SRU German Advisory Council on the Environment

Environmental Report 2012
Responsibility in a finite world

Chapter 1:

The New Growth Debate

June 2012

Forword

This is a chapter of the Environment Report 2012 on “Responsibility in a finite world” published by the German Advisory Council on the Environment in June 2012. Guiding principle of that report is that environmental limits should be taken seriously. Unlimited physical growth is not possible in a finite world. This means that the dramatic reduction of our resource and energy use and their environmental impacts are becoming a key question of the 21st century. The report has eleven focal themes[1], ranging from the new growth debate, the protection of important ecosystems such as peatlands, forests and oceans to a strengthening of integrated environmental protection.

With its Environmental Report 2012, the SRU extends the perspective beyond the energy transition towards other important future-oriented issues in German and European environmental policy. Using a “horizon scanning” approach, the seven council members of the SRU identify important unresolved problems and point towards specific options for political action. The starting point of the report is that serious impacts for economy and society have to be feared if safe planetary boundaries and environmental limits are being exceeded. Exploiting all potential for decoupling economic growth and environmental impact is therefore a matter of priority. Such an innovation strategy would offer at the same time considerable economic opportunities for German industry.

Analysing a number of intractable problems, the SRU highlights the potential for a reduction of environmental impacts, for example:

– The use of metallic and mineral raw materials can be reduced, for example through systematic introduction of closed-loop processes. The SRU proposes in this context mandatory deposit schemes for selected electronic devices. Raw material extraction – which tends to be very energy intensive – could become more climate-friendly if ambitious reduction targets are set for the European emissions trading system (the EU 30 % target for 2020) and if exemptions are cut back.

– Even the still growing goods transport could meet ambitious climate policy targets through a comprehensive electrification on the basis of renewable electricity. In addition to a shift from road to rail, the option of an overhead-cable system for electric-powered HGVs (“trolley trucks”) should be seriously pursued. The technology has already been tested in demonstration projects.

– In the area of food, policy should also provide effective incentives for decoupling. Bringing down food losses by 50 % until 2025 could decrease the environmental impact of our food consumption. Moreover, the high meat consumption which has equally negative impacts on the environment and on health, should be significantly reduced. Abolishing the reduced rate of value-added tax on animal products and introducing a tax on saturated fatty acids are therefore options to be investigated.

Despite this large untapped potential, a sufficient degree of decoupling may not be achievable. As part of a precautionary strategy, policy and society should therefore also reflect on conditions of social and political stability under conditions of low economic growth.

Ecosystems such as forests, oceans and peatlands do not only supply important resources, energy and food, but they also make important contributions to climate protection and provide other ecosystem services, including habitats for many species. These services, which are not rewarded by the market, are under threat unless economic pressures are reduced. German forests, for example, may soon reach a point where they release more greenhouse gases than they store. For this reason the SRU recommends introducing limits on forest biomass use to secure the long-term status of forests as carbon sinks. In addition, a comprehensive and integrated monitoring should be established as an early warning and evaluation system.

Environmental limits can only be observed if the remit and authority of environmental policy vis-a-vis other policy areas are considerably strengthened. As a basis for this, the SRU recommends the establishment of an encompassing national environment programme with ambitious targets which would give a new impetus to other policy areas.

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[1] The Environmental Report covers eleven topics: the new growth debate, decoupling prosperity from resource use: metallic and mineral resources, food consumption as a policy issue, freight transport and climate protection, mobility and quality of life in urban agglomerations; appreciating the value of ecosystem services: environmentally sound use of forests; peatlands as carbon sinks, cross-sectoral marine protection; reinforcing integrative approaches: Integrated environmental protection: the example of industrial permitting, integrated monitoring, environmental and sustainability strategies.

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1 The New Growth Debate

1.1 Introduction

40. In Germany and internationally, the issue of reconciling economic growth with sustainable development has found its way back onto the policy agenda and into public debate. Thoughtful, growth-critical voices can be heard from many camps (Binswanger 2010; Enderlein 2010; Fitoussi and Laurent 2008; Hinterberger et al. 2009; Jackson 2009a; Miegel 2010; Paech 2009a; Schor 2010; Seidl and Zahrnt 2010b). The interest shown in the political arena can be seen, for example, in the appointment of a German Bundestag study commission to address the issues of growth, prosperity and quality of life.

The debate on growth in a limited world is nothing new. As early as the 1970s, the Limits to Growth report submitted to the Club of Rome triggered scientific, academic and public controversy (Meadows et al. 1972). Now the debate is re-emerging, albeit with a shift in focus. While in the 1970s, the debate on the limits to growth focused on the availability of non-renewable resources, today the spotlight is on over-use and destruction of vital ecosystems in the light of identifiable biophysical limits.

In this chapter, the German Advisory Council on the Environment (SRU) looks at this new debate on growth. The SRU believes that the concept of environmental limits must be made a focus of environmental, economic and social policy debate. Transgression of environmental limits has serious economic, social and (security) policy consequences. While accepting that both the existence of environmental limits and the need to prevent their transgression has far-reaching implications for economic activity and policymaking, it should not necessarily be seen as the end of economic growth. Rather, the task at hand is to identify the extent to which an absolute decoupling of the use of natural resources from economic growth might suffice. The 'green economy' idea as discussed in the lead-up to the Rio +20 conference (see Chapter 11) is highly optimistic in this regard. In this chapter, the SRU supports the assumption that although there is significant potential for such a decoupling, whether it would be enough cannot be verified with certainty. This precautionary aspect means that the scientific community and policymakers should think about the conditions for welfare independent of economic growth.

1.2 A sustainable economy within environmental limits

1.2.1 The environment-dependent economy and strong sustainability

41. Recent publications (IPCC 2007; EEA 2010a; Reid et al. 2005) refocus awareness on the frequently overlooked insight that the natural environment, and particularly the climate and biodiversity, are vital to human survival. Stable social and economic systems would be unthinkable without functioning ecosystems and the conservation of natural capital. In thermodynamic terms, the global environmental system is characterised by structural complexity and low entropy, meaning a high degree of order. By contrast, the economic system converts natural structures with low entropy into something else (by burning coal and oil, for example), thus increasing the entropy level (Daly 1996; Georgescu-Roegen 1971; Cleveland and Ruth 1997). Without the all-encompassing environmental system, which by virtue of its inherent productivity constantly renews negentropic structures (for example by photosynthesis and genetic proliferation), economic activity would be inconceivable in the longer term (SRU 2002, Item 20 ff). The economy, in its resource-related dimensions, relies on 'factors' it cannot itself produce but can only consume. The economic system must therefore keep within the limits of nature's reproductive capacity. Sustainability means operating within the given environmental limits.

The first and second laws of thermodynamics

– The first law of thermodynamics states that energy can be neither produced nor destroyed. Energy can merely be converted from one form to another in thermodynamic processes like combustion. In a closed system, the sum of all energy forms remains constant each time energy is converted. Similarly, material in a closed system can be neither produced nor destroyed. The law of mass conservation thus applies.

– The second law of thermodynamics is to be seen as a fundamental restriction of the first. All natural processes, and not just thermodynamic processes, are irreversible. This means that unaided they can only go in one direction. During such processes, energy degrades and they can only be turned round by adding effort 'from outside', which always leaves behind changes in the surrounding environment.

For the purpose of quantifying the degree of irreversibility and expressing it in mathematical terms, entropy, 'S', is made the determining variable. Entropy is the measure of disorder in a system. The following rules apply:

– The greater the entropy in a system, the greater its disorder.

– Entropy is always greater than zero.

– The entropy of a fully isolated (adiabatic) closed system can never decrease.

– For irreversible processes, this implies that whenever there is any change, the entropy of a fully isolated (adiabatic) closed system increases.

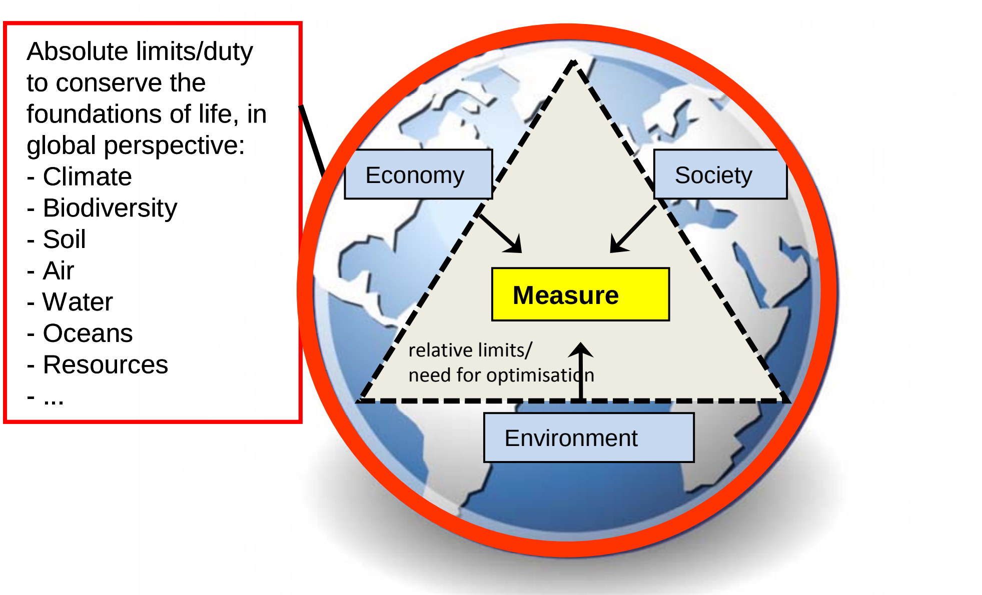
– A reversal of natural processes, which equates to a reduction in entropy, is always associated with a certain input of energy 'from outside'.

The conventional sustainability model, which gives essentially equal weight to economic, environmental and social objectives, does not adequately take account of the superordinate character of the environment. In neoclassical economics in particular, there is a widely held notion that future generations must merely be left a constant overall stock of capital resources (SRU 2002). This implies that it is acceptable to use natural capital and to transform it into material capital or knowledge as long as the overall stock of useful capital is undiminished. This notion of the substitutability of natural capital with other forms of capital is at the heart of the concept of *weak* sustainability.

In contrast, the SRU adheres to the concept of *strong* sustainability, and sees only limited possibilities for substituting natural capital with other forms of capital. The maintenance of environmental carrying capacity requires trade-offs between various sustainability goals within a given environmental framework (Figure 1-1).

Figure 1-1

Sustainability model with human activity embedded in a limited environment



Source: SRU 2011b

42. It is a matter of controversy, however, to what extent these limits leave discretionary scope when it comes to making the trade-off between the various dimensions of sustainability (SRU 2002, Section 1.3). While a degree of substitutability of natural capital with knowledge and material capital may be plausible in respect of abiotic resources, no such substitutability can be assumed when it comes to biogenic resources, ecosystems and ecosystem services (SRU 2002, Item 28). Under the precautionary principle, this implies that natural capital must be kept as constant as possible (Ott 2009).

In a 'full world' (Daly 2005), meaning a world in which people and man-made things have displaced nature to a significant extent, limits must therefore be set for the physical energy and material throughput that is necessarily associated with the use of natural resources and natural sinks for waste flows. As Daly (1992) has shown, given the shrinking spare capacity of the natural environment, it is no longer a matter of the traditional tasks of efficient allocation and fair distribution of natural resources. Rather, the primary issue is managing the scale of resource use and pollution. An overloaded ship can be saved from sinking not by shifting its cargo, but most readily by reducing the cargo to an acceptable size (ibid.). This means that rather than focusing on efficient use and distribution of natural resources, limits must be placed on the use of the environment in absolute terms.

43. Use of global resources also raises the issue of intra-generational and in particular global equity in distribution. The SRU expressly endorses the principle of fair and equal per capita rights to natural resources, as set out in Germany's National Strategy for Sustainable Development: 'Ethically, every human being has the same right to make use of resources, as long as these resources are not overexploited.' (Bundesregierung 2008, p. 20). The objective must therefore be to reduce the use of environmental resources in Germany to a level that could be generalised to a global scale.

The SRU believes that Germany should meet its global responsibility in this way even if other countries fail to follow suit. Firstly, pioneers are needed both to convince other industrialised nations and emerging economies that sustainable strategies are feasible and to gain the trust of developing countries. Secondly, such pioneers can themselves benefit by becoming technology leaders and being better equipped than other countries to meet new requirements and market conditions (SRU 2002; 2008).

At the same time, relevant targets and measures (Chapter 11) must be adopted at European and international level to enable the fastest possible and greatest possible improvement to the environmental situation.

1.2.2 Ecosystem services

44. An illustration and concrete expression of the role of natural capital is supplied by the concept of ecosystem services. Introduced by Ehrlich and Ehrlich (1981), the ecosystem services concept builds on attempts in earlier publications to bring out the social utility of the environment and its functions (Gómez-Baggethuna et al. 2010). That earlier body of work showed that biodiversity loss directly affects ecosystem processes in a way that can be fundamental to human wellbeing. An early attempt to monetarise the environment and its functions was made by Costanza et al. (1997). The topic found its way onto the political agenda with the Millennium Ecosystem Assessment (MA) (Reid et al. 2005). The MA was commissioned by the United Nations to provide an overview of the global status of key ecosystem services.

Ecosystem services are defined as the benefits people obtain from ecosystems (MA 2003, p. 3, Box 1 Key Definitions), or more simply as ecological processes that are important to human wellbeing and therefore of value (Eser et al. 2011). The definition of ecosystem services used both in the MA and the Economics of Ecosystems and Biodiversity Study (known as the TEEB Study, TEEB 2010, p. 33) also includes resources like timber and food, and thus covers material, energy and non-material aspects. The TEEB Study distinguishes between direct contributions (e.g. consumption of food and enjoyment of beautiful scenery) and indirect contributions (e.g. purification of drinking water by soil filtration).

45. The aim in all of these typologies is to make human dependence on the environment more transparent and to show the value of ecosystem services to human life and the economy. Supporting services, such as the nutrient cycle and soil formation, and many regulating services like pollination and the control of pests and soil erosion have long been taken for granted by a society that has used them free of charge and failed to adequately protect them (Table 1-1).

46. Problems arise, however, when individual ecosystem services are viewed in isolation, independent of their role in an environmental context. In some cases this has resulted in courses of action being taken on the grounds that they promote or provide certain ecosystem services although they simultaneously lead to biodiversity loss. Unthinking use of the ecosystem services concept can thus stand in the way of nature conservation and environmental protection. Only when protection of ecosystem services is made an integral part of nature conservation and environmental protection can both sub-goals be achieved. For this reason, in connection with the Convention on Biological Diversity (CBD), reference is always made to the conservation of biodiversity *and* ecosystem services (e.g. in the Strategic Plan 2001-2020, SCBD 2010a). The new EU Biodiversity Strategy for 2020 also uses the two terms in combination (European Commission 2011c).

Table 1-1

Ecosystem Service Categories

Supporting services	E.g. primary production by means of photosynthesis, soil formation and nutrient cycles
Provisioning services	E.g. provision of food, water, wood and fuels, and also pharmaceutical products
Regulating services	E.g. purification of the air and water, climate regulation, protection from natural disaster and disease
Cultural services	E.g. inspiration, education, aesthetic values, recreation and relaxation

Source: Beck et al. 2006, with changes

47. Consideration must also be given to the fact that economic analysis of ecosystem services reaches its limits where ecosystems become highly complex, where there are uncertainties regarding interactions, and where tipping points beyond which systems are unstable become hard to predict. In these cases, monetary analysis becomes particularly unreliable for scientific purposes. Economic analysis methodologies are also far more difficult to apply to some environmental goods than to others. Additionally, the outcomes of economic analysis always depend on necessarily subjective methodological choices made by study authors. Such choices vary, however, depending on the type of the good being evaluated, the methodologies used and the analysis timeframe (Brondizio and Gatzweiler 2010). In practice, economic analysis of ecosystems harbours the risk of narrowing or distorting perceptions of various environmental aspects.

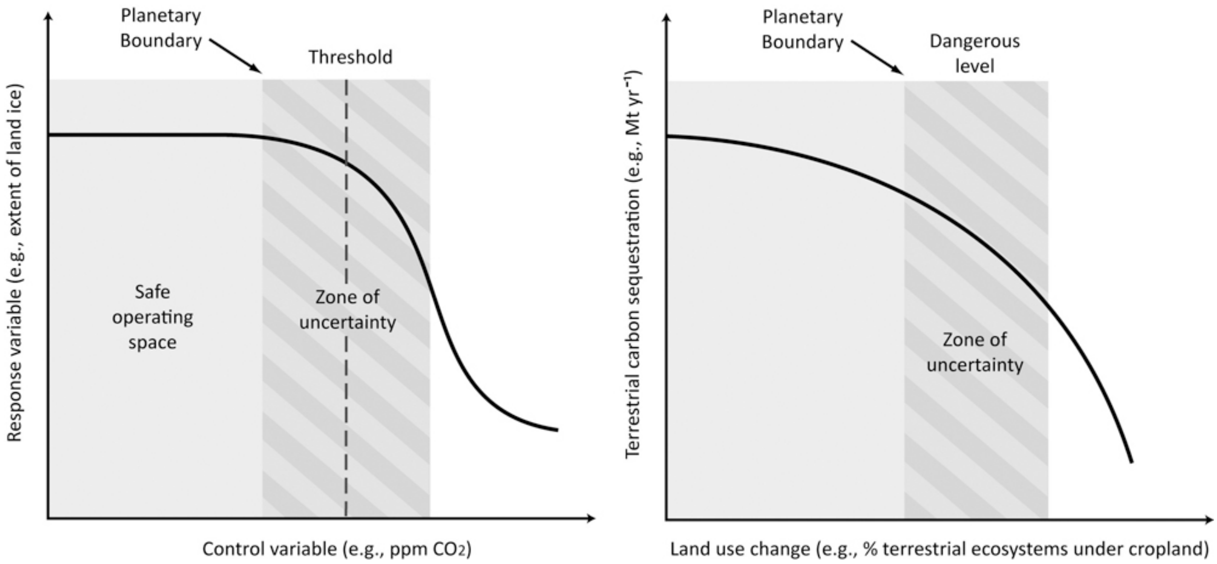
1.2.3 Environmental limits

48. The concept of environmental limits relates first and foremost to the undisputable biophysical limitations of the Earth in terms of the availability of natural resources and the absorption capacity of sinks. It cannot, however, be seen as a purely natural science concept. The natural sciences can supply instrumental knowledge through the description of factual relationships. They can, for example, identify causal relationships and causal chains, and under certain circumstances predict the probability of specific trends and events. Environmental limits, in contrast, describe thresholds beyond which undesirable events can be expected. What is deemed ‘undesirable’ cannot be determined purely on the basis of natural science. Given the scientific uncertainties, conclusions on environmental limits are always judgements concerning the degree of precaution that appears acceptable to society (Rockström et al. 2011, SRU 2011c). With this in mind, the concept of guard rails is also used, as ‘quantitatively defined damage thresholds that if exceeded can result in intolerable consequences either today or in the future' (WBGU 2005, p. 28, 1997). In a democratic society, the setting of environmental limits or guard rails calls for broad societal and political acceptance based on long-term, informed self-interest (see Section 1.6.1 and Chapter 11).

49. The idea of environmental limits is operationalised, for example, by the concept of 'planetary boundaries' and that of the 'safe operating space' for human activities (Rockström et al. 2009). A distinction is made here between processes with critical global thresholds (such as global emissions of greenhouse gases) and processes like land use change in which, according to available knowledge, no such global thresholds exist. With this second category of processes, a constant or gradual decline can lead to the failure of key functions (such as the ability to absorb carbon dioxide) which impact global processes or when aggregated can become a global problem (Figure 1-2). Transgression of planetary boundaries can trigger 'non-linear, abrupt environmental change within continental-to-planetary-scale systems' (Rockström et al. 2009, p. 1).

Figure 1-2

Planetary Boundaries, Thresholds and Uncertainty



Source: Rockström et al. 2009

With gradual trends, the critical threshold lies where the 'resilience' of natural systems – their ability to recover from disturbances and shocks and to maintain their ability to function – becomes impaired (Walker and Salt 2006). Given the complexity of the systems and processes involved, environmental limits cannot be thought of as a thin line but as 'corridors of elasticity' (Sachs and Santarius 2005).

Earth systems studies at regional and local level have long included analysis of capacity limits or 'critical loads', notably as regards acidifying and eutrophying air pollutants (see Chapter 10). Limits can also be identified based on natural reproduction of renewable resources.

Environmental limits and strong sustainability

50. It is important to note that conserving natural capital – a core element of the strong sustainability model (see Item 41) – is a fundamentally different protection concept than respecting environmental limits. Conservation of natural capital is fundamentally the more rigorous yardstick, because it seeks to prevent any form of reduction and is not solely focused on preventing disaster. Nonetheless, the concept of environmental limits is a meaningful addition to the strong sustainability model because it is more explicit in incorporating critical load thresholds for key global ecosystems. It must, however, be seen as complementary in that it is used to formulate minimum requirements for environmental protection without calling into question the more demanding standards of strong sustainability.

1.2.4 Transgression of environmental limits: Crisis trends and indicators

Examples of global environmental limits being exceeded

51. Humankind uses ever-growing quantities of the available environmental resources and in doing so causes irreversible damage to natural systems. Human activity has such a severe impact on the Earth system that some scientists refer to the current geological age as the 'Anthropocene' (Steffen et al. 2007; Crutzen 2002). At global level, environmental limits are exceeded in the following areas:

– With advancing climate change, sea levels are rising, glaciers are melting, extreme weather events are becoming more frequent and it is becoming increasingly likely that irreversible tipping points will be attained (IPCC 2007).

– Despite international negotiations and efforts, it has not been possible to slow biodiversity loss in the way the international community aimed to achieve between 2002 and 2010. Species loss continues unabated at several times the natural loss rate. The Living Plant Index, a measure of trends in global biodiversity, shows that populations of selected indicator species have declined by as much as 30 percent since 1970 (WWF et al. 2010).

– Around 60 percent of assessed ecosystem services are already degraded or at risk from non-sustainable use (Reid et al. 2005). Forest cover is shrinking around the world, with tropical rainforests suffering ongoing, dramatic decline. Tropical coral reefs are collapsing (UNEP 2007a, p. 888, SCBD 2010b). Overfishing of the oceans remains one of the biggest unresolved problems; around 80 percent of fish stocks in the world's oceans are already fished to the limits of their capacity or beyond (FAO 2009). In the face of climate change, non-sustainable land and water use results in desertification and loss of soil fertility due to erosion, salination and nutrient loss.

– Global per capita available water supply is on the decline, notably due to overexploitation of ground and surface water resources. In future, more and more people will suffer from water shortage (UNEP 2007b, p. 11). Water pollution remains one of the biggest causes of death and disease around the world.

– Humankind already appropriates about one quarter of the Earth's potential net primary production – largely by harvesting biomass for the production of food, construction materials and energy, but also by using land for housing and infrastructure (Haberl et al. 2007). Habitats and food supply for other species are thus significantly restricted by human activity. With the growing global population and changing nutritional habits, the demand for agricultural products could rise by 70 percent by 2050. Land use and land use change would thus increase even further.

52. All in all, these differing and in many cases mutually reinforcing transgressions of environmental limits put the livelihoods of hundreds of millions of people at risk. They have many impacts on environmental and social systems in that they cause food crises, exacerbate water shortages and heighten social the conflicts surrounding natural resources. Transgression of environmental limits can destroy habitats for people and animals and thus trigger migration and flight. As a result, they play a key role not just in environmental policy, but also in economic policy and security. Acute impacts are already visible, largely among the poorest sections of the population in developing countries, where livelihoods depend on the availability of local natural resources (Niekisch 2006). The degradation of ecosystems is therefore also an obstacle in achieving the Millennium Development Goals (UNDP 2011). Industrialised countries, by contrast, have so far felt hardly any direct impact. Losses of ecosystem services in Germany, for example, are less severe in many areas than at global level, partly due to environmental protection and nature conservation legislation and related measures. At the same time, German goods imports and greenhouse gas (GHG) emissions contribute to the damage caused to ecosystems in other countries (Beck et al. 2006).

Indicators of environmental limits being exceeded

53. Various global indicator systems show that environmental limits can already be assumed to have been exceeded. Although all indicators, and especially complex indicator systems, have unavoidable methodological weaknesses, this conclusion is robust.

54. *Environmental footprint* calculations show that humankind has come to use more natural resources than the Earth can provide on a sustained basis. The environmental footprint measures the biologically productive land and water area required to provide the renewable resources used by humankind and to absorb the carbon dioxide (CO_2) generated by human activity. Biocapacity relates to the area actually available for production of resources and sequestration of pollutants. Pressures have constantly increased in line with economic and population growth since the beginning of the 1960s, with the Earth's carrying capacity exceeded in the early 1970s. Today, humankind's environmental footprint exceeds the Earth's biocapacity by 50 percent (WWF et al. 2010).

Another land-based indicator uses lifecycle analysis to measure the area of land needed along the entire production chain. For this purpose, Bringezu and Bleischwitz (2009, p. 39 ff.) propose the Global Land Use Accounting for Agricultural Cropland ($GLUA_{cropland}$) indicator. This takes in global land use for agricultural production for food and non-food use (including animal farming) and also includes land use in the production of imported products. If the farmland expected to be globally available by 2050 is to be equally divided among 9 billion people, this means a target of 0.2 ha per person (Bringezu 2009). Given its very high agricultural productivity in global comparison, the target for Germany should be significantly lower (see Chapter 3). However, according to the analysis by Bringezu and Schütz (2009, p. 131), Germany's actual per capita $GLUA_{cropland}$ in 2004 was 0.25 ha, some 25 percent above the target. With approximately 61 percent, animal-based food made up the biggest share of this land use (see Chapter 3). If use of biomass rises significantly as expected – notably for energy – $GLUA_{cropland}$ in 2030, at 0.28 to 0.3 ha, could significantly exceed the amount of land then globally available (BAU scenarios in Bringezu and Schütz 2009, p. 132).

55. Using a different methodology, Rockström et al. (2009) propose planetary boundaries for ten different natural systems and processes (Table 1-2). The planetary boundaries define the safe operating space for human activity, which in each case is far enough removed from potential tipping points or harmful impact levels. Systems should remain within these boundaries in order to avoid abrupt, irreversible and catastrophic environmental change. Wherever possible, limit setting draws upon available scientific research, but given the available data, it cannot be done with the same degree of precision in every case. With regard to biodiversity loss, for example, the relationship between ecosystem stability and ecosystem resilience has yet to be adequately researched. Rockström et al. (2009) set a loss rate of ten species per million species per year as a preliminary limit. This is between ten and one hundred times the natural loss rate. For CO_2 levels in the atmosphere, the safe threshold is set at 350 ppm. This estimate is supported, among other things, by models used by US research teams (Hansen et al. 2008) taking account of slow feedback processes – for example through changes in the radiation capacity of the Earth's surface. Also, at 350 ppm, the stability of the polar ice caps would be ensured.

In the case of climate change, loss of biodiversity and impacts on the global nitrogen cycle, the authors believe the planetary boundaries have already been exceeded. Other pressures (the phosphorous cycle, acidification of the oceans, land use and fresh water use) are close to their boundaries (Table 1-2).

56. Added to this are the systemic interrelationships between the various environmental problems. These problems can no longer be seen as unrelated, easy-to-identify issues. Rather, they must be seen as a complex set of circumstances shaped by feedback mechanisms and non-linear interrelationships (EEA 2010b, p. 113 ff., PBL 2009, OECD 2008). For example, the increased demand for biofuels, originally environment-driven, can lead to deforestation in developing countries and to the planting of biomass crops in monocultures. This results in the release of greenhouse gases, destroys habitats, impairs soil fertility, fosters erosion, and puts the livelihoods of indigenous populations at risk, thus triggering considerable social conflict. Loss of biodiversity is one example of a highly complex environmental problem whose causes are rooted in numerous economic activities and their interrelationships. These include the use of renewable resources in farming and fishing, destruction and impairment of ecosystems and habitats through extraction of non-renewable resources, and fragmentation of ecosystems due to infrastructure development, industrialisation and human settlement.

Table 1-2

Planetary Boundaries

Earth System Processes	Parameters	Proposed Boundary	Current Status	Pre-Industrial Values
Climate change	1. Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	2. Changes in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (extinctions per million species per year)	10	> 100	0.1 – 1
Nitrogen cycle (part of a boundary with the phosporous cycle)	Amount of N_2 removed from atmosphere for human use (millions of tons per year)	35	121	0
Phosphorous cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions of tons per year)	11	8.5 – 9.5	−1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis	To be determined		
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disruptors, heavy metals, and nuclear waste in the global environment, or the effects on ecosystem and functioning of Earth system thereof	To be determined		
Grey shading: Planetary boundaries have been crossed.				

Source: Rockström et al. 2009

1.3 The growth and sustainability debate: From green growth to degrowth

57. One particularly contentious issue in the current growth debate is whether systematic respect of environmental limits can be reconciled with economic growth on a sustained basis. This is largely a conceptual issue. The current debate on the limits to growth has two poles: optimistic models of green growth, and growth-critical models of a 'post-growth' society. The following section sets out the salient points of the debate along with the key arguments and points of contention.

Green growth

58. The green growth model is based for the most part on the concept of ecological modernisation (Jänicke 2008; Mol and Sonnenfeld 2000; see Chapter 11 on the concept of the green economy). It marks a shift away from the short-term, static paradigm of environmental protection as a cost factor and an obstacle to international competitiveness. The green growth model assumes that economic growth can be decoupled from environmental damage and that, at the same time, environmental protection can bring economic opportunities. This is based on the notion that targeted investment in environmentally efficient, resource-saving technologies will open up development paths that serve to prevent environmental damage, spare non-renewable resources and foster economic growth (OECD 2011b). Technological advancement would increase energy and material efficiency to the extent that it boosts value creation and reduces environmental pressures. It has been shown that an increase in eco-efficiency by a factor of five (von Weizsäcker et al. 2010) or even ten (Schmidt-Bleek 2009) is technically feasible for key economic and technology sectors. Similar ideas to that of green growth include the earlier models of 'qualitative growth' (Majer 1984, Capra and Henderson 2009) and 'ecological structural change' (Simonis 2011).

The green growth model has attracted much attention during the recent economic and financial crisis. Following the global economic crisis in 2008, numerous proposals emerged for a 'Green New Deal' with investment programmes designed to promote environmental-friendly infrastructure and other environment-focused measures as a form of economic stimulus policy (UNEP 2010, Blasch et al. 2010, OECD 2011b, Jaeger et al. 2009, Jänicke and Jacob 2008, Ekinis 2000).

Prosperity without growth, post-growth and degrowth

59. The idea of green growth contrasts with notions of prosperity without growth (Jackson 2009a, Miegel 2010), post-growth (Paech 2009a, Seidl and Zahrnt 2010b) and, in more extreme forms, degrowth (see for example Flipo and Schneider 2008, Latouche 2010). These are largely based on the proposition that economic growth cannot be decoupled from its material and energy basis to the extent needed and that economic growth cannot continue unabated in a finite world.

60. Growth critics do not, therefore, share the technology and regulatory optimism behind the notion of green growth. Rather, they argue that increases in efficiency in a growing economy can be easily compensated for by the overall increase in production (rebound effect), and argue that there are limits to decoupling and dematerialisation. They base these limits on the laws of thermodynamics, the realities of prevailing production structures and the observed close relationship between economic growth and environmental pressures (Sorrell 2010, Schor 2010, Jackson 2009a, Paech 2009b, Sorrell 2007, Huesemann 2003, Chapter 1-4). In addition, two further arguments are put forward for critical analysis of economic growth. Firstly, there is the proposition that in many industrialised countries, due to a wide range of economic and social factors, growth rates are already on a decreasing trend (Reuter 2010; Miegel 2010; Diefenbacher and Zieschank 2009). Secondly, it is argued that in countries where a certain material standard of living has been achieved, higher incomes lead less and less to an increase in social wellbeing, meaning that the marginal utility of rising incomes decreases (for an in-depth view see Jackson 2009b, p. 38 ff.). This is shown both in the findings of happiness research and in an analysis of differing objective factors like longevity, education and social cohesion (Frey and Frey Marti 2010, p. 460; Miegel 2010, p. 30). While this indicates that for rich countries *average* income has relatively little influence on many prosperity-related indicators, there is reliable evidence of a relationship between the degree of *income inequality* within a country and social wellbeing (Wilkinson and Pickett 2010).

61. While the degrowth movement and related lines of thought explicitly call for a shrinking of the economy as a prerequisite of sustainability, for others the prime objective is complete liberation from the growth imperative. An underlying problem is seen in a fixation on economic growth that fails to distinguish more sustainable production methods and structures (which should be encouraged) from methods and structures that need to be reduced, and instead welcomes everything that is produced, sold and generates income (Scherhorn 2010, p. 3). 'Post-growth society' denotes the goal of a society that is not dependent on economic growth for survival and in which growth is no longer the dominant paradigm of industry, policymaking and society (Seidl and Zahrnt 2010b, p. 34). It is also one in which a non-growing – or less rapidly growing – economy can still be dynamic. Whether gross domestic product (GDP) continues to increase is no longer the central issue. Economic growth is welcome as long as it does not eat away at the foundations of natural capital (Scherhorn 2010, Daly 1996.)

Despite their differences, these arguments against growth have in common that they call for a paradigm shift in which not economic growth but the model of sustainable development is placed at the centre of political, social and economic activity (Scherhorn 2010, p. 6).

1.4 Decoupling: Prospects and limitations

62. Whether strategies for green growth are sufficient to achieve a development path within environmental limits or whether it is necessary to consider post-growth strategies depends on how far economic output can be decoupled from environmental pressures. Decoupling may be understood here in the narrower sense of decoupling economic output from the use of natural resources. From an environmental standpoint, however, it is helpful to use a broader definition that includes an extra dimension: the decoupling of energy and resource consumption from environmental pressures (see also Chapter 2, Figure 2-5). In addition, a distinction must be made between relative and absolute decoupling: Relative decoupling is when the environmental efficiency of economic activities increases but the improvement is partly cancelled out by economic growth. Absolute decoupling is only achieved when despite economic growth the absolute volume of environmental consumption declines.

Historical development: Close relationship between economic output and environmental pressures in key problem areas

63. The relationship between economic output and environmental pressures has long been a subject of scientific research and debate. One finding produced by research is that the relationship must be given a nuanced analysis due to significant differences between problem areas. At the beginning of the 1990s there was widespread optimism that by the logic of development, environmental pressures (which initially increased due to industrialisation) would drop as a result of modernisation processes with rising prosperity (Jänicke 2001; Torras and Boyce 1998; de Bruyn et al. 1998). The hope that as rich countries developed into service societies their environmental footprint would shrink as a matter of course has not come to fruition. While this pattern of change applies to some problem areas, notably those capable of being addressed with technology, the picture is very different when it comes to numerous other environmental pressures (Victor 2010, p. 241; Jänicke and Volkery 2001).

64. Historical time series highlight the fact that in the past, growth in the world population and average incomes went hand in hand with a rise in global CO_2 emissions, use of energy and raw materials, and the environmental footprint (WWF et al. 2010). As a result, overall environmental pressures constantly increased although resources were used more efficiently, meaning that relative decoupling took place. Country comparisons produce similar findings. For example, it has been shown that income is a key driver of increased carbon emissions and of a range of other environmental pressures (Bradshaw et al. 2010). On average, a doubling of wealth effects an 80 percent rise in per capita CO_2 emissions (UNEP and IPSRM 2010).

65. Nonetheless, even in countries with similar income levels, emissions differ due to varying demographic, technological, cultural and geographic conditions (Girod and de Haan 2009; Lenzen et al. 2006). Differing emission levels with similar per capita income are thus an indicator of decoupling potential. Ambitious environmental policy can achieve absolute decoupling for key variables. Examples include energy and resource use in Germany and greenhouse gas emissions in the EU. Contrary to the global trend, there is evidence of a trend towards absolute decoupling in energy and resource use in Germany. Energy consumption has gone down slightly in recent years despite increased economic output (BMWi 2001), while resource use has remained almost constant (Buyny et al. 2009, p. 51; Schütz and Bringezu 2008).

66. One reason for the difficulty with absolute decoupling is the rebound effect. This refers to the fact that efficiency improvements often trigger a rise in demand, which under certain circumstances can cancel out the achieved savings. A number of effects contribute to this phenomenon. Firstly, efficiency improvements tend to result in price cuts, which can directly increase consumption of the efficient product or service. Secondly, they bring with them an increase in real incomes, which allows greater consumption of other products and services. The environmental impact of this additional consumption determines the extent to which environmental efficiency effects are cancelled out. With regard to energy efficiency in particular, the rebound effect is empirically well supported (Sorrell 2007; 2010 for an overview). Similar effects also occur in other sectors, however, such as resource and material consumption (Meyer et al. 2011) and transport (Frondel et al. 2008).

Relative rather than absolute decoupling has thus tended to be the rule in the past with regard to key problem areas like total resource consumption and greenhouse gas emissions. It is important to note, however, that even relative decoupling is not automatic, but is a response to global market prices or regulatory environmental policy (Edenhofer et al. 2009, p. 4).

Theoretical perspectives in economics and thermodynamics

67. The debate on how growth can be maintained in the face of limited natural resources has a long tradition in economic theory (going back to the 1970s: Solow 1974; Dasgupta and Heal 1979). If in the production function, scarce natural resources are treated as a form of capital in their own right, this only acts as a limit to growth if the resources are not renewable and cannot be substituted with man-made capital. The answer economic theory provides as regards the decoupling issue thus depends on how optimistic are the assumptions regarding substitutability. If backstop technologies are assumed to exist that mean the same product can be manufactured without using limited resources and without harming the environment, then the growth constraint is removed (Solow 1974; Dujmovits 2009; Aghion and Howitt 2009, p. 379 ff.).

Neoclassical economics, and environmental economics that developed from neoclassicism, were traditionally highly optimistic on the point of substitutability. At the end of the 1990s, in response to a vigorous critique from environmental economist Herman Daly, two leading economists, Robert Solow and Joseph Stiglitz, admitted that full substitution of natural capital with man-made capital is impossible because physical capital always requires the use of natural resources (Daly 1997; Solow 1997; Stiglitz 1997). Solow (1997) corrected earlier statements saying that the crux of the matter was substituting non-renewable resources with renewables, and not whether they could be substituted with man-made capital.

It is now necessary to assume significant use limits for most renewable resources (WBGU 2009). And given available knowledge from environmental science, it is no longer enough to concentrate on specific limited natural resources and their substitutability. Rather, the differing environmental limits and the possible problem-shifting effects that could arise when substituting one resource with another must be seen as an integral part of the problem (Westley et al. 2011).

Decoupling and energy supply

68. That it is impossible to completely decouple economic activity from the energy and material base follows from the natural sciences and in particular the laws of thermodynamics, although this is acknowledged only with great reluctance by the mainstream economics community. Any economic activity requires an input of useful energy (exergy) and results in increased entropy (no longer usable energy and irreversibly dissipating material) (Georgescu-Roegen 1971). Thus, material production is by default linked to the creation of materials that can no longer be used, largely dissipative waste flows, and emissions (Cleveland and Ruth 1997). On the input side, there are no prima facie limits to the flow of energy: The Earth is an open system in relation to energy. Directly and indirectly usable solar radiation provides a renewable energy source. The conversion of solar-derived energy sources into usable energy is always associated with environmental impacts, however, not least the use of land. A further bottleneck lies in the ability of key natural systems to act as sinks for the necessary by-products of consuming useful energy.

69. In the key area of energy supply, the decoupling of economic output and energy use must reach its limits at some point due to the laws of thermodynamics. The dependence of economic growth on a growing supply of high-grade energy is also well supported by empirical research. Neoclassical studies subjecting the link between economic growth and energy consumption to econometric analysis based on energy costs and prices already suggest a mutual relationship between the two (feedback hypothesis, see Apergis and Payne 2009; Chontanawat et al. 2008; Narayan and Prasad 2008; Payne 2010; Frondel and Schmidt 2004). More environment-focused economic analysis adds clear indications that energy input contributes significantly more strongly to economic growth than the small fraction of input costs accounted for by energy and the resulting price elasticities in the production function would imply (Sorrell 2010; Ayres and Warr 2010; Victor 2008, p. 33; Homer-Dixon 2006; Grahl and Kümmel 2006).

70. However, the thermodynamic limits may still be far from being reached if use can be made of the available potential for energy efficiency improvements. Ayres and Warr (2010) show that the 'useful work' generated for production processes from energy increased considerably since the start of the 20th century relative to actual fuel consumption because energy conversion efficiency improved greatly over the decades. The authors argue that productivity growth in past centuries was only made possible by the availability of ever-greater quantities of high-grade energy, and that 'technological progress' and 'total factor productivity' – concepts left vague in economic theory – should actually be seen as equivalent to the efficiency of energy and resource conversion in industry. The observed increase in productivity thus arose largely from the fact that workers were aided by increasing quantities of high-grade energy (Sorrell 2010, p. 1790). Ayres and Warr (2010) also see huge potential in increased efficiency. Cullen et al. (2011) estimate that from a technical and physics standpoint, 73 percent of global energy use could be saved solely by improving passive energy-relevant systems (such as building insulation and the design of devices, vehicles, aircraft, etc.).

The second decoupling step, separating energy consumption from environmental pressures, calls for a switch to energy sources with the lowest possible environmental impact. The following section looks at the opportunities available in this regard.

Opportunities decoupling in energy supply

71. A range of climate change scenario studies illustrate that from a technological and economic point of view, a largely zero-emissions energy supply and thus absolute decoupling of energy production from greenhouse gas emissions is possible (Edenhofer et al. 2010). A number of recent studies come to the unanimous conclusion that demand for electricity in Germany and in the rest of Europe could be largely or even completely satisfied from renewable energy sources (SRU 2001d; EREC 2010; PwC et al. 2010; ECF et al. 2010; Öko-Institut and Prognos AG 2009; FoEE and SEI 2009). A largely renewables-generated energy supply is also conceivable at global level (IPCC 2011; EREC and Greenpeace International 2010; WWF et al. 2011). Policy strategy documents at national and European level also now assume that an 80 percent reduction in greenhouse gas emissions can be achieved by 2050 (European Commission 2011d; BMWi and BMU 2010).

For one of the central environmental problems – emissions of greenhouse gases – it is thus likely that with the right policymaking and societal effort, absolute decoupling can be achieved. Exploitation of the available potential for decoupling requires policy-induced, radical environmental technological innovation and its rapid widespread adoption (Jänicke 2010a, 2008). However, this may shift problems elsewhere because renewable energy sources can trigger negative environmental impacts due to the sometimes large areas of land needed (SRU 2011, Item 53 ff., see also Section 1.2.4). On the other hand, this problem-shifting effect can be significantly reduced by excluding environmentally sensitive areas in site selection.

Conclusion

72. It cannot be ruled out that environmental limits may force economic growth to slow down, not least because environmental problems themselves – such as climate change – have a negative impact on economic development. If such interactions are identified ahead of time and are responded to adequately in institutional, political and societal terms, there is a chance that existing decoupling potential can be mobilised. On the whole, it can be assumed that there is still a large amount of leeway. While in the longer term, there are thermodynamic limits to the ability to decouple economic activity from energy and material inputs, these limits have not yet been reached. It is vital to make use of this leeway by improved efficiency, fuel substitution and changes in consumption patterns if crisis is to be avoided, and this should be expedited by policy. Among other things, a fundamental transformation of large-scale supply systems and infrastructure is necessary to prevent disturbance to natural systems from having uncontrolled and potentially catastrophic impacts on the economic system.

73. Strong sustainability must be made the prime policymaking objective, with long-term system stability given priority over short-term growth targets. The economic dynamic must be made to accommodate precautionary limits. At the same time, it is not helpful or realistic to explicitly restrict or even prevent growth, but neither should growth be actively promoted in disregard of the environmental costs. Value enhancement in terms of better-quality and more expensive products using the same or smaller quantities of material and energy is less of a problem if environmental pressures do not increase or are reduced to sustainable levels, meaning that environmental limits are observed (Lawn 2010; Paqué 2010).

It remains to be seen, however, whether respect of environmental limits supported by science and determined by policymakers can be reconciled with growth over time. For the event that impacts on growth cannot be avoided due to global environmental limitations and to demands for fairer use of scarce resources, industry, society and policymakers must be prepared to tackle the resulting challenges. The better they are able to do so, the lower will be the costs of adapting to remain within environmental limits.

1.5 Risks of non-growth

74. Growth supporters and many green growth advocates believe growth is a necessary prerequisite of a functioning society (Paqué 2010; Bär et al. 2011). They stress the role of growth in maintaining high employment and the stability of public budgets and social insurance systems. Others see the quest for growth as part of human nature, and as a condition for ethical and moral advancement, and warn against attempts to constrain it (Friedman 2005).

Many opponents of growth take the risk of non-growth seriously but see the main challenges in its management. Jackson (2009a) coined the phrase ‘growth dilemma’ in relation to the problems in rich countries. Without growth, economies would fall into a recession spiral, yet in its current form, growth would lead to environmental collapse (see also Victor 2008). The dilemma may have become less acute in that for some decades a trend towards lower growth rates has been observed in many industrialised countries, notably Germany (on declining growth rates, see Bourcade and Herzmann 2006; Diefenbacher and Zieschank 2009; Priewe and Rietzler 2010; Reuter 2010).

There are two different issues involved here:

- Is the stability of market economic systems reliant on growth?
- If economic growth is not possible in the longer term (e.g. because of rebound effects from the environmental to the economic system), how can greater independence from growth be achieved?

The next section looks at to what extent a growth imperative is to be derived from economic theory (Section 1.5.1). In a further step, growth imperatives are placed in the context of political reality (Section 1.5.2). Approaches for greater independence from growth are addressed in Section 1.6.3.

1.5.1 The ‘growth imperative’ in economic theory

75. Growth of an economy is largely dependent on investment and the investment rate. Investment has a modernisation, a capacity and a demand effect (Priewe and Rietzler 2010, p. 44 f.). In order to be competitive, a new technology introduced on the back of investment must be better than an old technology, either because it cuts costs or because it enhances product quality (Barro and Sala-i-Martin 2004; Elsenhans 2011, p. 35 f.; Romer 1990). Investment is thus indispensable when it comes to modernising an economy and upholding its competitiveness. It can also have a capacity effect that can be determined from the size of the capital coefficient, meaning the value of capital goods needed for each additional unit value creation (Harrod 1968; Domar 1968). Investment finally has a demand effect because investment spending illustrates the demand for labour, goods and services. In growth theory, the level of investment is initially explained by the level of savings (Harrod 1968; Helpman 2004; Domar 1968; Solow 1968; critical assessment: Binswanger 2006). It is, however, in no way a given that all domestic savings will be invested in-country (Koo 2003; on a dramatic decrease in the investment rate concurrently with a rising savings rate in Germany, Jaeger 2011; Reuter 2000, p. 151 f. and 320 f.; Priewe and Rietzler 2010). Because business decisions are largely dependent on profit expectations, the supply and demand sides must create the conditions for a private propensity to invest that matches the private savings rate

(Kaldor and Mirrlees 1968; Reuter 2000, p. 63 and 156 ff.; Priewe and Rietzler 2010; Elsenhans 2011). State investment can sometimes compensate for a lack of private investment (Koo 2003; Mitchell and Kuysken 2008), but – as shown in the recent confidence crisis in the financial markets – it cannot be arbitrarily increased on the basis of debt.

76. Adequate returns on investment are more likely to be had in markets that are growing in at least monetary terms than in markets that are shrinking. The growth process is also subject to risks of market contraction and potential disequilibria, whether due to rising costs, reluctance to invest due to falling demand or other factors. To this extent the growth process is vulnerable (Reuter 2000). There is no endogenous law of nature to say a market economy should grow in constant equilibrium (Elsenhans 2011); at the same time, stagnation and contraction is highly risky because of the attendant destabilising and self-reinforcing trends – 'centrifugal forces' (Harrod 1968, p. 44) – as seen in the current financial crises (Peukert 2011). In reality, it is not always possible to share the neoclassical optimism concerning market adjustment that assumes the various markets will always seek a supply and demand equilibrium (Priewe and Rietzler 2010, p. 41). For example, a drop in interest rates, especially in times of crisis, does not automatically lead to a revival of investment activity (Koo 2003). Structural discontinuities following economic slowdowns often hasten the irreversible loss of entire industrial sectors, as seen in the textile industry and parts of the steel industry in the 1970s (Paqué 2010, p. 187 f.).

77. Ultimately, without growing demand, investment would largely consist of demand-reducing rationalisation investment. In theory, a relatively stable shrinkage path is conceivable with this type of rationalisation, with the emphasis on cost-saving rationalisation investment and productivity gains passed on in the form of reductions in working hours (Jackson 2009a; Binswanger et al. 1988). It is questionable, however, whether a long-term drop in consumer demand can be reconciled with a stable investment rate that is largely based on rationalisation investment. In Germany at any rate, the dwindling and, in international comparison, very low investment rates seen in the last two decades are closely related to weak demand (Priewe and Rietzler 2010).

Monetary theory approaches emphasising the credit dependency of private investment (Binswanger 2006; Sorrell 2010) likewise come to the conclusion that a minimum level of return must be secured for private investment and that it is easier to achieve this in a growth environment than in a non-growth situation.

The risks of economic stagnation and recession must therefore be taken seriously.

1.5.2 Growth imperatives in policy practice

78. The growth focus of industry, policymaking and society is also institutionally firmly embedded in democratic market economies. The expansionary drive for higher profits and incomes is one of the constituting traits of competition in a market economy and has become ingrained in 'mental infrastructures' (Welzer 2011), values and actions. Without the taming effect of civil society and the democratically legitimated state, this expansionary drive tends towards immoderation and excess (Streeck 2011). At the same time, key elements of the modern welfare state are reliant on a growing economy (Seidl and Zahrnt 2010b, p. 23; Offe and Borchert 2006; Paqué 2010; Holzinger 2010; Streeck 2011).

79. Finally, the political legitimacy of governments in western democracies largely depends on their ability to deliver results (output legitimacy), in particular in the form of a successful economy that promises rising incomes and high employment together with a high standard of public goods and welfare services. Nonetheless, examples and experience elsewhere show that in policy processes that credibly communicate material and policy constraints, burdensome restrictions can be made acceptable (Scharpf 2011).

80. The growth dependence of key institutions can be illustrated by the examples of employment, public services and state expenditure. Labour-saving technical progress once went hand in hand with productivity-driven wage increases, was thus a major driver of income growth and enabled broad participation in the generated wealth (Paqué 2010, p. 184; Holzinger 2010, p. 30 f.). But labour-saving technical progress also means fewer working hours are needed for the same output. Without growth, either the average length of working life is shortened accordingly or unemployment goes up (Spangenberg 2010; Reuter 2010; Victor 2008, p. 211). Although annual working time has steadily fallen by a total of 100 working hours across the OECD in the last decade (OECD 2011), academic and policy debate on reductions in working hours has abated significantly during the same period (on the current status of the debate, see Holzinger 2010, p. 38 f.).

Other areas that currently depend on growth to function include pension, healthcare and education systems, and not least state finances (Paqué 2010, p. 159 ff.). Given the foreseeable demographic trend, zero growth would make any pension system – pay-as-you-go or fully funded – unaffordable if stable real non-wage costs of labour and income-linked pensions continue to count as non-negotiable constraints. In the healthcare system, a standstill in contributions would require a review of service levels and system efficiency as a whole.

Economic growth is seen as a prerequisite for social inclusion. While in western industrialised countries there is an empirically strong link between the incomes of the poorest sections of society and economic growth, the equivalent link with welfare policy on the whole is very weak (Kenworthy 2010; Helpman 2004, p. 108). If suitably implemented, however, welfare policy, too, can improve the incomes of the poorest 20 percent of society without impairing other social policy objectives (Holzinger 2010, p. 32; Kenworthy 2011b).

Redistributing the gains from growth causes less conflict than redistributing existing wealth (on the conflicts surrounding redistributive policies see Lowi 1972; Holzinger 2010). But irrespective of this aspect, it would be illusory to think that growth can prevent distribution conflict in wealthy societies. Because distribution rivalry in saturated consumer societies is focused more on status goods that cannot be multiplied at will and hence are structurally scarce, rising incomes tend to negate the status value of such goods and shift status rivalry to other goods rather than actually placating or satisfying society (Hirsch 1980). Typical status goods that lose status value once broadly accessible include houses in the countryside, exotic holidays, educational titles and key positions in society. Increased rivalry for such 'positional goods' that symbolise the few top positions in society stimulates and re-stimulates the growth spiral because they ultimately require higher incomes or greater private investment in individual careers. If everyone joins the bandwagon, then status differences are merely reproduced at a higher level without greater actual satisfaction being achieved.

Government debt also creates pressure for growth. High growth rates promise secure interest payments and the ability to reduce debt without cost-cutting measures or having to raise taxes. The option of taking on debt to be reduced at a later date based on future growth provides governments with an attractive window of opportunity (Paqué 2010, p. 204).

81. On the whole, it is clear that it is easier to maintain key social systems in a growth economy. Without growth, goal conflicts intensify, as do decision-making dilemmas and ultimately many social conflicts. Policy aimed at social integration becomes more ambitious and more difficult, but not impossible. Market economic systems, the welfare state and social integration may also be substantially more crisis-prone in a non-growth economy. If society is to forgo economic growth as a preventive measure or in the wake of environmental crisis, it must be prepared and in a position to do so. It is thus one of the greatest scientific and social policy responsibilities to put thought at an early juncture to finding ways of significantly reducing the dependency of many societal functions on economic growth, and to finding a solution to the resulting problems. Section 1.6.2 sets out a number of potential approaches.

1.6 Challenges for policymaking, society and research

82. In the previous section, it was argued that there is still large scope for decoupling growth from environmental exploitation, and that more resolute policies are needed to reduce the use of natural resources across the board. However, it cannot be ruled out that decoupling may not succeed in all areas to the desired extent and that transgression of environmental limits can only be prevented in the longer term by limiting or slowing down economic growth. In this event, the aim of conserving the natural foundations of life must remain at the forefront and all necessary efforts be made to achieve it. The analysis so far yields three basic strategic approaches aimed at respecting environmental limits:

– Firstly, at all levels – global, European, national and possibly also sub-national according to the type of environmental good – environmental targets must be formulated and institutionalised that at least ensure the observance of science-based limits to carrying capacity.

– With a view to these targets, strategies must be developed for far-reaching transformation of industrial society which, apart from radical technological change, also take in social innovation and changes in consumer behaviour and lifestyles.

– Finally, key social function systems must be prepared for a future of only marginal economic growth. This can only be achieved by turning away from the previous dominant strategy of trying to attain social aims by increasing economic growth. The better this succeeds, the less dependent society will be on continued economic growth.

To develop such approaches, a new economic science research agenda must be developed which focuses on the issue of macro-economic stability in a 'full world' (see Daly 2005).

1.6.1 Setting environmental targets and better integrating research and policy

83. Policy action can only be aligned to the observance of environmental limits if there is broad social consensus on the environmental targets involved (see Chapter 11). The setting of environmental quality targets must take adequate account of knowledge regarding environmental limits; ultimately, however, environmental targets are essentially also social conventions (see Section 1.2.3). This is evident not least from the fact that many such targets are associated with implicitly and explicitly formulated notions of what can be considered fair allocation of global commons. Such generally applicable value judgements fall within the core domain of democratic policymaking (Habermas 1992). For this reason, environmental targets cannot be purely science-based, but are ultimately a product of democratic consensus building and decision making processes that must nonetheless be informed by science. Of key importance in this regards is a systematic strengthening of the knowledge base in relation to biophysical limits and its integration into policymaking.

84. The structure and working practices of the Intergovernmental Panel on Climate Change (IPCC) serve as a model for successful institutionalisation of scientific policy consultation, because they link policymaking with science in a way that the integrity and autonomy of both systems are upheld. The IPCC is seen as one of the most influential international institutions for climate policy (WBGU 2000). Without its work, the long road to international consensus on the 2° Celsius target would have been more or less unthinkable. The IPCC's success is largely due to the policy integration of its work. This occurs through the summary for decision makers being mandated and adopted by member state representatives and also through the synchronisation of its activities with international climate change talks. The very broad-based participation of several hundred scientists also gives high-level authority to the research findings. All this is underpinned by sophisticated quality assurance processes and reviews of available knowledge.

This contrasts with the failure of a purely science-based institutionalised approach in the Global Biodiversity Assessment of 1995. The process attracted insufficient political support at government level because some states doubted the legitimacy of the panel and its findings (Larigauderie and Mooney 2010; Vohland et al. 2011). This influenced initiatives which, along similar lines to the IPCC, were designed to establish the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES). The use of natural resources is covered by the International Resource Panel. However, in terms of its resources and international policy integration, this is a relatively weakly institutionalised expert panel that remains an arm of the United Nations Environment Programme (UNEP) and deserves upgrading to give it similar status as the IPCC. Ideas have already been developed for an Intergovernmental Panel for Sustainable Resource Management (Bringezu and Bleischwitz 2009).

As early as 2000, the German Advisory Council on Global Change (WBGU) recommended the establishment of an 'Earth Council' to provide timely warning of high-risk developments and to formulate environmental guard rails (WBGU 2000, p. 179 f.). Particularly with regard to the interactions between global systemic risks, at minimum close cooperation between various international research and government platforms is of great importance. These also largely depend for their success on financing and staffing and on the scope and the depth of available knowledge concerning planetary boundaries, tipping points and systemic risks. The German government should thus actively support capacity building for such platforms. This applies both for the necessary further expansion of basic research on endangered earth systems under the remit of the Federal German Ministry for Education and Research (BMBF) WBGU 2011), and for the creation and establishment of international scientific expert panels. The key role of 'epistemic' communities in which there is consensus on problem diagnosis and resolution is adequately supported by research in relation to international environmental conventions (Böcher 2007; Braun 1998; Haas et al. 1993; Haas 2004; 1992). Science-based expert consensus in the international research community can secure a standard of environmental policy in environmental conventions that 'political realism' based upon economic and national interests would not be able to achieve.

85. Approaches for the identification of critical limits at the interface between policy and research are also in place at European level. The European Environment Agency's State of the Environment Report (EEA 2010b) gives a worrying account of overexploitation and overstretching of specific resources. Yet it lacks a sufficiently strong coupling with the policy processes that would be necessary for policy consensus-based setting of quantitative limits. In other respects, integration of scientific and analysis is relatively well established in other areas. One example is fisheries, where in recent times the International Council for the Exploration of the Sea (ICES) has based its recommendations for determining catch quotas for specific fish stocks on the concept of maximum sustainable yield (SRU, 2011a). The Clean Air for Europe (CAFE) Programme supplies the basis for EU clean air policy designed to minimise health risks and prevent critical levels from being exceeded (Wurzel 2002; SRU 2008; Bruckmann 2010; see also Chapter 10). EU clean air policy in particular has served as an example of intensive and successful institutional integration of natural science and economic modelling and policymaking with the ability to formulate ambitious and robust quality targets and emission budgets for key air pollutants. It relies to a significant extent on findings from the World Health Organisation (WHO). Systematic processes for precautionary, science-based identification of environmental limits should also continue to be advanced with regard to other natural commons, resources and sinks (e.g. forests, soils, the oceans, fresh water, 'green infrastructure', sustainable land use and the nitrogen cycle). They should be coupled with high-ranking environmental policy processes and receive consideration at the highest policymaking level in programme development. There is still considerable need for institutional capacity building in this regard to promote the integration of research and policymaking at all levels of governance, to lay the groundwork for robust limits, budgets and guard rails and to integrate these into environmental policy goal formulation. In the process, increasing attention must be paid to coherence and interactions between individual sectors in order to anticipate and prevent any shifting of problems from one area to another. In many cases, the task at hand will be to make existing processes and research findings available at a high policymaking level and to translate them into politically communicable messages.

1.6.2 Exploiting decoupling potential

86. In order to attain a sustainable development path within environmental limits, full use must be made of the potential for decoupling growth from the exploitation of resources and the environment (Fischer-Kowalski et al. 2011). The greater the reduction in energy and material throughput in industry, the less urgent the need to address the issue of growth. To achieve absolute decoupling, two approaches are necessary. Firstly, the infrastructure of industrial society must undergo fundamental change. This infrastructure includes the entire energy supply system, including generation and transmission (SRU 2011d), all transport infrastructure (Chapter 4) and, in a broader sense, agricultural supply structures (SRU 2009). This must lead to biogenic resources being managed sustainably (SRU 2007; 2011a; see also Chapters 2, 6 and 7). In addition, where technological solutions reach their limits, changed consumption patterns and behaviour can also play a key role in decoupling (e.g. in food consumption and mobility; see Chapters 3 and 5).

Various future scenarios show that the potential for technological innovation and improved efficiency has yet to be fully exploited, but in many areas new technological solutions must go hand in hand with social innovation. In the following it is argued that the free market alone cannot utilise this potential. The state must thus introduce regulation, but in doing so, it should be careful not to undermine the innovative powers of private enterprise.

87. The SRU (2011d) used the example of a switch to a 100 percent renewables-generated electricity supply to show how a key sector can aid the achievement of climate change targets based on available knowledge of environmental limits. A climate-neutral electricity supply based on renewable energy sources can be made feasible not just for Germany, but for the rest of Europe and for North Africa (Hertin et al. 2010; Patt et al. 2011; European Commission 2011b; 2011a), and also globally (IPCC 2011; WBGU 2011; WWF et al. 2011). With judicious choice of locations, renewables-based energy production and the successful use of potential for energy savings can prevent the shifting of problems to the detriment of nature conservation and protection of the countryside. Thus, intensive use of biomass is not recommended due to the foreseeable land use conflicts. Any expansion of cropland made available for energy crops tends to be connected with negative impacts on the environment and agriculture, especially with regard to biodiversity, the hydrological cycle and soil, and greater land use competition (SRU 2011d, p. 55, 2007; Schümann et al. 2010; Doyle et al. 2007; Nitsch et al. 2008; WBGU 2009; Thrän et al. 2011).

While the project for a sustainable energy basis for industry is already taking shape, the same cannot be said for the conservation of other natural resources, particularly biodiversity. This will depend on the transformation agenda being supplemented to take in other elements of the environment, not least to prevent problem-shifting strategies that pursue climate change objectives at the cost of natural resources (Westley et al. 2011; on interdependencies see Maclean et al. 2010). Other key areas for action addressed in this report include resource management (Chapter 2), transport policy (Chapters 6 and 7), and sustainable management of various vital ecosystems (Chapters 8 and 9). The list should also include policy for more sustainable consumption. Strategies can be developed everywhere to significantly reduce the economic pressures to use valuable and in some cases endangered ecosystems.

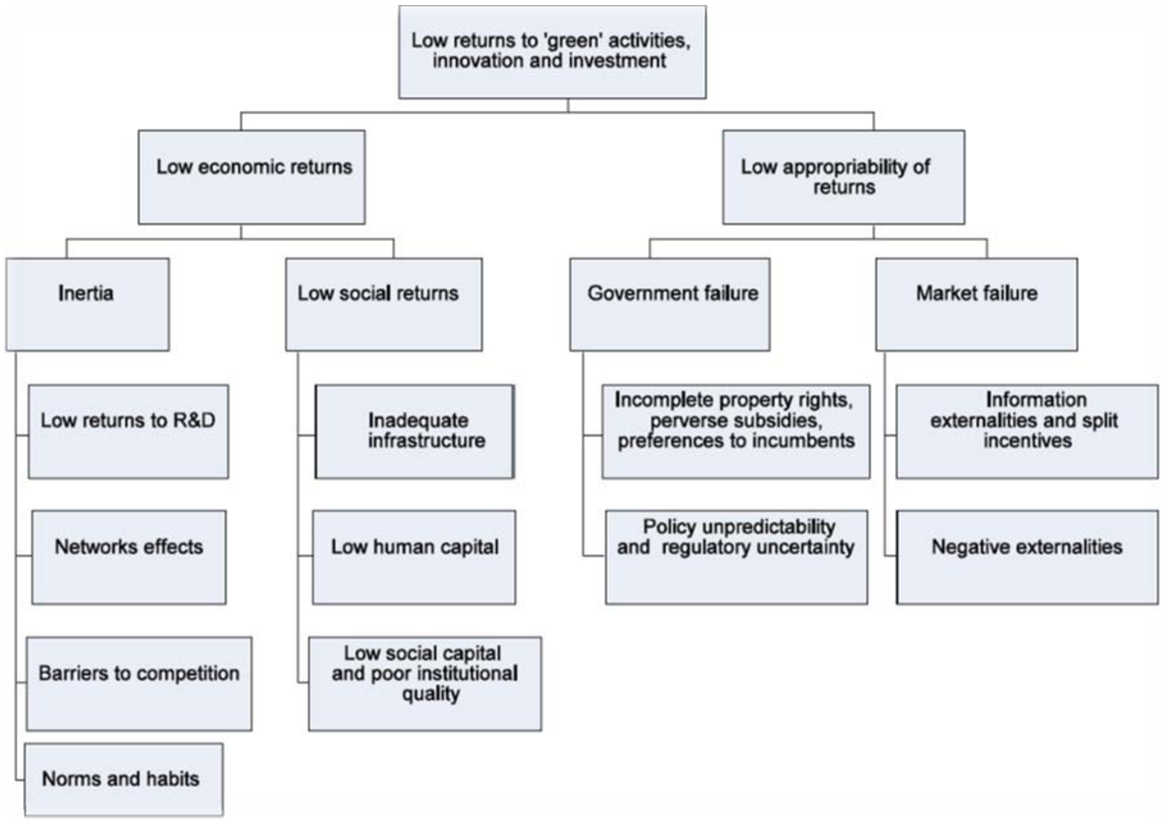
88. Capacity to innovate in a free market economy is largely to be found in the private sector, making this the key actor that must be mobilised in order to embark on paths towards more sustainable development (Allenby 1994). There is, however, the possibility that technological innovation is more part of the problem than of the solution (Westley et al. 2011; van de Leeuw 2010). Businesses must pursue ongoing innovation to remain competitive. The task now is to channel this innovativeness to areas where it either has no negative impact on the environment or offers solutions to the challenges of a sustainable economy.

Radical innovation and broader technological breakthroughs often come in response to economically or politically triggered scarcities (Ayres and Warr 2010, with many historical examples). Although frequently not seen as such by the sectors it targets, regulation that provides an operating framework for private enterprise can serve as a driver of innovation. This can open up economic opportunities. In many sectors, green investment (in renewable energy sources, building modernisation, infrastructure and networks) will have to increase to such an extent that – at least in the interim – further growth in GDP can be generated without harming the environment (Blasch et al. 2010; Jaeger et al. 2009; UNEP 2010).

89. So that these opportunities can be exploited, active structural policy must be implemented to underpin more sustainable technology paths (e.g. in electricity supply, see SRU 2011d). An enabling state is justified most of all on account of the innovation barriers inherent in the market. Westley et al. (2011) see a particular challenge in relation to the ‘ingenuity gap’, meaning the lag between supply and demand for technological solutions. The reason is a certain path dependency with innovations that lead to steady, incremental improvement but not to fundamental new developments. Such path dependencies are also one of the reasons why the OECD (2011a) warns against low overall economic returns and low appropriability of returns from green investment. Far-reaching institutional change must be initiated, both top-down by means of state-provided policy frameworks and bottom-up by means of learning processes (Westley et al. 2011).

Figure 1-3

Market Barriers to Green Growth



Source: OECD 2011a, p. 6, after Hausmann et al. 2008

It is clear that parallel policy intervention is not only justified on grounds of market failure in relation to external effects (SRU 2008, p. 86 ff.; Jänicke 2008; 2010a). In fact, the OECD study shows that a range of market imperfections serve as barriers to investment (Figure 1-3). In industrialised nations where environmental policy is far advanced, this is the deciding factor.

The ‘ensuring state’ (Giddens 2009, p. 69) is defined for the most part as the state having ultimate responsibility for respecting environmental objectives based on environmental limits, for monitoring them and for the development of target-driven processes that lead to their institutionalisation. Within the stipulated guard rails, the rules of the free market apply, meaning that there is no deliberate allocation of scarce resources. The aim is to foster large-scale private investment, in part against prevailing market trends, to stimulate the transformation of production processes and infrastructures. But at the same time, regulation should not lead to further uncertainties. Rather it must determine the long-term environmental limits within which the economy is free to develop.

1.6.3 Better quality of life independent of growth

90. There are good reasons to assume that even when exploiting all available potential for environmental transformation, limits for economic growth will emerge (Item 72). It is thus important to begin an early conceptual debate on how social stability can be maintained without growth or with very low growth rates. Ultimately this means finding ways to achieve key social policy objectives and a high standard of living even with very low growth. The following issues must be looked at in this regard:

– Measuring welfare

– Defusing distribution conflict

– Securing employment

– Investment in a non-growth economy

– Financing of state spending and social systems

Initial ideas as to how a post-growth society might look (Jackson 2009a, Holzinger 2010; Seidl and Zahrnt 2010b) have already been put forward, but there is a need for further debate on the challenges to be faced in a society without growth.

The following sets out preliminary solutions to the problems outlined earlier for further analysis and development. It is important that key actors from the science and policymaking communities – the big economic research institutes, political parties, employers and the unions – start to discuss these issues. State-run institutions should support this process by creating appropriate research programmes, putting projects out to tender, awarding contracts, and initiating public debate.

Measuring welfare

91. If economic growth is no longer able or intended to serve as the main means of increasing welfare, it is first necessary to arrive at a more discerning definition of welfare. Welfare is to be understood as a measure of a society's wellbeing and quality of life. While a degree of material prosperity is a key factor in high quality of life, once a certain income level is reached, a range of other indicators like health, education, nature, friendships and social status become increasingly important, especially in wealthy industrialised nations. The Easterlin paradox (Easterlin 1974) describes the phenomenon where increasing per capita income has little influence on subjective wellbeing within a society. In the US, the world's leading economic power, per capita incomes have risen three-fold since 1950, yet the portion of the population that perceives itself to be happy has barely risen and has even gone down again slightly since 1970 (for statistics on several countries see Veenhoven 2012). These findings allow the conclusion that focusing purely on economic wealth should not be a government's top policy objective. Other factors like social balance in the population, a clean and intact environment, a functional healthcare system and cultural education opportunities are at least as important.

That GDP itself is not an adequate measure of social welfare is largely undisputed. Defensive expenditure to clean up environmental damage and deal with social disharmony results in a loss of prosperity, but it counts positively towards GDP. The prime importance attached to GDP as a prosperity indicator in public presentation and perceptions is also unjustified because it fails to reflect many relevant policy objectives such as sustainable development and social cohesion (Pennenkamp 2011, p. 14).

92. At both national and international level, broad debate is underway on alternative methodologies and indicators for the measurement of prosperity (for overviews see Pennekamp 2011, p. 16 ff.; Pollitt et al. 2010, p. 59 ff.; Bandura 2008; European Commission 2007, fact sheets). This debate centres on the controversial issue of whether alternative measurement methodologies should be based on aggregated indices (such as GDP adjusted to take in environmental and social factors) or on a broad set of indicators. Disaggregated indicator sets are recommended in some current publications because they are more transparent and avoid the problems of aggregation (SVR and CAE 2010; Stiglitz et al. 2009; Bachmann and Steuwer 2010). While a large number of indicators have been identified and are already in use (e.g. in policy strategy processes, see Chapter 11), awareness to them and their importance as a reference of measure in policymaking remains low compared with GDP. As opposed to disaggregated indicator sets, aggregated monetary indices have greater communicative effect because they can be directly compared with GDP (Diefenbacher and Zieschank 2009). It thus makes sense to develop existing approaches further to form a robust key indicator that is recognised in professional circles.

One promising approach for an aggregated alternative measurement methodology is Germany's National Welfare Index (NWI) (Diefenbacher and Zieschank 2009). This is based on private consumption, a key component of traditional GDP. Following the assumption that for society as a whole, additional growth in private consumption contributes less to increasing welfare the less equitably incomes are distributed, private consumption is weighted by an income distribution index (ibid). Selected welfare-increasing components are also added in that are not included in GDP (such as unpaid housework and voluntary work). Components that detract from welfare (e.g. costs of road accidents and from environmental pollution) are deducted. Finally, adjustments are made for the timing mismatch between expenditure and benefits, and for the environmental sector (e.g. net available capital). Because the core variables can be compared, the trend in the NWI can be directly compared with the trend in GDP. At the same time, the individual variables that are included in the NWI can be presented separately to make their respective impact more transparent.

The SRU believes that, building on existing research, the German government should as a next step commission the Federal Statistical Office with the development of a robust, standardised methodology for an aggregated welfare index. This should then, like GDP, be published prominently at regular intervals and its components analysed and debated. It could also be used in the National Strategy for Sustainable Development.

Use of a standardised welfare index does not do away with the need to further develop relevant individual indicators. It is important, therefore, alongside indicators for monetary flow quantities to develop and compile indicators that illustrate the stocks of natural and social capital (Stiglitz et al. 2009).

Distribution conflicts

93. In an economy in which both tax revenues and GDP continue to grow, it is possible to organise social redistribution without imposing an absolute cost on specific groups. However, distribution conflicts manifest themselves in industrialised nations in the form of competition for status goods and cannot be entirely avoided by means of economic growth. Independent of future growth in an economy, models must be developed that tame this competition. In his seminal book on the 'social limits' to growth, Hirsch (1980) put forward numerous proposals to this effect (see Section 1.5.2). His key approaches include:

- Reduced premiums on status goods (e.g. by providing public access to exclusive properties)
- Reducing positional competition (e.g. with flat hierarchies)
- Restructuring income and wealth distribution (e.g. with a socially accepted ratio between top and average earners)
- Reducing the attractiveness of positional employment positions (e.g. by creating transparency with regard to time and mobility requirements)

Some of these approaches are also to be found in more recent growth-critical literature, where the focus is on income distribution. The greater the income inequality, the stronger the competition for status goods, at ever-higher levels, without satisfaction ever being achieved. Social consensus on restricting excessive income inequality can thus be seen as a prerequisite for sustainability and greater independence from growth (Daly 2009; Scherhorn 2010; Jackson 2009a, Wilkinson and Pickett 2010). Additionally, reducing inequality can help increase average quality of life. Specific proposals relate to the setting of minimum and maximum incomes, limits for the ratio between the highest and the lowest levels of pay in a given business enterprise (Daly 2009) and more widespread employee shareholding (Wilkinson and Pickett 2010). What must be remembered with all of these proposals is that the relationship between income distribution and growth has not been fully explained by research, although there are reliable indications that contrary to global perceptions, greater social inequity can also be a barrier to growth (Helpman 2004, p. 90 f.). It is thus also conceivable that greater income redistribution to the benefit of the poorest fifth of society can foster growth (Kenworthy 2011b, p. 96 f.).

There are also conventional demands for higher taxation of inheritances and high personal wealth and incomes (Scherhorn 2010; Bofinger 2010). Private savings could thus be channelled to investment, for example to finance more socially needed services and to enable more equitable access to education and infrastructure (taken from Moore et al. 2010; Reuter 2010).

The impacts of a worsening income position could be lessened by means of supporting measures. Social debate on the substance of a new welfare indicator (Item 92) can give rise to new models that challenge notions of happiness based solely on work and material goods.

Employment

94. One of the key reasons why policymakers rely on growth is the perception that it helps combat unemployment. It is assumed that economic growth must maintain a certain level to ensure that, with average working lives held constant, employment figures remain buoyant (the employment threshold). In a non-growth economy, the increase in productivity, meaning the number of units of GDP generated by each unit of work would (ceteris paribus) lead to a rise in unemployment. Solutions could be found, for example, in restricting the supply of labour. This could be achieved by reducing the working week and the length of working lives in general (Jackson 2009a; Scherhorn 2010; Schor 2010). Schor (2010) shows that since the beginning of industrialisation, cutting annual working hours per person in the US and in other industrialised countries has contributed to preventing unemployment without the entire rise in productivity resulting in growth. In initial scenario studies featuring attainment of the transition to a stable non-growth economy, a reduction in formal working time serves as a key lever (Victor and Rosenbluth 2007; Raskin et al. 2010). Shorter working hours can readily be identified as prosperity-enhancing to the extent that prosperity is not solely defined in terms of income, but as including quality of life and the environment. Social aspects must also be taken into account, however. A cut in working time must not be allowed to lead to loss of income that pushes socially weaker sections of the population into poverty. It also must also be ensured that the reduction in work time is appropriately distributed.

It must be remembered, however, that in future, as a consequence of demographic change, an equal labour supply surplus will not be found across all skill sectors, meaning that any measures taken must be flexible. Höpflinger (2010) argues that to finance pension systems in non-growth economies (particularly in the face of demographic change), an upward adjustment of both formal and informal working lives will be necessary (productive ageing).

The rise in a society's overall productivity can be reduced without having to restrict innovation in industry that must hold its own in international competition. Simply placing greater focus on private and state consumption of labour-intensive goods (such as organic produce and quality goods) and services (such as education, childcare and nursing care) increases labour intensity, which is measured as labour input relative to GDP. If the deployment of human labour is increasingly what creates value, productivity in these sectors can only be increased within narrow limits without a fall in output quality (Jackson 2009a, p. 132 f.).

A change in taxation arrangements so that they do not punish enterprises with labour-intensive production, as is currently the case, can also reduce the relative advantages of labour-saving technical progress. A win-win situation can be achieved in this regard by introducing taxation on environmental and resource consumption. While the pros and cons of various models must be analysed in more detail, the aim of a restructured taxation system must be to reduce the tax burden on labour and place a greater tax burden on the consumption of energy and the environment.

Investment in a growth-independent economy

95. Section 1.5 addressed the vulnerability to crisis of market economic systems that are largely based on profitability expectations from private investment. Low growth and associated low expectations regarding sales volumes can lead to a downward spiral of increasing reluctance to invest and falling incomes (Item 76).

Unlike private investment, state investment is not reliant on minimum returns and is thus less vulnerable to crisis processes. A precondition, however, is that it must consist of productive future-focused investment that, while appreciated, cannot be mobilised to the same extent among private investors (e.g. education and infrastructure) (Paqué 2010, p. 205). For this precondition to be met, state investment proposals must be appraised on a far broader basis than straightforward economic return-on-investment analysis (Priewe and Rietzler 2010).

Private investment induced by the state or by incentives and regulation will be necessary if the economic system is to be made more sustainable. According to various estimates, ambitious climate change policy alone can boost investment rates in the EU by between one and four percent of GDP (European Commission 2011b; Jaeger et al. 2011). Investment can help create the necessary infrastructure and can also be made to flow to a greater extent into natural capital, such as into the conservation of ecosystems and 'cultivated' natural capital like managed forests and livestock herds (Daly 1996, p. 80; also Pollitt et al. 2010, p. 78; Helm 2010). Scherhorn (2010) speaks of 'reinvestment in common goods'. And in its approach to a 'green economy', UNEP (2011) also stresses a significant rise in investment in the conservation of natural capital. This approach, according to Jackson (2009a), calls for a change in the 'ecology of investment' itself: Green investment can produce lower returns and longer return periods and is possibly less 'productive' from a conventional standpoint. A similar situation could arise in respect of greater investment in public goods such as public transport, education, long-term care and healthcare (Reuter 2010). In respect of state net investment in such public goods, Germany lags behind its European neighbours and has at times had a negative net investment rate (Priewe and Rietzler 2010, p. 20). This is in part the result of the precarious financial situation of German local government.

State investment is, however, reliant on state revenue. With shrinking state finances, incomes and value creation based on state revenue decline by default, placing the issue of state financing in question. This kind of approach eventually results in income being used more to finance public rather than private goods and thus to a rise in the public spending ratio. One of the great challenges in this regard is to win the much-needed broad public acceptance for this approach.

Financing state expenditure and social systems

96. Financing of state expenditure relies largely on the amount of tax revenue collected. In an international comparison, there is no indication that the level of taxation – at least in the broad range observed – has any impact on a country's economic productivity (Kenworthy 2011a). There are some countries with extremely dynamic growth and extremely high rates of taxation and other levies. Nonetheless, for whatever reason, a low-growth economy would be difficult to achieve in a socially acceptable way without an increased public spending ratio.

Germany's financing structure for the welfare state, with above-average non-wage costs of labour and a relatively low level of income taxation in international comparison, is seen as unfavourable, especially in employment policy terms (Kenworthy 2011b, p. 85; Bofinger 2010, p. 169 f.; Jarass 2010) and is in need of adjustment for many reasons. In recent decades, income-related taxation – especially in light of ineffective international coordination in closing tax havens – has steadily decreased, while indirect taxation has increased despite its more regressive effects (Scharpf 2006; Genschel and Zangl 2007).

Issues involving effectively securing revenue for state financing and social security schemes and their structure in an integrated European and globally interwoven economy must be addressed with greater urgency in the context of a low-growth economy as opposed to the situation with high growth rates.

Government debt also requires discerning analysis. It must be remembered that debt with interest rates constantly above the state revenue growth rate leads to ever-increasing debt ratios. Particularly when the level of government debt is already high relative to GDP, this results in a dangerous debt spiral where no economic growth occurs.

At the same time, rapid reduction of government debt is not helpful in every economic situation (Scharpf 2011; Bofinger 2010; von Weizsäcker: Das Janusgesicht der Staatsschulden (The Two Faces of State Debt), FAZ.NET, June 5th 2010). How a socially acceptable, cyclically neutral reduction in debt can be achieved while maintaining the state's ability to act is undeniably one of the key challenges to be faced in a post-growth economy. Rigid institutional requirements that force a balanced budget without taking account of economic and pan-European interrelationships (Seidl and Zahrnt 2010a) could be counterproductive.

A further problem arises in respect of social insurance systems, especially pension systems, and will be further compounded by demographic change (Höpflinger 2010). The share of national income that must be spent on pensions is rising. Without growth, this will lead to lower incomes net of payroll deductions for those in employment. While the latter face lower costs of childcare and children's education, in all likelihood there will be objections to higher payroll deductions. At the same time, this trend adds to relative labour costs under today's system for financing the welfare systems and thus increases the advantages of labour-saving technical progress. How to make welfare systems sustainable is an ongoing focus of research and policy debate. How they can be made independent from growth should be made an integral part and a key focus of the research work.

1.6.4 Challenges for the development of economic theory

97. The further development of economic theory and its teaching in German schools and universities should place greater focus on the environmental limits of growth and their importance in determining economic objectives and structures.

This debate has yet to reach the mainstream academic economics community. Current text books on economic growth theory (Aghion and Howitt 2009; Barro and Sala-i-Martin 2004; Romer 2012) fail to adequately address natural science findings on the physical limits of growth. Fundamental theoretical thinking is lacking with regard to the opportunities and limits of growth and the stability of the economic system with ever-increasing pressures on the environment, which in turn have a rebound effect on the wellbeing of economic subjects and the functioning of the economy.

While eco-economics, resource economics and environmental economics have helped shine the spotlight back on the resource base of the economy, there is still much to be done in this regard. Environmental economics does not present an overarching macroeconomic theory and is unable to provide satisfactory conclusions as to the impact of environmental restrictions on economic growth and whether or under what conditions it might be possible to transform the economy without macroeconomic crisis (Kronenberg 2010, p. 1492). The current literature provides only initial inroads towards or calls for the development of an environmental macroeconomics of this kind (Schor 2010; Johnson 2010; Miegel 2010; Jackson 2009a; Victor 2008; Fitoussi and Laurent 2008).

The prevailing focus in environmental economics on specific scarce resources and environmental problems should be widened because it is no longer in keeping with current natural science research on the limits of growth. Instead, system relationships must be taken into account and environmental limits treated as a multi-dimensional problem. The SRU recommends as follows in this connection:

– The issues of how environmental pressures might be decoupled from growth using environmental technology innovation, and of how growth may be limited by the finite nature of natural resources, must be subjected to more empirical research in collaboration with the natural sciences and taking into account the tendency of effects to be transferred between the various environmental problems.

– Greater attention must be given in future to the question of *substitutability between renewable and non-renewable resources*. The maximum sustainable use rate for renewable resources (and for sinks for environmental pollution) then becomes a deciding factor in calculating the maximum attainable growth rate and the physical size of the economy to be achieved in the longer term (Aghion and Howitt 2009, p. 382; Dujmovits 2009, p. 18; Jones 2002). A prerequisite for this type of research is a discerning approach to the concept of capital that alongside man-made production capital also takes in the various types of natural capital and their respective significance to the production process.

– Finally, managing uncertainty and risk deserves greater attention in economics. While environmental science increasingly focuses on how to deal with uncertainty, probabilities and non-linear events, economic theory remains largely deterministic. Alongside ‘least cost planning’, increasing emphasis could be placed on ‘least risk planning’ (Johnson 2010, p. 9).

1.7 Conclusions

98. A sustainable economy is one that respects environmental limits. Transgression of such limits not only causes irreversible harm to ecosystems, but undermines the foundations of the economy, with long-term impacts on further prospects for economic development. Respecting environmental limits is thus long-term economics.

While the existence of environmental limits goes uncontested, defining them remains a challenge. The SRU believes the concept of environmental limits cannot be understood from a purely natural science standpoint because they always have a normative component. Limits are always defined relative to what is to be avoided or achieved and hence contain a precautionary element. Determining them therefore requires science-based debate on the types of risk that need to be prevented and how big the safety thresholds need to be. A democratic political consensus building process should also be bound by what are deemed to be fair national rights to the use of globally finite common goods. To this end, close integration is needed between scientific information and democratically legitimated policymaking, perhaps taking the IPCC as a role model for its part in the climate change debate.

For an economy to operate within safe planetary boundaries, there is no alternative to a technological innovation strategy that targets resource efficiency, thus reducing demand for energy and materials in the production of goods and services while placing the large-scale and necessary continued use of energy and materials as far as possible on an environmentally compatible basis (see Chapters 2 and 4). An innovation strategy of this kind that achieves absolute decoupling of economic growth from use of the environment will not only involve the transformation of large-scale infrastructure and production systems, but also a transformation of consumption patterns and lifestyles.

There are, however, serious indications that in the longer term, respect of environmental limits cannot be reconciled with economic growth even with a radical decoupling and substitution strategy. For precautionary reasons, policymakers, society, the scientific community and industry must begin to prepare for this eventuality as soon as possible. Currently, key functional systems in the economy, the state and society – such as social insurance systems – are fundamentally reliant on growth. If high quality of life is made the central objective of economic activity, however, then that objective can in principle also be achieved without a primary focus on growth. As part of a precautionary strategy, the SRU considers that there is a need for broad-based public debate addressing the following issues:

– What is the aim of economic activity? Is it to increase available income or to increase some new measure of welfare? What might that measure of welfare look like?

– What consumption patterns and lifestyles can be scaled up to global level and which need to be changed?

– How should the public spending ratio evolve – the ratio of expenditure on public goods and common interests to private investment and consumption? It is likely that public spending will have to increase in the foreseeable future, and will play a stabilising role in economic development if private investment falls away in a low-growth economy. At the same time, maintaining the standards and quality of social insurance systems will require greater state support in the face of marginal growth rates.

– How should (possibly rising) public expenditure be funded? Structural underfunding of public expenditure, which is made up for by borrowing, will no longer be an option in a low-growth economy. This will require the taxation system to be enhanced and expanded.

– How should income distribution evolve? Very large income disparities coupled with heightened competition for status goods are seen as one of the main social engines of growth. At the same time, social cohesion will be placed at risk given low growth rates and extreme inequality.

– How should productivity gains be distributed in the future? In the form of higher wages or shorter working hours, or by greater appropriation for public expenditure to fund social insurance systems made vulnerable by demographic change?

In a precautionary strategy that anticipates growth-related risk in a limited world, such fundamental issues call for extensive natural and social science research and broad public debate.

1.8 Literature

Aghion, P., Howitt, P. (2009): The economics of growth. Cambridge, Mass., London: MIT Press.

Allenby, B. R. (Hrsg.) (1994): The Greening of Industrial Ecosystems. Washington, DC: National Academy Press.

Apergis, N., Payne, J. E. (2009): Energy consumption and economic growth: Evidence from the Commonwealth of Independent States. Energy Economics 31 (5), S. 641–647.

Ayres, R. U., Warr, B. (2010): The Economic Growth Engine. How Energy and Work Drive Material Prosperity. Cheltenham, Northampton, Mass.: Edward Elgar.

Bachmann, G., Steuwer, S. (2010): Nachhaltigkeits-Indikatoren zur Messung der gesamtwirtschaftlichen Entwicklung. Gutachten an den Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung zum Bericht der Stiglitz-Sen-Fitoussi-Kommission. Berlin: Rat für Nachhaltige Entwicklung.

Bandura, R. (2008): A Survey of Composite Indices Measuring Country Performance: 2008 Update. New York: Office of Development Studies, United Nations Development Programme.

Bär, H., Jacob, K., Werland, S. (2011): Green Economy Discourses in the Run-up to Rio 2012. Berlin: Forschungszentrum für Umweltpolitik. FFU-Report 07–2011.

Barro, R. J., Sala-i-Martin, X. (2004): Economic Growth. 2nd ed. Cambridge, Mass.: MIT Press.

Beck, S., Born, W., Dziock, S., Görg, C., Hansjürgens, B., Henle, K., Jax, K., Köck, W., Neßhöver, C., Rauschmayer, F., Ring, I., Schmidt-Loske, K., Unnerstall, H., Wittmer, H. (2006): Die Relevanz des Millennium Ecosystem Assessment für Deutschland. Leipzig: UFZ. UFZ-Bericht 02/2006.

Binswanger, H.-C. (2010): Vorwärts zur Mäßigung. Perspektiven einer nachhaltigen Wirtschaft. 2. Aufl. Hamburg: Murmann.

Binswanger, H.-C. (2006): Die Wachstumsspirale. Geld, Energie und Imagination in der Dynamik des Marktprozesses. Marburg: Metropolis-Verlag.

Binswanger, H.-C., Frisch, H., Nutzinger, H. G., Schefold, B., Scherhorn, G., Simonis, U. E., Strümpel, B., Teichert, V. (1988): Arbeit ohne Umweltzerstörung. Strategien für eine neue Wirtschaftspolitik. Überarb. Fassung. Frankfurt am Main: Fischer-Taschenbuch-Verlag. Fischer Taschenbuch 4189.

Blasch, J., Schubert, R., Soete, B. (2010): Grün aus der Krise. Was können „grüne“ Konjunkturpakete leisten? Zürich: ETH Zürich, Institute for Environmental Decisions. IED Working Paper 10.

BMWi (Bundesministerium für Wirtschaft und Technologie) (2011): Energiedaten. Energiegewinnung und Energieverbrauch. Tabelle 6: Endenergieverbrauch nach Energieträgern. Deutschland. http://www.bmwi.de/BMWi/Navigation/Energie/Statistik-und-Prognosen/Energiedaten/energiegewinnung-energieverbrauch.html (19.12.2011).

BMWi, BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit) (2010): Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung. Berlin: BMWi, BMU.

Böcher, M. (2007): Wissenschaftliche Politikberatung und politischer Prozess. In: Krott, M., Suda, M. (Hrsg.): Macht Wissenschaft Politik? Erfahrungen wissenschaftlicher Beratung im Politikfeld Wald und Umwelt. Wiesbaden: VS Verlag für Sozialwissenschaften, S. 14–42.

Bofinger, P. (2010): Ist der Markt noch zu retten? Warum wir jetzt einen starken Staat brauchen. Akt. Ausg., 1. Aufl. Berlin: Ullstein. Ullstein 37341.

Bourcade, K., Herzmann, K. (2006): Normalfall exponentielles Wachstum? Ein internationaler Vergleich. Zeitschrift für Wachstumsstudien 2, S. 4–10.

Bradshaw, C. J. A., Giam, X., Sodhi, N. S. (2010): Evaluating the Relative Environmental Impact of Countries. PLoS ONE 5 (5), S. 1–16.

Braun, D. (1998): Der Einfluß von Ideen und Überzeugungssystemen auf die politische Problemlösung. Politische Vierteljahresschrift 39 (4), S. 797–818.

Bringezu, S. (2009): Targets for Global Resource Consumption. Vortrag, Factor X: Policies, strategies and instruments towards a sustainable resource use. Workshop des Umweltbundesamtes, 18.06.2009, Berlin.

Bringezu, S., Bleischwitz, R. (Hrsg.) (2009): Sustainable resource management: Global trends, visions and policies. Sheffield: Greenleaf Publishing.

Bringezu, S., Schütz, H. (2009): Nachhaltige Flächennutzung und nachwachsende Rohstoffe. Optionen einer nachhaltigen Flächennutzung und Ressourcenschutzstrategien unter besonderer Berücksichtigung der nachhaltigen Versorgung mit nachwachsenden Rohstoffen. Dessau-Roßlau: Umweltbundesamt. UBA-Texte 34/09.

Brondízio, E. S., Gatzweiler, F. (2010): Socio-cultural context of ecosystem and biodiversity valuation. In: Kumar, P. (Hrsg.): The economics of ecosystems and biodiversity – Economical and ecological foundations. London: Earthscan, S. 149–182.

Bruckmann, P. (2010): Umsetzung wissenschaftlicher Erkenntnisse in die Politik am Beispiel der EU Luftqualitäts-Richtlinien. Umweltmedizin in Forschung und Praxis 15 (2), S. 113–121.

Bruyn, S. M. de, Bergh, J. C. J. M. van den, Opschoor, J. B. (1998): Economic growth and emissions: reconsidering the empirical basis of environmental Kuznets curves. Ecological Economics 25 (2), S. 161–175.

Bundesregierung (2008): Für ein nachhaltiges Deutschland. Fortschrittsbericht 2008 zur nationalen Nachhaltigkeitsstrategie. Berlin: Presse- und Informationsamt der Bundesregierung.

Buyny, Š., Klink, S., Lauber, U. (2009): Weiterentwicklung des direkten Materialinputindikators. Endbericht. Dessau-Roßlau, Wiesbaden: Umweltbundesamt, Statistisches Bundesamt.

Capra, F., Henderson, H. (2009): Qualitative Growth. A conceptual framework for finding solutions to our current crisis that are economically sound, ecologically sustainable, and socially just. London: Institute of Chartered Accountants in England and Wales.

Chontanawat, J., Hunt, L. C., Pierse, R. (2008): Does energy consumption cause economic growth?: Evidence from a systematic study of over 100 countries. Journal of Policy Modeling 30 (2), S. 209–220.

Cleveland, C. J., Ruth, M. (1997): When, where, and by how much do biophysical limits constrain the economic process? A survey of Nicholas Georgescu-Roegen's contribution to ecological economics. Ecological Economics 22 (3), S. 203–223.

Costanza, R., D'Arge, R., Groot, R. de, Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., Belt, M. van den (1997): The value of the world's ecosystem services and natural capital. Nature 387 (6630), S. 253–260.

Crutzen, P. J. (2002): Geology of mankind. Nature 415 (6867), S. 23.

Cullen, J. M., Allwood, J. M., Borgstein, E. H. (2011): Reducing Energy Demand: What are the Practical Limits? Environmental Science & Technology 45 (4), S. 1711–1718.

Daly, H. E. (2009): Steady-State-Ökonomie. Ein Wirtschaftssystem des langfristigen Gleichgewichts. Zeitschrift für Sozialökonomie 162/163, S. 39–42.

Daly, H. E. (2005): Economics in a full world. Scientific American 293 (3), S. 100–107.

Daly, H. E. (1997): Georgescu-Roegen versus Solow/Stiglitz. Ecological Economics 22, S. 261–266.

Daly, H. E. (1996): Beyond Growth. The Economics of Sustainable Development. Boston, Mass.: Beacon Press.

Daly, H. E. (1992): Allocation, distribution, and scale: towards an economics that is efficient, just, and sustainable. Ecological Economics 1992 (6), S. 185–193.

Dasgupta, P., Heal, G. M. (1979): Economic Theory and Exhaustible Resources. Welwyn: Nisbet.

Diefenbacher, H., Zieschank, R. (2009): Wohlfahrtsmessung in Deutschland. Ein Vorschlag für einen nationalen Wohlfahrtsindex. Dessau-Roßlau: Umweltbundesamt. UBA-Texte 02/10. http://www.umweltdaten.de/publikationen/fpdf-l/3902.pdf (05.07.2010).

Domar, E. D. (1968): Kapitalexpansion, Wachstumsrate und Beschäftigung. In: König, H. (Hrsg.): Wachstum und Entwicklung der Wirtschaft. Köln: Kiepenheuer & Witsch. Neue wissenschaftliche Bibliothek 23, S. 55–66.

Doyle, U., Vohland, K., Rock, J., Schümann, K., Ristow, M. (2007): Nachwachsende Rohstoffe – eine Einschätzung aus Sicht des Naturschutzes. Natur und Landschaft 82 (12), S. 529–535.

Dujmovits, R. (2009): Nicht erneuerbare Ressourcen, Grenzen des Wachstums und Fallstricke des technologischen Optimismus. Graz: Universität Graz, Institut für Finanzwissenschaft und Öffentliche Wirtschaft. Working Paper 2009–1.

Easterlin, R. A. (1974): Does Economic Growth Improve the Human Lot? In: David, P. A., Reder, M. W. (Hrsg.): Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz. New York: Academic Press, S. 89–125.

ECF (European Climate Foundation), McKinsey & Company, KEMA, The Energy Futures Lab at Imperial College London, Oxford Economics (2010): Roadmap 2050: A practical guide to a prosperous, low-carbon Europe. Vol. 1: Technical analysis. Den Haag: ECF. http://www.roadmap2050.eu/attachments/files/Volume1_fullreport_PressPack.pdf (20.04.2010).

Edenhofer, O., Knopf, B., Barker, T., Baumstark, L., Bellevrat, E., Chateau, B., Criqui, P., Isaac, M., Kitous, A., Kypreos, S., Leimbach, M., Lessmann, K., Magné, B., Scrieciu, S., Turton, H., Vuuren, D. P. van (2010): The Economics of Low Stabilization: Model Comparison of Mitigation Strategies and Costs. The Energy Journal 31 (Special Issue 1), S. 11–48.

Edenhofer, O., Knopf, B., Kalkuhl, M. (2009): CCS: CO2-Sequestrierung: Ein wirksamer Beitrag zum Klimaschutz? ifo Schnelldienst 62 (3), S. 3–6.

EEA (European Environment Agency) (2010a): The European environment – State and outlook 2010. Assessment of global megatrends. Copenhagen: EEA.

EEA (2010b): The European environment – State and outlook 2010. Synthesis. Copenhagen: EEA.

Ehrlich, P. R., Ehrlich, A. (1981): Extinction: The Causes and Consequences of the Disappearance of Species. New York, NY: Random House.

Ekins, P. (2000): Economic Growth and Environmental Sustainability. The prospects for green growth. London, New York: Routledge.

Elsenhans, H. (2011): The rise and demise of the capitalist world system. Leipzig: Leipziger Universitätsverlag.

Enderlein, H. (2010): Wenn der Kuchen nicht mehr größer wird. Berliner Republik 2010 (2). http://www.b-republik.de/archiv/wenn-der-kuchen-nicht-mehr-groesser-wird (02.03.2012).

EREC (European Renewable Energy Council) (2010): RE-thinking 2050. A 100% Renewable Energy Vision for the European Union. Brüssel: EREC

EREC , Greenpeace International (Hrsg.) (2010): Energy [R]evolution. A Sustainable World Energy Outlook. 3rd ed. Brussels, Amsterdam: EREC, Greenpeace International.

Eser, U., Neureuther, A.-K., Müller, A. (2011): Klugheit, Glück, Gerechtigkeit. Ethische Argumentationslinien in der Nationalen Strategie zur biologischen Vielfalt. Bonn-Bad Godesberg: Bundesamt für Naturschutz. Naturschutz und Biologische Vielfalt 107.

Europäische Kommission (2011a): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Commitee and the Commitee of the Regions. Energy Roadmap 2050. COM(2011) 885/2. Brüssel: Europäische Kommission.

Europäische Kommission (2011b): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Fahrplan für den Übergang zu einer wettbewerbsfähigen CO2-armen Wirtschaft bis 2050. KOM(2011) 112 endg. Brüssel: Europäische Kommission.

Europäische Kommission (2011c): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Lebensversicherung und Naturkaptial: Eine Biodiversitätsstrategie der EU für das Jahr 2020. KOM(2011) 244 endg. Brüssel: Europäische Kommission.

Europäische Kommission (2011d): Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen. Ressourcenschonendes Europa – eine Leitinitiative innerhalb der Strategie Europa 2020. KOM(2011) 21. Brüssel: Europäische Kommission.

Europäische Kommission (2007): Beyond GDP. Measuring progress, true wealth and the well-being of nations Brüssel: Europäische Kommission, GD Umwelt und GD Eurostat. http://www.beyond-gdp.eu/ (19.12.2011).

FAO (Food and Agriculture Organisation) (2009): The state of world fisheries and aquaculture 2008. Rome: FAO.

Fischer-Kowalski, M., Swilling, M., Weizsäcker, E. U. von, Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A. (2011): Decoupling natural resource use and environmental impacts from economic growth. A report of the Working Group on Decoupling to the International Resource Panel. Genf: United Nations Environment Programme.

Fitoussi, J.-P., Laurent, É. (2008): La nouvelle écologie politique. Économie et développement humain. Paris: Éditions du Seuil et La République des Idées.

Flipo, F., Schneider, F. (Hrsg.) (2008): Proceedings of the First International Conference on Economic De-Growth for Ecological Sustainability and Social Equity. Paris, 18.–19. April 2008. Paris.

FoEE (Friends of the Earth Europe), SEI (Stockholm Environment Institute) (2009): The 40% Study. Mobilising Europe to achieve climate justice. Brüssel, Stockholm: FoEE, SEI.

Frey, B. S., Frey Marti, C. (2010): Glück – Die Sicht der Ökonomie. Wirtschaftsdienst 90 (7), S. 458–463.

Friedman, B. M. (2005): The Moral Case for Growth. The International Economy 40 (Fall 2005), S. 40–45.

Frondel, M., Peters, J., Vance, C. (2008): Identifying the Rebound: Evidence from a German Household Panel. The Energy Journal 29 (4), S. 154–163.

Frondel, M., Schmidt, C. M. (2004): Facing the truth about separability: nothing works without energy. Ecological Economics 51 (3–4), S. 217–223.

Genschel, P., Zangl, B. (2007): Die Zerfaserung von Staatlichkeit und die Zentralität des Staates. Aus Politik und Zeitgeschichte 2007 (20–21), S. 10–16.

Georgescu-Roegen, N. (1971): The entropy law and economic process. Cambridge, Mass.: Harvard University Press.

Giddens, A. (2009): The politics of climate change. Cambridge: Polity Press.

Girod, B., Haan, P. de (2009): GHG reduction potential of changes in consumption patterns and higher quality levels from Swiss household consumption survey. Energy Policy 37 (12), S. 5650–5661.

Gómez-Baggethun, E., Groot, R. de, Lomas, P. L., Montes, C. (2010): The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. Ecological Economics 69 (1), S. 1209–1218.

Grahl, J., Kümmel, R. (2006): Produktionsfaktor Energie – Der stille Riese. Energie & Zukunft 1, S. 1–20. http://www.sfv.de/pdf/prodelaspdf.pdf (02.03.2012).

Haas, P. M. (2004): When does power listen to truth? A constructivist approach to the policy process. Journal of European Public Policy 11 (4), S. 569–592.

Haas, P. M. (1992): Introduction: Epestemic Communities and International Policy Coordination. International Organization 46 (1), S. 1–35.

Haas, P. M., Keohane, R. O., Levy, M. A. (Hrsg.) (1993): Institutions for the Earth. Sources of Effecitve International Environmental Protection. Cambridge, Mass.: MIT Press.

Haberl, H., Erb, K. H., Krausmann, F., Gaube, V., Bondeau, A., Plutzar, C., Gingrich, S., Lucht, W., Fischer-Kowalski, M. (2007): Quantifying and mapping the human appropriation of net primary production in the Earth's terrestrial ecosystems. Proceedings of the National Academy of Sciences 104 (31), S. 12942–12947.

Habermas, J. (1992): Faktizität und Geltung. Beiträge zur Diskurstheorie des Rechts und des demokratischen Rechtsstaats. 4. Aufl. Frankfurt am Main: Suhrkamp.

Hansen, J., Sato, M., Kharecha, P., Beerling, D., Berner, R., Masson-Delmotte, V., Pagani, M., Raymo, M., Royer, D. L., Zachos, J. C. (2008): Target atmospheric CO2: Where should humanity aim? Open Atmospheric Science Journal 2008 (2), S. 217–231.

Harrod, R. F. (1968): Ein Essay zur dynamischen Theorie. In: König, H. (Hrsg.): Wachstum und Entwicklung der Wirtschaft. Köln: Kiepenheuer & Witsch. Neue wissenschaftliche Bibliothek 23, S. 35–54.

Hausmann, R., Velasco, A., Rodrik, D. (2008): Growth diagnostics. In: Serra, N., Stiglitz, J. E. (Hrsg.): The Washington Consensus reconsidered: Towards a new global governance. Oxford ; New York: Oxford University Press, S. 324–355.

Helm, D. R. (2010): Rethinking the Economic Borders of the State. London: The Social Market Foundation.

Helpman, E. (2004): The Mystery of Economic Growth. Cambridge, Mass.: Belknap Press.

Hertin, J., Hey, C., Ecker, F. (2010): The Future of the European Electricity Supply: Moving from Energy-Mix Projections to Renewables-Based Scenarios. Renewable Energy Law and Policy Review 1 (2), S. 131–139.

Hinterberger, F., Hutterer, H., Omann, I., Freytag, E. (Hrsg.) (2009): Welches Wachstum ist Nachhaltig? Ein Argumentarium. Wien: Mandelbaum.

Hirsch, F. (1980): Die sozialen Grenzen des Wachstums. Eine ökonomische Analyse der Wachtumskrise. Reinbeck bei Hamburg: Rowohlt.

Holzinger, H. (2010): Wirtschaften jenseits von Wachstum? Befunde und Ausblicke. Salzburg: Robert-Jungk-Bibliothek für Zukunftsfragen. Zukunftsdossiers 1.

Homer-Dixon, T. (2006): The upside of down. Catastrophe, creativity and the renewal of civilization. Washington, Covelo, London: Island Press.

Höpflinger, F. (2010): Alterssicherungssysteme: Doppelte Herausforderung von demografischer Alterung und Postwachstum. In: Seidl, I., Zahrnt, A. (Hrsg.): Postwachstumsgesellschaft. Konzepte für die Zukunft. Marburg: Metropolis-Verlag. Ökologie und Wirtschaftsforschung 87, S. 53–63.

Huesemann, M. H. (2003): The limits of technological solutions to sustainable development. Clean Technologies and Environmental Policy 5 (1), S. 21–34.

IPCC (Intergovernmental Panel on Climate Change) (2011): Summary for Policy Makers. In: IPCC (Intergovernmental Panel on Climate Change) (Hrsg.): Renewable Energy Sources and Climate Change Mitigation. Special Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, S. 3–26.

IPCC (2007): Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

Jackson, T. (2009a): Prosperity without growth. Economics for a finite planet. London: Earthscan.

Jackson, T. (2009b): Prosperity without growth? The transition to a sustainable economy. London: Sustainable Development Commission UK.

Jaeger, C. C. (2011): Wachstum – wohin? Eine kurze Geschichte des 21. Jahrhunderts. München: oekom. Carl-von-Carlowitz-Reihe 2.

Jaeger, C. C., Horn, G., Lux, T. (2009): Eckpunkte einer nachhaltigen Antwort auf die Wachstumskrise. Gutachten im Rahmen der Studie „Wege aus der Wachstumskrise“. Potsdam, Kiel, Düsseldorf: European Climate Forum, Institut für Weltwirtschaft, Institut für Makroökonomie und Konjunkturforschung, Potsdam-Institut für Klimafolgenforschung.

Jaeger, C. C., Paroussos, L., Mangalagiu, D., Kupers, R., Mandel, A., Tabara, J. D. (2011): A New Growth Path for Europe. Generating Prosperity and Jobs in the Low-Carbon Economy. Synthesis Report. Potsdam: European Climate Forum.

Jänicke, M. (2010a): Die Akzeleration von technischem Fortschritt in der Klimapolitik – Lehren aus Erfolgsfällen. Zeitschrift für Umweltpolitik und Umweltrecht 33 (4), S. 367–389.

Jänicke, M. (2010b): Innovationstempo in der Klimapolitik forcieren! In: Altner, G., Leitschuh, H., Michelsen, G., Simonis, U. E., Weizsäcker, E. U. von (Hrsg.): Die Klima-Manipulateure – Rettet uns Politik oder Geo-Engineering? Stuttgart: Hirzel. Jahrbuch Ökologie 2011, S. 138–147.

Jänicke, M. (2008): Megatrend Umweltinnovation. Zur ökologischen Modernisierung von Wirtschaft und Staat. München: oekom.

Jänicke, M. (2001): Towards an end to the „Era of Materials”? Discussion of a hypothesis. In: Binder, M., Jänicke, M., Petschow, U. (Hrsg.): Green Industrial Restructuring. International Case Studies and Theoretical Interpretations. Berlin: Springer, S. 45–57.

Jänicke, M., Jacob, K. (2008): Eine Dritte Industrielle Revolution? Wege aus der Krise des ressourcenintensiven Wachstums. In: BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit) (Hrsg.): Die Dritte Industrielle Revolution – Aufbruch in ein Ökologisches Jahrhundert. Dimensionen und Herausfoderungen des industriellen und gesellschaftlichen Wandels. Berlin: BMU, S. 10–31.

Jänicke, M., Volkery, A. (2001): Persistente Probleme des Umweltschutzes. Natur und Kultur 2 (2), S. 45–59.

Jarass, L. (2010): Faire und Effiziente Steuerpolitik. In: Seidl, I., Zahrnt, A. (Hrsg.): Postwachstumsgesellschaft. Konzepte für die Zukunft. Marburg: Metropolis-Verlag. Ökologie und Wirtschaftsforschung 87, S. 155–166.

Johnson, I. (2010): The New Economics of Growth, Wealth and Real Values: Towards a New Economics for a Global Society. Seed-Ideas. http://www.sd-network.eu/pdf/doc_workshops/2010%20berlin/Ian%20Johnson%20-%20The%20New%20Economics% 20of%20Growth.pdf (22.12.2011).

Jones, C. I. (2002): Introduction to Economic Growth. 2nd ed. New York, NY: Norton.

Kaldor, N., Mirrlees, J. A. (1968): Ein neues Modell des wirtschaftlichen Wachstums. In: König, H. (Hrsg.): Wachstum und Entwicklung der Wirtschaft. Köln: Kiepenheuer & Witsch. Neue wissenschaftliche Bibliothek 23, S. 97–124.

Kenworthy, L. (2011a): Is heavy taxation bad for the Economy? http://lanekenworthy.net/2011/05/22/is-heavy-taxation-bad-for-the-economy/ (15.12.2011).

Kenworthy, L. (2011b): Progress for the Poor. Oxford: Oxford University Press.

Kenworthy, L. (2010): Economic Growth, Social Policy and Poverty. Social Science Research Network. Tomorrow´s Research Today. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1666931 (15.12.2011).

Koo, R. (2003): Balance Sheet Recession. Japan´s struggle with uncharted economies and its global implications. Clementi Loop, Singapore: Wiley.

Kronenberg, T. (2010): Finding common ground between ecological economics and post-Keynesian economics. Ecological Economics 60 (7), S. 1488–1494.

Larigauderie, A., Mooney, H. (2010): The Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services: moving a step closer to an IPCC-like mechanism for biodiversity. Current Opinion in Environmental Sustainability 2 (1–2), S. 9–14.

Latouche, S. (2010): Editorial: Degrowth. Journal of Cleaner Production 18, S. 519–522.

Lawn, P. (2010): Facilitating the transition to a steady-state economy: Some macroeconomic fundamentals. Ecological Economics 69 (5), S. 931– 936.

Leeuw, S. van der (2010): The archaeology of innovation: Lessons for our times. In: Moss, F., Machover, T. E. (Hrsg.): Innovation: Perspectives for the 21st Century. Madrid: BBVA, S. 33–53.

Lenzen, M., Wier, M., Cohen, C., Hayami, H., Pachauri, S., Schaeffer, R. (2006): A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. Energy 31 (2–3), S. 181–207.

Lowi, T. J. (1972): Four Systems of Policy, Politics, and Choice. Public Administration Review 32 (4), S. 298–310.

MA (Millennium Ecosystem Assessment) (2003): Ecosystems and Human Well-being: A Framework for Assessment. Washington, DC: Island Press.

MacLean, H., Duchin, F., Hagelücken, C., Halada, K., Kesler, S. E., Moriguchi, Y., Mueller, D., Norgate, T. E., Reuter, M. A., Voet, E. van der (2010): Stocks, flows, and prospects of mineral ressources. In: Graedel, T. E., Voet, E. van der (Hrsg.): Linkages of sustainability. Cambridge, Mass., London: MIT Press, S. 199–218.

Majer, H. (Hrsg.) (1984): Qualitatives Wachstum Einführung in Konzeptionen der Lebensqualität Frankfurt am Main: Campus Verlag.

Meadows, D., Meadows, D., Zahn, E., Milling, P. (1972): Die Grenzen des Wachstums. Bericht des Club of Rome zur Lage der Menschheit. Stuttgart: Deutsche Verlags-Anstalt.

Meyer, B., Meyer, M., Distelkamp, M. (2011): The Policy Implications of Economy-Wide Rebound Effects: Insights From A Macroeconomic Model Simulation of Concurrent Climate Policy and Resource Efficiency Actions for Germany. Vortrag, European Association of Environmental and Resource Economists, 18th Annual Conference, 02.07.2011, Rome.

Miegel, M. (2010): Exit. Wohlstand ohne Wachstum. 3. Aufl. Berlin: Propyläen.

Mitchell, W., Muysken, J. (2008): Full Employment Abandoned. Shifting Sands and Policy Failures. Cheltenham: Edward Elgar.

Mol, A. P. J., Sonnenfeld, D. A. (Hrsg.) (2000): Ecological Modernization Around the World. Perspectives and Critical Debates. London, Portland, Or.: Frank Cass.

Moore, N. aus dem, Drautz, C., Graeger, L., Hommer, M., Jacobi, B., Leipprand, A., Lemke, M., Türk, V., Gracht, H. von der (2010): Wohlstand ohne Wachstum. Analyse von Wechselbeziehungen der drei Ökonomien. Berlin: Stiftung Neue Verantwortung. Policy Paper 2/10. http://www.stiftung-nv.de/143667,1031,111427,-1.aspx (11.10.2010).

Narayan, P. K., Prasad, A. (2008): Electricity consumption-real GDP causality nexus: Evidence from a bootstrapped causality test for 30 OECD countries. Energy Policy 36 (2), S. 910–918.

Niekisch, M. (2006): Internationale Entwicklungspolitik vor dem Hintergrund schwindender biologischer Ressourcen: Ein Beitrag zu den Beziehungen zwischen Naturschutz und Entwicklungszusammenarbeit. Natur und Landschaft 81 (9–10), S. 484–486.

Nitsch, H., Osterburg, B., Buttlar, C. von, Buttlar, H.-B. von (2008): Aspekte des Gewässerschutzes und der Gewässernutzung beim Anbau von Energiepflanzen. Braunschweig: Institut für Ländliche Räume, vTI. Arbeitsberichte aus der vTI-Agrarökonomie 03/08.

OECD (Organisation for Economic Co-operation and Development) (2011a): Tools for Delivering on Green Growth. Paris: OECD.

OECD (2011b): Towards Green Growth. Paris: OECD.

OECD (2008): OECD Environmental Outlook to 2030. Paris: OECD.

Offe, C., Borchert, J. (2006): Strukturprobleme des kapitalistischen Staates: Aufsätze zur Politischen Soziologie. Veränd. Neuausg. . Frankfurt am Main, New York: Campus.

Öko-Institut, Prognos AG (2009): Modell Deutschland – Klimaschutz bis 2050: Vom Ziel her denken. Endbericht. Basel, Freiburg: Prognos AG, Öko-Institut.

Ott, K. (2009): Zur Begründung der Konzeption starker Nachhaltigkeit. In: Hey, C., Koch, H.-J. (Hrsg.): Zwischen Wissenschaft und Politik. 35 Jahre Gutachten des Sachverständigenrates für Umweltfragen. Berlin: Erich Schmidt. Materialien zur Umweltforschung 38, S. 63–88.

Paech, N. (2009a): Die Postwachstumsökonomie – ein Vademecum. Zeitschrift für Sozialökonomie 160–161, S. 28–31.

Paech, N. (2009b): Wachstum „light"? Qualitatives Wachstum ist eine Utopie. Wissenschaft & Umwelt Interdisziplinär 2009 (13), S. 84–93.

Paqué, K.-H. (2010): Wachstum! Die Zukunft des globalen Kapitalismus. München: Hanser.

Patt, A., Komendantova, N., Battaglini, A., Lilliestam, J. (2011): Regional integration to support full renewable power deployment for Europe by 2050. Environmental Politics 20 (5), S. 727–742.

Payne, J. E. (2010): A survey of the electricity consumption-growth literature. Applied Energy 87 (3), S. 723–731.

PBL (Netherlands Enviornmental Assessment Agency) (2009): Growing within Limits. A Report to the Global Assembly 2009 of the Club of Rome. Bilthoven: PBL.

Pennekamp, J. (2011): Wohlstand ohne Wachstum. Ein Literaturüberblick. Köln: Max-Planck-Institut für Gesellschaftsforschung. MPIfG Working Paper 11/1.

Peukert, H. (2011): Die große Finanzmarkt- und Staatsschuldenkrise. Eine kritisch-heterodoxe Untersuchung. 3., erg. und akt. Aufl. Marburg: Metropolis-Verlag.

Pollitt, H., Barker, A., Barton, J., Pírgmaier, E., Polzin, C., Lutter, S., Hinterberger, F., Stocker, A. (2010): A Scoping Study on the Macroeconomic View of

Sustainability. Final Report for the European Commission, DG Environment. Cambridge, Wien: Cambridge Econometrics, Sustainable Europe Research Institute.

Priewe, J., Rietzler, K. (2010): Deutschlands nachlassende Investitionsdynamik 1991–2010. Ansatzpunkte für ein neues Wachstumsmodell. Berlin: Friedrich-Ebert-Stiftung.

PwC (PricewaterhouseCoopers), PIK (Potsdam-Institut für Klimafolgenforschung), IIASA (International Institute for Applied Systems Analysis), ECF (European Climate Forum) (2010): 100% renewable electricity. A roadmap to 2050 for Europe and North Africa. London, Potsdam, Laxenburg: PwC, PIK, IIASA, ECF. http://www.pwc.co.uk/pdf/100_percent_renewable_electricity.pdf (06.04.2010).

Raskin, P. D., Electris, C., Rosen, R. A. (2010): The Century Ahead: Searching for Sustainability. Sustainability 2010 (2), S. 2626–2651.

Reid, W. V., Mooney, H. A., Cropper, A., Capistrano, D., Carpenter, S. R., Chopra, K., Dasgupta, P., Dietz, T., Duraiappah, A. K., Hassan, R., Kasperson, R., Leemans, R., May, R. M., McMichael, T., Pingali, P., Samper, C., Scholes, R., Watson, R. T., Zakri, A. H., Shidong, Z., Ash, N. J., Bennett, E., Kumar, P., Lee, M. J., Raudsepp-Hearne, C., Simons, H., Thonell, J., Zurek, M. B. (2005): Ecosystems and Human Well-being. Synthesis. A Report of the Millennium Ecosystem Assessment. Washington, DC: Island Press.

Reuter, N. (2010): Der Arbeitsmarkt im Spannungsfeld von Wachstum, Ökologie und Verteilung. In: Seidl, I., Zahrnt, A. (Hrsg.): Postwachstumsgesellschaft. Konzepte für die Zukunft. Marburg: Metropolis-Verlag. Ökologie und Wirtschaftsforschung 87, S. 85–102.

Reuter, N. (2000): Ökonomik der „Langen Frist“. Zur Evolution der Wachstumsgrundlagen in Industriegesellschaften. Marburg: Metropolis-Verlag.

Rockström, J., Costanza, R., Will, S. (2011): How defining planetary boundaries can transform our approach to growth. Solutions 2 (3). http://www.thesolutionsjournal.com/node/935 (15.12.2011).

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., Wit, C. A. de, Hughes, T., Leeuw, S. van der, Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J. A. (2009): A safe operating space for humanity. Nature 461 (7263), S. 472–475.

Romer, D. (2012): Advanced macroeconomics. 4th ed. New York, NY: McGraw-Hill, Irwin.

Romer, P. M. (1990): Endogenous Technological Change. Journal of Political Economy 98 (5,2), S. 71–102.

Sachs, W., Santarius, T. (2005): Fair Future. Begrenzte Ressourcen und Globale Gerechtigkeit. Ein Report. Wuppertal: Wuppertal-Institut für Klima, Umwelt, Energie.

SCBD (Secretariat of the Convention on Biological Diversity) (2010a): COP 10 Decision X/2. Strategic Plan for Biodiversity 2011-2020. Montreal: SCBD. http://www.cbd.int/decision/cop/?id=12268 (19.12.2011).

SCBD (2010b): Global Biodiversity Outlook 3. Executive Summary. Montréal: SCBD. http://www.cbd.int/gbo/gbo3/doc/GBO3-Summary-final-en.pdf (19.12.2011).

Scharpf, F. W. (2011): Monetary Union, Fiscal Crisis and the Preemption of Democracy. Köln: Max-Planck-Institut für Gesellschaftsforschung. MPIfG Discussion Paper 11/11.

Scharpf, F. W. (2006): The Joint-Decision Trap Revisited. Journal of Common Market Studies 44 (4), S. 845–864.

Scherhorn, G. (2010): Hintergrundpapier zur Tagung „Politik in der Wachstumsfalle“. Vortrag, Tagung „Politik in der Wachstumsfalle“, 2.–4.07.2010, Loccum.

Schmidt-Bleek, F. (2009): Wo bleibt die Faktor-10-Revolution? Die Regierung ist am Zug. DNR-Themenheft 2009 (2), S. 4–5.

Schor, J. B. (2010): Plenitude. The New Economics of True Wealth. New York: Penguin Press.

Schümann, K., Engel, J., Frank, K., Huth, A., Luick, R., Wagner, F. (2010): Naturschutzstandards für den Biomasseanbau. Ergebnisse des gleichnamigen F+E-Vorhabens (FKZ 3507 82-150). Bonn-Bad Godesberg: Bundesamt für Naturschutz. Naturschutz und Biologische Vielfalt 106.

Schütz, H., Bringezu, S. (2008): Ressourcenverbrauch von Deutschland – aktuelle Kennzahlen und Begriffsbestimmungen. Erstellung eines Glossars zum „Ressourcenbegriff“ und Berechnung von fehlenden Kennzahlen des Ressourcenverbrauchs für die weitere politische Analyse. Dessau-Roßlau: Umweltbundesamt. UBA-Texte 02/08. www.umweltdaten.de/publikationen/fpdf-l/3426.pdf (04.01.2012).

Seidl, I., Zahrnt, A. (2010a): Staatsfinanzen und Wirtschaftswachstum. In: Seidl, I., Zahrnt, A. (Hrsg.): Postwachstumsgesellschaft. Konzepte für die Zukunft.

Marburg: Metropolis-Verlag. Ökologie und Wirtschaftsforschung 87, S. 179–188.

Seidl, I., Zahrnt, A. (Hrsg.) (2010b): Postwachstumsgesellschaft. Konzepte für die Zukunft. Marburg: Metropolis-Verlag. Ökologie und Wirtschaftsforschung 87.

Simonis, U. E. (2011): „Ökologischer Strukturwandel“ und „Green New Deal“. Beispiele transformativer Forschung. Berlin: Wissenschaftszentrum Berlin für Sozialforschung.

Solow, R. M. (1997): Reply: Georgescu-Roegen versus Solow-Stiglitz. Ecological Economics 22 (3), S. 267–268.

Solow, R. M. (1974): The Economics of Resources or the Resources of Economics. The Ameridan Economic Review 64 (2), S. 1–14.

Solow, R. M. (1968): Ein Beitrag zur Theorie des wirtschaftlichen Wachstums. In: König, H. (Hrsg.): Wachstum und Entwicklung der Wirtschaft. Köln: Kiepenheuer & Witsch. Neue wissenschaftliche Bibliothek 23, S. 67–96.

Sorrell, S. (2010): Energy, Economic Growth and Environmental Sustainability: Five Propositions. Sustainability 2 (6), S. 1784–1809.

Sorrell, S. (2007): The Rebound Effect: An assessment of the evidence for economy-wide energy savings from improved energy efficiency. London: UK Energy Research Centre.

Spangenberg, J. H. (2010): The growth discourse, growth policy and sustainable development: two thought experiments. Journal of Cleaner Production 18 (6), S. 561–566.

SRU (Sachverständigenrat für Umweltfragen) (2011a): Fischbestände nachhaltig bewirtschaften. Zur Reform der Gemeinsamen Fischereipolitik. Berlin: SRU. Stellungnahme 16.

SRU (2011b): Ökologische Leitplanken setzen, natürliche Lebensgrundlagen schützen – Empfehlungen zum Fortschrittsbericht 2012 zur nationalen Nachhaltigkeitsstrategie. Berlin: SRU. Kommentar zur Umweltpolitik 9.

SRU (2011c): Vorsorgestrategien für Nanomaterialien. Sondergutachten. Berlin: Erich Schmidt.

SRU (2011d): Wege zur 100 % erneuerbaren Stromversorgung. Sondergutachten. Berlin: Erich Schmidt.

SRU (2009): Für eine zeitgemäße Gemeinsame Agrarpolitik (GAP). Berlin: SRU. Stellungnahme 14.

SRU (2008): Umweltgutachten 2008. Umweltschutz im Zeichen des Klimawandels. Berlin: Erich Schmidt.

SRU (2007): Klimaschutz durch Biomasse. Sondergutachten. Berlin: Erich Schmidt.

SRU (2002): Umweltgutachten 2002. Für eine neue Vorreiterrolle. Stuttgart: Metzler-Poeschel.

Steffen, W., Crutzen, P. J., McNeill, J. R. (2007): The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature. AMBIO 36 (8), S. 614–621.

Stiglitz, J. E. (1997): Reply: Georgescu-Roegen versus Solow/Stiglitz. Ecological Economics 22 (3), S. 269–270.

Stiglitz, J. E., Sen, A., Fitoussi, J.-P. (2009): Report by the Commission on the Measurement of Economic Performance and Social Progress. http://www.stiglitz-sen-fitoussi.fr/ documents/rapport_anglais.pdf (05.07.2010).

Streeck, W. (2011): Taking Capitalism Seriously: Toward an Institutionalist Approach to Contemporary Political Economy. Köln: Max-Planck-Institut für Gesellschaftsforschung. MPIfG Discussion Paper 10/15.

SVR (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung), CAE (Conseil d'Analyse Economique) (2010): Wirtschaftsleistung, Lebensqualität und Nachhaltigkeit: Ein umfassendes Indikatorensystem. Expertise im Auftrag des Deutsch-Französischen Ministerrates. Paris, Wiesbaden: SVR, CAE. http://www. sachverstaendigenrat-wirtschaft.de/fileadmin/dateiablage/Expertisen/2010/ex10_de.pdf (04.01.2012).

TEEB (2010): The Economics of Ecosystems & Biodiversity: Mainstreaming the Economics of Nature. A synthesis of the approach, conclusions and recommendations of TEEB. Mriehel: Progress Press.

Thrän, D., Edel, M., Pfeifer, J., Ponitka, J., Rode, M., Knispel, S. (2011): Identifizierung strategischer Hemmnisse und Entwicklung von Lösungsansätzen zur Reduzierung von Nutzungskonkurrenzen beim weiteren Ausbau der Biomassenutzung. Leipzig: Deutsches BiomasseForschungsZentrum. DBFZ-Report 4

Torras, M., Boyce, J. K. (1998): Income, inequality, and pollution: a reassessment of the environmental Kuznets Curve. Ecological Economics 25 (2), S. 147–160.

UNDP (United Nations Development Programme) (2011): Human Development Report 2011. Sustainability and Equity: A Better Future for All. New York: UNDP.

UNEP (United Nations Environment Programme) (2011): Towards a GREEN economy. Pathways to Sustainable Development and Poverty Eradication. A Synthesis for Policy Makers. Genf: UNEP.

UNEP (2010): GREEN economy. Driving a Green Economy Through Public Finance and Fiscal Policy Reform. Genf: UNEP. Working Paper 10.

UNEP (2007a): Global Environment Outlook 4: environment for development. Valletta: Progress Press. http://www.unep.org/geo/GEO4/report/GEO-4_Report_Full_en.pdf (22.12.2011).

UNEP (2007b): Global Environment Outlook 4: environment for development. Summary for Decision Makers. Valletta: Progress Press.

UNEP, IPSRM (International Panel for Sustainable Resource Management) (2010): Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials. Nairobi: UNEP, IPSRM. http://www.unep.org/resourcepanel/documents/pdf/PriorityProductsAndMaterials_Report_Full.pdf (16.07.2010).

Veenhoven, R. (2012): World Database of Happiness: Continuous register of scientific research on subjective appreciation of life. Rotterdam: Erasmus University. http://www1.eur.nl/fsw/happiness/ (30.01.2012).

Victor, P. A. (2010): Ecological economics and economic growth. Annals of the New York Academy of Sciences 1185, S. 237–245.

Victor, P. A. (2008): Managing without Growth. Slower by Design, Not Disaster. Cheltenham, Northampton, Mass.: Edward Elgar.

Victor, P. A., Rosenbluth, G. (2007): Managing without growth. Ecological Economics 61 (2–3), S. 492–504.

Vohland, K., Mlambo, M. C., Horta, L. D., Jonsson, B., Paulsch, A., Martinze, L. I. (2011): How to ensur a credible and efficient IPBES? Environmental Science & Policy. First Published Online.

Walker, B., Salt, D. (2006): Resilience thinking. Sustainin Ecosystems and People in a Changing World. Washinton, DC: Island Press.

WBGU (Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen) (2011): Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation. Hauptgutachten. Berlin: WBGU.

WBGU (2009): Welt im Wandel. Zukunftsfähige Bioenergie und nachhaltige Landnutzung. Berlin: WBGU.

WBGU (2005): Welt im Wandel. Armutsbekämpfung durch Umweltpolitik. Berlin: Springer.

WBGU (2000): Welt im Wandel. Neue Strukturen globaler Umweltpolitik. Berlin: Springer.

WBGU (1997): Ziele für den Klimaschutz 1997. Stellungnahme zur dritten Vertragsstaatenkonferenz der Klimarahmenkonvention in Kyoto. Berlin: WBGU.

Weizsäcker, E. U. von, Hargroves, K., Smith, M. (2010): Faktor Fünf: Die Formel für nachhaltiges Wachstum. München: Droemer.

Welzer, H. (2011): Mentale Infrastrukturen. Wie das Wachstum in die Welt und in die Seelen kam. Berlin: Heinrich-Böll Stiftung. Schriften zur Ökologie 14.

Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., Thompson, J., Nilsson, M., Lambin, E., Sendzimir, J., Banerjee, B., Galaz, V., Leeuw, S. van der (2011): Tipping Toward Sustainability: Emerging Pathways of Transformation. AMBIO 40 (7), S. 726–780.

Wilkinson, R., Pickett, K. (2010): The Spirit Level. Why Equality is Better for Everyone. London: Penguin.

Wurzel, R. W. (2002): Environmental policy-making in Britain, Germany and the European Union. The Europeanisation of air and water pollution control. Manchester: Manchester University Press.

WWF (World Wide Fund for Nature), Ecofys, OMA (Office for Metropolitan Architecture) (2011): The Energy Report. 100% Renewable Energy by 2050. Gland: WWF.

WWF, Zoological Institute of London, Global Footprint Network (2010): Living Planet Report 2010. Biodiversität, Biokapazität und Entwicklung. Gland, London, Oakland, Calif.: WWF, Institute of Zoology, Global Footprint Network.

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