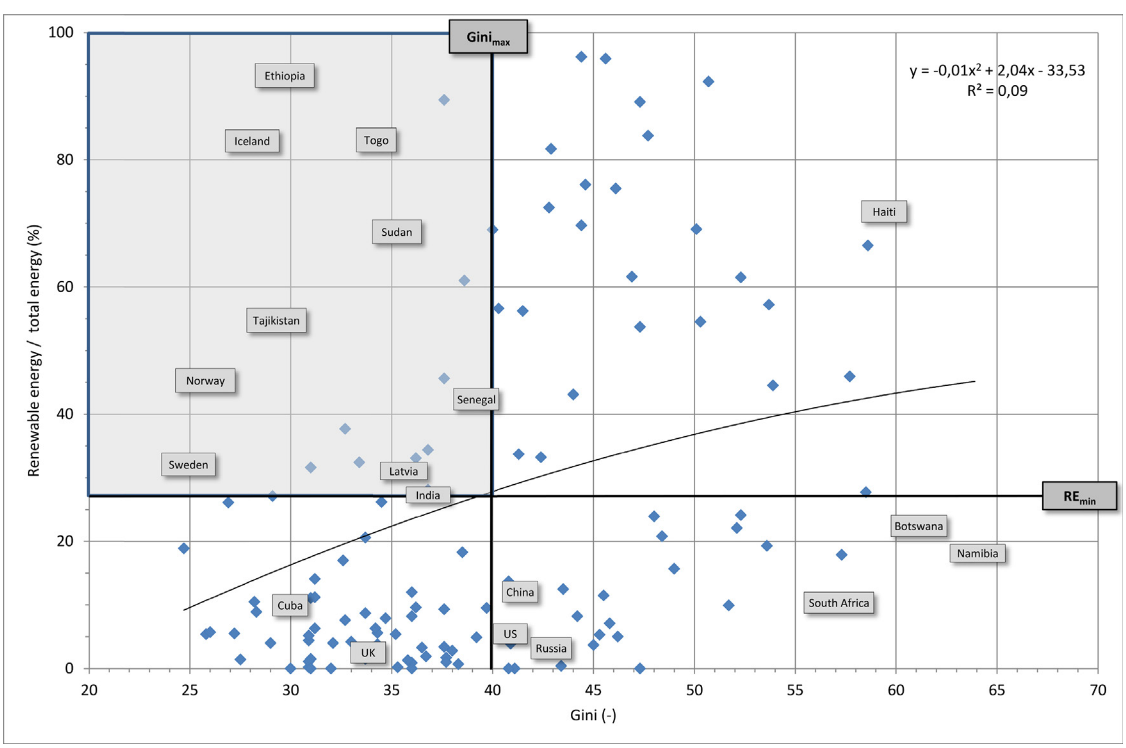

Fig. 6. The sustainable development space (SDS) for dimensions 3 (Gini coefficient) and 4 (renewable energy/total energy). The SDS is in the upper left quadrant (shaded). Country data are for 2008/2009 ($N = 130$).

correlation between the Gini coefficient and the proportion of renewable energy in total primary energy production. Countries with higher levels of social and economic inequality have a higher proportion of renewable energy in total primary production. However, the correlation is weak and there may be no clear relationship between the two.

5. Discussion of results

No country meets the thresholds for all four dimensions; that is, no country has currently achieved sustainable development, and some countries are far off the target. Thus, the thought of actually achieving sustainable development may seem overwhelming. It is therefore reasonable to ask, are the changes necessary to achieve sustainable development socially desirable, and if so, are they within reach? Assuming that the answer to the first part of the question is yes, we now examine each threshold value to evaluate its reasonability in the context of current conditions and predicted changes in the future.

First, consider the maximum threshold value for daily per capita ecological footprint of 2.3 global hectares. No high-income country currently meets this threshold, and the average is 5.6 global hectares. A number of countries classified by the UNDP as having "very high human development" have per capita ecological footprints close to 4.0 global hectares (e.g., Japan, Hong Kong, Israel, Latvia, and New Zealand (WWF, 2012)). These countries must reduce their per capita ecological footprint by about 40%, which is a manageable task using current knowledge and technologies (IEA, 2012). Thus, achieving very high human development (which is what most countries are aiming for) and achieving a sustainable per capita ecological footprint are both possible, although some countries may find it harder to achieve them simultaneously than others.

Second, consider the minimum threshold value of 0.630 for human development index. In 1980, the world average human development index was 0.558; today it is 0.682, which is well above the threshold and represents an annual growth rate of 0.6%. The least developed countries have experienced an even higher annual growth rate in human development index (1.37%) over the same period. Nevertheless, less developed countries have an average human development index of 0.493, which is well below the threshold value (UNDP, 2011). If the pace of human development index growth continues, the average human development index for the world's least developed countries will be above the threshold value within 20 years. Thus, meeting this minimum threshold value by 2030 seems within reach.

Third, consider the maximum threshold value of 40 for the Gini coefficient. Sadly, over the last two decades income inequality has increased in most countries and regions – with some notable exceptions in Latin America and sub-Saharan Africa (UNDP, 2011). More specifically, detailed studies show a striking increase in the wealthiest group's share of income in much of Europe, North America, Australia, and New Zealand. From 1990 to 2005, within-country income inequality increased 23.3% in countries having very high human development indexs (UNDP, 2011). The gap between the rich and the poor widened over the last two decades in more than three-quarters of OECD countries and in many emerging-market economies. Wealth has become concentrated in fewer hands in China, India, and South Africa. In China, for example, the Gini coefficient rose from 31 in 1981 to 42 in 2005 (UNDP, 2011). Thus, reducing wealth inequality seems to be a serious challenge to achieving sustainable development.

Finally, consider the minimum renewable energy share of 27%. According to IPCC (2011), deployment of renewable energy technologies has increased rapidly in recent years; on a global basis, renewable energy currently accounts for 12.9% of the total primary energy production. A significant increase in the development of renewable energy by 2030, 2050, and beyond is indicated in most of the 164 energy scenarios reviewed in the IPCC report (ibid). More than half the scenarios show a 17% contribution from renewable energy to primary energy supply in 2030, rising to more than 27% in 2050. The scenarios with the highest renewable energy shares reach approximately 43% in 2030 and 77% in 2050. Renewable energy's share of total production can be expected to expand even under baseline scenarios.

More importantly, however, the IPCC report (ibid) argues that the global technical potential of renewable energy sources will not limit continued growth in the use of renewable energy. 'Technical potential' is defined in the report as the proportion of renewable energy output obtainable by full implementation of demonstrated technologies or practices. Moreover, it also states that there are few, if any, fundamental technological limits to integrating a portfolio of renewable energy technologies to meet a majority share of total energy demand in locations where suitable renewable energy resources exist or can be supplied. Even in regions with relatively low levels of technical potential for any individual renewable energy source, there are typically significant opportunities for increased use of renewable energy. We therefore consider achieving a 27% renewable energy share by 2030 to be a realistic and achievable threshold.

Under most conditions, however, increasing the share of renewable energy in the energy mix will require policies that stimulate changes in the energy system. Thus, the actual rate of integration and the resulting shares of renewable energy will be influenced by factors such as costs, environmental issues and their social aspects, public acceptance, and infrastructure constraints.

6. Policy implications

As can be seen in the previous section, the proposed approach to the measurement of sustainable development along these four independent dimensions presents a set of interesting comparisons that can be used by national and international policy makers in their decisions about sustainable development futures. The value of the approach is in its simplicity and the transparency of the four dimensions that are seen as being non-tradable and equally important – so the four dimensions cannot be reduced to one composite dimension. The approach is built upon the development of the indicators and the key thresholds that need to be reached. The limitations of such an approach are recognized, but the need for such a pragmatic and operational approach has been justified.

This paper raises two important questions for decision makers. Firstly, each of the four threshold values must be met. But, simultaneously meeting all thresholds raises a complex issue about how can we meet one particular threshold value (e.g., reducing ecological footprint) without simultaneously reducing the possibility of meeting another threshold value (e.g., increasing human development index). The key to solving this problem is to decouple the present unwanted correlations between the dimensions, and this is one of the challenges presented to decision makers. Secondly, we must achieve sustainable development without compromising other important principles, for example, democratic and libertarian principles, as sustainable development is one of many key policy objectives facing society.

Underlying these questions is the fundamental issue being addressed here, namely the need to move away from the primary concern of governments over the premise that economic growth will lead to sustainable development. In this paper, it has been argued that economic growth is one means by which sustainable development can be achieved, but that it is not one of the primary dimensions. Secondly, the four dimensions and the measurement issues have been separated from some of the important implementation issues that must address participation and acceptance of change. These are both central to sustainable development, but they form the next stages in the process. The graphs produced here are helpful in determining where each country is "located" on each of the pairs of dimensions, and this demonstrates their position globally and where "best" practice resides, so that there is a learning process that can be initiated. As more data becomes available, more countries can be included in the graphic presentations, and it also means that subsequent research can look in more detail over the positional changes of the individual countries to review their progress towards sustainable development.

The graphs also demonstrate the mutual dependence of countries and that we are all part of the global picture on sustainable development as promoted by the Brundtland Report. Positive interventions to promote higher levels of sustainable development as measured by the four dimensions depends on national governments, as this is the level at which the potential for effective intervention is strongest. But it should also be realized that a global framework is also desirable, as sustainable development is dependent on all countries contributing to the overall "health and wellbeing" of the planet. These are massive challenges, and they were acknowledged in the Brundtland Report 25 years ago, which modestly stated that "Sustainable development proves to be one of the more difficult concerns with which we have to struggle" (WCED, 1987, p. xiii).

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