gws Discussion Paper 2015/3 ISSN 1867-7290

MEASURING TRANSFORMATION TOWARDS A GREEN ECONOMY IN GERMANY

Dr. Christian LUTZ (GWS mbH)
Roland ZIESCHANK (FFU)
Dr. Thomas DROSDOWSKI (GWS mbH)

Gesellschaft für Wirtschaftliche Strukturforschung mbH
Heinrichstr. 30
D - 49080 Osnabrück

Corresponding author:
Christian Lutz (lutz @ gws-os.com)
Tel.: +49 (541) 40933-120
Fax: +49 (541) 40933-110
Internet: www.gws-os.com

This research has been supported by the German Federal Environmental Agency as part of the UFOPLAN research project

„FKZ 3711 12 101: Green Economy: Measuring sustainable welfare using System of Environmental and Economic Accounting (SEEA) data".

Addresses of the authors:

Dr. Christian Lutz

Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH, Heinrichstr. 30,

49080 Osnabrück, lutz@gws-os.com

Roland Zieschank

Forschungszentrum für Umweltpolitik (FFU), Freie Universität Berlin, Ihnestr. 22, 14195 Berlin, zieschan@zedat.fu-berlin.de

Dr. Thomas Drosdowski

Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH, Heinrichstr. 30, 49080 Osnabrück, drosdowski@gws-os.com

Publisher of the gws Discussion Papers

Gesellschaft für Wirtschaftliche Strukturforschung mbH
Heinrichstr. 30
D - 49080 Osnabrück

ISSN 1867-7290

Title

Measuring transformation towards a green economy in Germany.

Publication date

April 2015

TABLE OF CONTENTS

Abstract

This paper reports results of the study „Green economy: Measuring sustainable welfare using SEEA data“. It contributes to measuring the progress towards green economy and its understanding for political decision making process in Germany. The definition of green economy follows the BMU approach of 2012. The concept to measure the green economy consists of six different dimensions: (A) use of natural resources and environmental damages, (B) natural capital, (C) environmental quality of life, (D) green economy: economic dimension and fields of action, (E) policies: institutional framework and measures, and (F) background information on economic and social development. For each dimension the concept includes indicators that can be generated from available data and in part have characteristics of desirable indicators. The concept is tested for Germany using scenario analysis (PANTA RHEI model) with regard to the energy transition (‘Energiewende’). Many indicators improve despite some trade-offs such as increases in resource use.

1 INTRODUCTION

Coinciding with the alarming reports on the global climate change and the state of the earth's ecosystems (e.g. MEA 2005, Rockström et al. 2009, Steffen et al. 2015), the global economy has experienced a sudden and painful economic and financial crisis beginning in 2008. This "double crisis" of economy and ecology (Bina & La Camera 2011) has intensified the search for solutions aiming at a new, social and ecological sustainable economy beyond simple growth strategies (Hertwich & Peters 2009, Wiedmann et al. 2014, Zieschank & Diefenbacher 2010, Diefenbacher, Zieschank & Rodenhäuser 2010). An emerging promising strategy has become "green economy" driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services, as defined by the United Nations Environment Programme in its report "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication" (UNEP 2011). Although conservative in nature due to its reliance on markets and technology (Brockington 2011), this detailed and thorough report provided an important foundation for the Rio+20 summit, during which representatives of 191 countries discussed a green economy in the context of sustainable development and poverty eradication as one of its only two topics. In the meeting's concluding UN resolution "The Future We Want" (2012), the international community officially acknowledged for the first time that green economy may enhance the ability to manage natural resources sustainably and with lower negative environmental impacts, to increase resource efficiency and reduce waste, even though no international commitments have been achieved, as Barbier (2012) emphasized in his critique.

As reflected by Bina (2013), the notion of green economy is far from being universally shared, ranging from business-as-usual to all-change strategies. By the definition of the German Federal Ministry for the Environment (BMU 2012), the term green economy describes an economic strategy that protects the climate, that continually reduces harmful emissions and pollutant inputs into the environment, that is based on closed cycle and waste management, that reduces the use of resources in absolute terms and that strictly acts in harmony with nature and environment. The concept of the green economy positively connects ecology and economy to increase social welfare and advance social justice. The concept is regarded as an example for an environmentally responsive economic development. It requires an action plan for all stakeholders in economy and society on the goods, labour and financial market, with regard to both supply and demand (BMU 2012).

Additionally, a green economy is supposed to contribute to the decrease of the risk level which was established historically and which affects natural, social as well as economic capital (Zieschank & Diefenbacher 2010, World Bank 2011). The risks imposed by the climate change, the loss of biodiversity, overfishing and ocean acidification or the increasing water scarcity endanger social welfare in many regions worldwide and the associated policy challenges are recognized by the OECD as well. Hence the conflict between ecology and economy does no longer exist in its fundamental form, when taking risk minimization into account (OECD 2011a).

In the study "Green Economy: Measuring sustainable welfare using System of Environmental and Economic Accounting (SEEA) data" (UBA 2013), which this paper is largely based upon, a measurement concept has been developed against the background of the current discussion centered around a green economy and measuring sustainable

welfare. Previous efforts by political and economic agents towards a green economy have not been easily recognizable and measurable, at least in a systematic and consistent way. The concept is based on an ecological welfare concept and applicable for environmental policy and societal transformation strategies. The related indicators are fillable with actual or estimated data, while at the same time some aspects of the concept generate new information requirements. Social aspects of a green economy are also taken into account, as long as they are related to environmental or economic impacts. Moreover, the concept includes further elements of welfare measurement such as interfaces between environment and health as well as justice.

The analytical focus regarding the development of indicators is set on the interlinkages between economy and environment. With regard to the environment, the most important issues and fields of action are considered and interlinked with the economically caused environmental pressures and according changes of the environmental condition. In addition, the indicator set accounts for both producers and those affected by environmental changes. Concerning the economy, both the output side, i.e. domestic production etc., and the expenditure side, e.g. consumption, are included. Additionally, both the macro and the meso level, i.e. the economic structure given by economic sectors, are illustrated.

Overall, the concept is on the one hand supposed to serve the monitoring of progress towards a green economy (ex-post). On the other hand, an estimation of options for action should be possible with some of the proposed indicators (ex-ante).

The article is divided into five sections. The following section 2 briefly discusses relevant existing measurement concepts and examines their applicability on the development of the concept presented here. Afterwards, the actual measurement concept for the progress towards a green economy is introduced (section 3). In section 4, results of a practical test with regard to the case of energy transition in Germany (“Energiewende”) are presented, focusing mainly on data availability and validity of a chosen subset of indicators. It is important to note that the requirements for a national documentation of changes towards a green economy and the requirements for a scenario analysis with regard to particular fields of action and instruments of environmental policy are different with respect to content and cannot be fully integrated. The final section 5 focuses on conclusions, further applications of the indicator concept and future lines of research.

2 Synopsis of relevant national and international measurement concepts

In this section, relevant (also model-based) contributions to the measurement of progress towards a green economy are briefly examined. The evaluation particularly points out to which extent beyond a narrow consideration of economic measurement and few environmental indicators the topic of green economy and welfare measurement is captured by the existing studies. The analysis highlights approaches that improve the measuring of a green economy by innovatively connecting indicators.

The synopsis clearly shows that the indicators so far available for the green economy field have hardly been fleshed out with respect to a more comprehensive notion of welfare. In addition, the given indicator sets concerning welfare measurement that are advanced in

comparison with the GDP are not universally designed to capture processes of a green economy in a more detailed way.

Only the approaches in the research project IN-STREAM (Bosello et al. 2011), by European Commission ("iGrowGreen") and the OECD (2011b) that are based on indicators can be regarded as highly important, especially regarding the realization of the latter in Germany (Federal Statistical Office of Germany 2013) and the Netherlands (Statistics Netherlands 2011). Although the indicator set of the Dutch Statistical Office based on the OECD green growth approach neglects the social dimension of economic and environmental development, it can serve as a basis of comparison. This is also valid regarding the OECD indicators of the Federal Statistical Office developed for Germany, which are discussed in the next section.

The global modelling approach of UNEP (2011) is intriguing due to the consideration of natural resources in the production function as well as the inclusion of green investments as part of a green economy strategy. Based on similar methodology, Musango et al. (2012) present a respective ex-ante modelling approach for South Africa. In the context of degrowth-transitions towards a sustainable steady state O'Neill (2012) defines a complete set of idealized indicators, divided into biophysical and social accounts. Bartelmus (2015) argues however, that available economic-environmental accounts already provide most of the necessary information.

The report of the Stiglitz-Sen-Fitoussi commission (2009) with its mainly conceptual approach is less helpful. Likewise, the joint work of the councils of French and German experts CAE & SVR (2010) that make interesting demands concerning future indicators, can hardly provide anything new regarding the main purpose of the paper.

The modelling approaches are particularly relevant regarding the practical test presented in section 4. Among them, an analysis of a study carried out by Jäger et al. (2011) shows that the approach is quite conventional concerning the contained indicators. Due to its inclusion of the international dimension and the utilization of very detailed environmental indicators, especially regarding the construction of the concept, the approach of the Swiss Federal Office for the Environment (FOEM 2011) is found to be relevant. In addition, the findings of some modelling studies (Meyer et al. 2012, Barker et al. 2011) could be taken into account.

Conversely, an examination of the WBCSD Vision 2050 (2011) has shown that it is not applicable for green economy measuring, except for the ecological footprint, which is used as an indicator of the international ecological dimension of sustainability.

Due to their logic of construction, composite indicators such as Adjusted National Savings (ANS, World Bank 2011) and National Welfare Index (NWI, Diefenbacher & Zieschank et al. 2013) as aggregated figures are not suitable for an implementation in a complex indicator system, particularly because some of their monetary valuations are yet preliminary. However, some subcomponents of the indices play a role with regard to the economic costs of damage caused by environmental pressures. Other studies concerning a correction of the GDP estimation consistent with welfare (with composite indicators such as ISEW (Daly & Cobb 1994) and GPI (e.g. Kubiszewski et al. 2014)) are not further followed in this analysis, because the studies follow the same logic of an aggregated monetary index. Nevertheless, these concepts of economic, ecological and social welfare

generate important inputs for designing the framework of a green economy indicator system, as described in the next section.

Finally, approaches in the area of ecosystem services research, in particular the international TEEB (2010) studies, appear to be promising. However, in their current state they have only been taken up conceptually in the indicator system to measure a green economy, as empirical and workable indicators on the national level are still missing.

3 THE CONCEPT TO MEASURE PROGRESS TOWARDS A GREEN ECONOMY

3.1 CORE ELEMENTS

Against the background presented in section 1, two approaches that could provide a conceptual-theoretical input in order to create a German measurement concept for a green economy and possible impulses for an increase of welfare, are subsequently highlighted in more detail.

The first relevant approach concerns the OECD initiative for the fostering of a green growth (OECD 2011a), in which the OECD has acknowledged that the pursuit of a green economic growth has to be very closely linked to an indicator set allowing the documentation of the transformation process itself as well as its expected successes. Accordingly, it has suggested an extensive set of sub indicators on international level to support the reporting of interested countries (OECD 2011b). The Federal Statistical Office of Germany has undertaken a more concrete implementation, presenting an indicator set constructed by following OECD guidelines (Federal Statistical Office of Germany 2013). Here most of the green growth indicators chosen by the OECD were implemented in a statistically adequate way, especially using data from the System of Environmental and Economic Accounting (SEEA). Due to their quality and thematic congruence with relevant sectors of a green economy, they could serve as a good basis for further analyses.

In the conceptual structure underlying the OECD approach, inputs (labour, capital, natural assets and environmental services) are transformed in production processes into goods that are demanded by other businesses, consumed by households or exported. Especially natural assets are supposed to be used sparingly and efficiently in order to contribute to a green economic growth. At the same time, emissions and waste or, respectively, environmental pressures in general are to be reduced. The individual parts of the OECD system (economy, environment and policies) are connected to four groups of indicators that cover (1) environment and resource productivity, (2) natural capital, (3) environmental quality of life as well as (4) economic opportunities and political reactions. The indicator set of the SEEA as an application of the OECD concept for Germany covers numerous single indicators for each of these groups (Federal Statistical Office of Germany 2013).

The second building block for the creation of a measurement concept to capture a green economy is a study in the context of the project “Basic points of an environmentally acceptable welfare concept as a foundation for environmental policy innovation and transformation processes” (cf. Meyer, Ahlert, Zieschank & Diefenbacher 2013, Ahlert et al. 2014). The results of this study serve as a conceptual framework to identify and structure the different dimensions or indicators to measure a green economy. Thus, a

sustainable welfare concept consists among others of a so-called "positive" model that contains the complex linkages between the environmental, the economic and the social system, as well as a "normative" model in which the alternatives for action can be located and estimated based on politically, administratively, ethically and socially established goals.

Within the concept, the notion of social welfare exceeds economic growth and an increase of the GPD as it involves both material and immaterial components of social prosperity. This means that welfare results from the combined application of economic goods and infrastructures (real economic and financial capital), skills and relationships in the society (human and social capital) and the available wealth of a country in the form of resources, ecosystems and their functions (natural capital) (Zieschank & Diefenbacher 2012). In this sense, nature is recognized as an explicit productive factor and not only as a natural resource, as advocated for example by Dasgupta (2008).

Such a welfare concept requires an optimization of welfare (i.e. the realization of economic and social goals) subject to the condition that important environmental objectives are achieved. Above all, this implicates a strategy of absolute decoupling of the environmental pressures from the economic development. As the measuring of a green economy is understood as an ambitious task, involving contributions towards achieving environmental goals, the question of appropriate reference points arises.

In addition to the given main parts on which the intended measurement of a green economy can be based – on the one hand categories with indicator suggestions from the OECD and on the other hand the new conceptual frame of an ecological welfare model – some theoretical assumptions and conceptual ideas from the political economy and the environmental policy research are included.

The basis of a theoretical argumentation for the necessity of a green economy is the problem of the "externalization" of associated costs of economic activity. Thus, the thesis that a green economy will constitute the modern counterpart to the development of a social market economy, which has prevented the negative social outcomes of the industrialization and reduced its negative impacts, is supported. Similarly, the negative environmental consequences of the progressing industrialization can only be overcome appropriately by the development of a green economy that needs to be initiated and supported by a functioning environmental policy oriented towards sustainability.

Overcoming the environmental problems caused by economic processes is a central component of a modern welfare concept, if one takes natural capital into account as a crucial basis of social wellbeing and progress (cf. Zieschank & Diefenbacher 2010, World Bank 2011, SRU 2012). As a result, the thesis can therefore be supported, that the modern welfare state is based on the regulation and at least partly on the overcoming of social as well as ecological risk situations.

From this, several conclusions that exceed the OECD approach and simultaneously fit well into the concept of social welfare as an increase of economic, social and natural capital can be drawn for a concept to measure a green economy. The main conclusion is that nature and environment should become an integral component of an economic accounting. Supporting arguments for this integration are included in Bartelmus (2015). A stronger inclusion of the production functions of nature (ecosystem services) is desirable but at the same time very challenging (Kallis et al. 2013).

Regarding the costs of violation of the ecological limits, accounting of environmental damages brought by production and consumption activities in a country has to be an integral component to capture the state of a green economy as well. An amortization of environmental investments that do not only have an ecological value but can also generate an economic value added for the society is more likely as the specific time horizon is prolonged into the future. The demand for an intelligent overall accounting with an adequate indicator system that displays the physical environmental pressures and reliefs on a national level in the long term can be deduced from this.

This logic leads to the concluding understanding of a green economy as being characterized by socioeconomic development processes in the economic system and by an intensive interaction with the political system, taking into account the limits of ecological sustainability, although these limits are formulated more or less strictly in different studies (e.g. Hayer et al. 2015, Steffen et al. 2015, United Nations 1992, 2014). Hence, green economy is equally a development process as well as a strongly politically influenced transformation process.

3.2 Measurement concept

In the proposed measurement concept six different dimensions and according groups of indicators as well as socioeconomic framework data are distinguished: (A) natural resource use and environmental damages, (B) natural capital, (C) environmental quality of life, (D) green economy: economic dimension and fields of action, (E) policies: institutional framework and measures, as well as (F) background information on economic and social development.

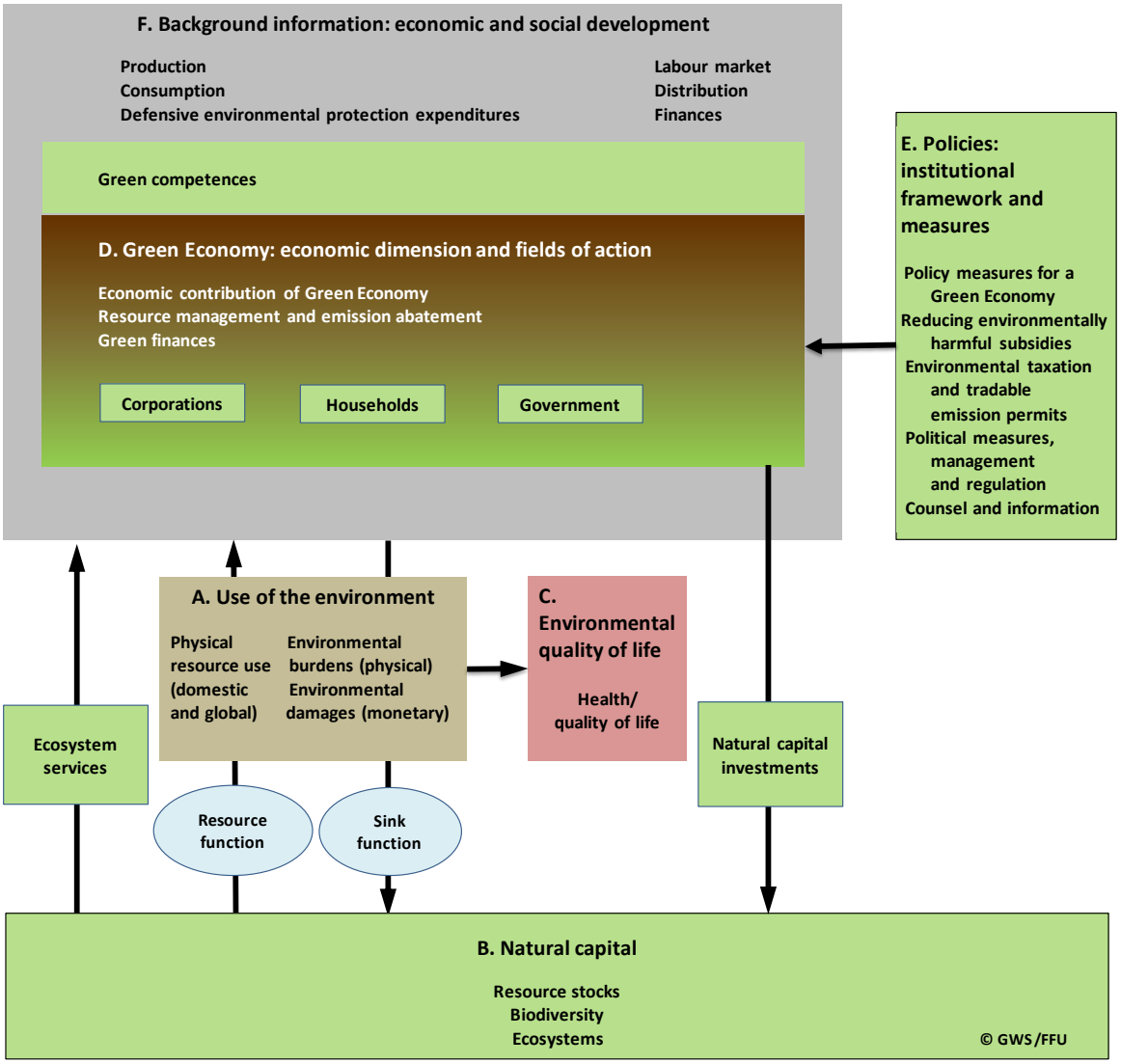
An illustration is displayed by Figure 1, which is partly related to the OECD Green Economy systematic, but contains new dimensions and relevant linkages between the main parts. The individual concept dimensions indicated with capital letters are associated with groups of indicators as their subcategories.

The core concept consists of two main dimensions, economy and environment, which have diverse interlinkages. The environment is important for the socioeconomic sector especially in its function as resource, as sink and as producer (or carrier) of ecosystem services. In the “traditional” socioeconomic system, only natural resources and the production factors labour and real capital provided by private households are transformed into goods and services in production processes. Additionally, financial capital, that can be transformed into real capital originates from company profits, the financial sector (for example private equity funds) or the central banks, has meanwhile become a new driving force to generate economic activities. Both production and consumption cause significant harmful environmental impacts that occur due to resource extraction, physical interventions in nature and landscape as well as emissions. As the study focuses on the national level, the situation in Germany is primarily highlighted at this stage; partial aspects of the international linkages are nevertheless kept in mind.

The logic of the concept is reflected by a broad set of around 100 indicators selected on the basis of existing measuring approaches. The indicators are preferably aggregated and proportional measures, i.e. related to national level or being percentage shares. Some of them are marked as “core indicators” due to their special importance and presentability.

The selection of the core indicators was undertaken depending on whether they can be connected with specific environmental policy goals so that directional reliability concerning their interpretation is ensured and the information value of practical tests can be increased. Furthermore, they can generally be considered as sufficiently established on the basis of broad literature evaluations and tested by statistical offices or, respectively, a part of officially published sets of indicators. Moreover, a compatibility with international indicator concepts is an additional advantage. The foundation is in part established by the SEEA data that was used to test the green growth approach in Germany too (Federal Statistical Office of Germany 2013).

Figure 1: Concept to measure progress towards a green economy



Source: own illustration.

Certain indicators that benefit from the conceptual foundation can currently not be developed mainly due to data limitations. They are marked as desirable indicators, which may be provided by public institutions in principle in the medium and long term. To a

large extent, the statistical data available in the year 2015 still draw from the ideas of the 1980s and 1990s, when end-of-pipe environment protection was focused upon.

The following detailed description of the concept is supported by indicator examples referring to some of its dimensions and categories.

Activities of private and public companies as well as consumers that decide on the transformation process towards a green economy take place in the economic system. Ecological modernization measures and modified consumption habits imply a growing economic importance of green sectors (dimension D) as e.g. increasing value added on the one hand. On the other hand, they can decrease the usage of the natural resources (displayed in the indicator table 1) and the pressures on the natural environment (dimension A) at the same time.

Table 1: Indicators of the category physical resource use (domestic)

Dimension A: natural resource use and environmental damages **Category: physical resource use (domestic)**	
Indicator/Index:	Energy use
	Water use
	Land use (settlement, transportation)
	Domestic material input
	Domestic material consumption
	Wood extraction
	Fish supply (from inland waters)

This progress is not only limited to the environmental protection industry but also involves the classical economic sectors that are interrelated. Particularly, the adoption of measures to increase resource and energy efficiency as well as emission reduction in these sectors, which, in many cases, is not policy-driven, is a key to the "mainstreaming" of environmental aspects and leads to an expansion of the green economy. At the same time, the awareness is growing that the classical separation in "green" and "brown" sectors of the economy has become obsolete and many classical sectors such as steel production or machinery can be central shapers of the green economy today (e. g. World Steel Association 2012). Table A in the appendix shows the concept indicators pertaining to resource management and emission abatement.

The financial economy plays an important, albeit ambivalent role in these processes. On the one hand, "green finance" provides a basis for environmental investments and innovations as private small and wholesale investors such as pension funds increasingly invest in accordance with ecological criteria. According to Barbier (2011), the funding problem poses the second most important challenge for green economy besides addressing further sustainability by markets, policy and institutions. On the other hand, the financial markets still tend to disregard environmental aspects in their profit-maximizing calculus. This is especially important in times of the financial crisis, as disruptions of the financial markets' core functions endanger the realization of important environmental projects.

The further development of the German economy towards a green economy is supported by the accumulation of "green competences" that have evolved by now and have become drivers of the transformation in Germany. This qualitative category contains according knowledge from the research and education sector, but also practical knowledge for example in mechanical engineering, new knowledge-intensive technologies and complementary qualifications as well as a high innovation capability in general. Included are also competences on political and administrative level, for example with regard to regulations and programs such as increasing of resource efficiency.

The natural environment is subject to negative changes due to production and consumption that entail the excessive depletion of natural resources, the excessive pressures on the ecosystem capacity as well as the exceeding of absorption boundaries for emissions and waste. The stock of natural assets (B) and their quality are reduced or degraded due to these flows. However, in this conception of a green economy it has to be emphasized that there is a possibility of a partial natural capital built-up by adequate investments. Moreover, the relevant ecosystem functions and services that are important for humans can be secured by the maintaining of ecosystems. If natural capital is seen as a major element of welfare for the economy and the society, then investments to foster the natural capital basis (indicator examples are given by Table 2) are an important and future-oriented task.

Table 2: Indicators of the category natural capital investments

Dimension B: natural capital **Category: natural capital investments**	
Indicator/Index:	Expenditure for nature protection
	Protected areas
	Agricultural environmental protection measures
	Expenditures for "green corridors" for biotope networking
	"Green" foreign aid

Meanwhile, the intensive use of nature and the generated pressures, in particular by emissions, do not only reduce natural stocks and potentials, they are also harmful for humans whose health and life quality is negatively affected as well (C). Besides, questions of distributional and social justice up to and including ethics are relevant due to the differences in vulnerability between social groups. This is valid regarding both physical and financial aspects. In principle, these questions would have to include the intergenerational dimension too (Diefenbacher, Zieschank, Duewell & Leggewie 2014).

Due to ecological modernization processes and economic structural change the use of resources, emissions and the excessive stress on ecosystem services can be reduced while the natural capital on the one hand as well as the environmental quality of life on the other hand can be maintained or in some cases increased. In this sense, it is important for welfare development of a society to what extent the costs of environmental damages and the expenses for the elimination or removal of these damages could be accounted for (Diefenbacher, Zieschank, Held & Rodenhäuser 2013). It cannot be assumed, however, that ecological degradation processes and damages can be universally reversed.

The transformation towards a green economy is inter alia dependent on institutional frameworks and measures (E) that offer incentives for companies and households and that directly affect the production and consumption sphere. Ideally, the environmental policy measures trigger a change of business activities and the behaviour of the population, consisting of private consumers and social stakeholders. In this respect, green economy is eventually a result of the interlinkages between economic stakeholders, institutional frameworks and measures as well as consumers and stakeholders of the civil society. Finally, the transformation to a green economy has to be seen in relation to further economic and social developments such as employment rate or the more conventional GDP (F). Such important background information is not directly part of the measurement concept, but it helps to put the development into context.

4 Practical test: ex-ante simulation of policy instruments in the energy-sector

Statistically available indicators were included in a practical test of feasibility and informative value of the concept in model analyses, which was conducted with the economy-energy-environment model PANTA RHEI (Lutz et al. 2005, Meyer et al. 2007, Lehr et al. 2008, Meyer et al. 2012). The behavioral equations of the model reflect bounded rationality rather than optimizing behavior of agents. All parameters are estimated econometrically from time series data from 1991 to 2010. Producer prices are the result of mark-up calculations of firms. Output decisions follow observable historic developments, including observed inefficiencies rather than optimal choices. The use of econometrically estimated equations means that agents have only myopic expectations and follow routines developed in the past. This implies in contrast to optimization models that markets will not necessarily be in an optimum and non-market (energy and environmental) policy interventions can have positive economic impacts.

A detailed description of the economic part of the model is presented in Maier et al. (2015). For detail of the complete model see Lutz (2011). Among others it has been used for economic evaluation of different energy scenarios that have been the basis for the German energy concept in 2010 (Lindenberger et al. 2010, Nagl et al. 2011), a recent energy reference forecast (Lutz et al. 2014a) and evaluation of the German energy transition within the monitoring process (GWS, Prognos, EWI 2014). Applications also include an evaluation of green ICT (Welfens & Lutz 2012), and employment impacts of renewable energy promotion (Lehr et al. 2012) and energy efficiency policies (Lutz et al. 2014b, Lutz & Lehr 2014).

Most indicators used in the practical test stem from the concept dimension “green economy: economic dimension and fields of action” (D). Some indicators were also taken from different categories of the dimension “natural resource use and environmental damages” (A), one indicator belongs to dimension “policies: institutional framework and measures” (E). Many indicators originate from the dimension “background information on economic and social development” (F) as well. However, indicators from dimension “environmental quality of life” (C) could not be used for the extended practical test. The situation regarding measures from the dimension “natural capital” (B) is similarly unsatisfying. An inclusion of indicators for natural gas, carbon and wood stock is nevertheless at least

possible. All "wish indicators" that were not included in the practical test belong to measures that cannot be provided by the official statistics producers or other comparable institutions yet, but are components of the measurement concept for good reason.

Especially indicators from dimension A (water utilization, land consumption, wood extraction, air pollutant emissions and their damage costs) are realizable in the future depending on some advanced modelling extensions. In addition, indicators for the macroeconomic importance of green economy and the material productivity belonging to dimension D can be calculated. Moreover, the inclusion of CO_2 emission certificates is possible. Further background information can be included as well.

The core of the practical test is the comparison of two different scenario calculations, one of which contains policy interventions by means of selected individual indicators of the newly developed measurement concept.

The energy sector in Germany was chosen as a current, relevant case of application. The simulations have been taken from the study "Economic evaluation of climate protection measures and instruments of different policy scenarios" for the Federal Environment Agency (Lehr et al. 2013, Lutz et al. 2014b). The policy scenarios for the climate protection VI (Öko-Institut et al. 2013) are the basis of the model-based analysis of the macroeconomic effects of climate protection measures. The policy scenarios concentrate on the illustration of climate protection measures in two scenarios: the Current Policies Scenario (CPS) takes all measures into consideration that have been implemented until 8 July 2011. The Energy Transition Scenario (ETS) also includes additional measures that contribute to the achievement of the climate protection goals of the German Government until 2030. Differences between the indicators, and hence between the measured welfare in both scenarios can be traced back to the measures of the scenario ETS then.

Compared to the scenario CPS, the scenario ETS is characterized by the need for additional investments in the extent of 25 to almost 40 billion Euros annually. These investments concentrate on energy efficiency measures and, as such, particularly on modernizing insulation of buildings. As a result, the gross domestic product in the scenario ETS is higher than in the ACS by 24 to 30 billion Euros. Positive employment effects range around 200 thousand additional employees.

The positive macroeconomic effects of the examined climate protection measures in the scenario EWS appear to be robust to changes of central assumptions. The results confirm findings of other studies about the macroeconomic effects of climate protection measures, in particular for the improvement of energy efficiency in Germany, both in direction and magnitude. Similar positive macroeconomic results are reported in country studies for Germany (Kuckshinrichs et al. 2012, Blazejczak et al. 2014) with annual net employment gains of some hundred thousand jobs due to additional energy efficiency measures and other countries such as Greece (Markaki et al. 2014). IEA (2014) also highlights the positive impacts of energy efficiency. Furthermore, the studies prove the macroeconomic advantages of the examined climate protection measures despite difficulties concerning a detailed comparison.

The results of the scenario ETS make clear that the validity of the development tendencies described in the reference scenario is largely maintained despite quantitative differences. Two clear, qualitative differences with respect to the reference are observed in the national material consumption which increases slightly in the scenario ETS together with

GDP and damages due to CO_2 emissions that decrease until 2030. The effect concerning the CO_2 damage costs is contingent upon the assumed linear increase of damage costs between 2010 and 2030.

The effects of the policy measures on the concept indicators assumed in the alternative scenario EWS as opposed to the reference CPS for the year 2030 show an explicit decline of the primary energy use (by 12.5 per cent). As a massive expansion of renewable energies is promoted at the same time, their share increases in the also decreasing final energy consumption (by more than 5 percentage points) and in the electricity consumption (by 6.6 percentage points). The decreasing energy consumption and the expansion of renewable energies are associated with the reduction of fossil fuel use in production processes. This results in a significant additional decrease of greenhouse gas emissions (by more than 16 per cent). The annual costs of carbon, calculated as CO_2 emissions multiplied by the linearly interpolated damage costs per tonne, are reduced by almost 16 billion Euros (-19 per cent).

The savings as part of the energy transition raise the cost efficiency of the national economy and cause an increase of the domestic demand in form of investments and consumption. The increase of the investments boosts the capital stock by approximately 2 per cent. In addition, private consumption (adjusted for price changes) increases by 3.1 billion Euros, which is low in terms of percentage points (0.2) however. In total, the annual increase of GDP adjusted for price changes amounts to nearly 30 billion Euros. This comes along with a higher employment and a hence decreasing unemployment rate.

The question whether the captured effects of the measures that are assumed in the alternative scenario EWS contribute to a green economy can be answered positively with a few exceptions. This is firstly due to the limited number of the considered indicators from the measurement concept. Secondly, some of the indicators such as domestic material consumption do not change in a desired direction. This case makes clear that the scenario measures do not represent a “one-fits-all” policy. Instead, it might be possible that the issue of material consumption has to be approached with further policy measures. However, if the other indicators used in the test are considered, a consistent transformation progress can be stated.

As expected, the first practical test that was run on the basis of a subset of indicators has led to a differentiated result that can be evaluated mainly positively with regard to the green economy. An even more complete and detailed illustration which would enable a better model-based evaluation focused here on environmental policy measures would be ensured by an inclusion of further indicators.

Table 3: Impact of energy transition on selected green economy indicators in 2030

Indicator	Absolute difference	Percentage deviation
Dimension A: natural resource use and environmental damages		
Primary energy consumption in PJ	-1426	-12.5
Domestic material input in mill. tonnes	23	1.9
Greenhouse gas emissions (index, 1990=100)	-8.7	-16.4
Damages caused by CO_2 emissions in bill. Euros	-15.7	-19
Dimension D: green economy: economic dimension and fields of action		
Energy productivity (index, 1990=100)	28.6	14.4
Share of renewable energies in total energy use in %	5.4	21.7
Share of renewable energies in electricity consumption in %	6.6	12.8
CO_2 productivity (index, 1990=100)	74.8	24.8
Dimension E: policies: institutional framework and measures		
Share of environmental taxes in total tax revenue in %	-0.9	-15.7
Dimension F: background information on economic and social development		
Gross domestic product (price adjusted) in bill. Euros	30	1.1
Structure of private consumption expenditure (in %): expendable goods	-0.8	-2.8
Structure of private consumption expenditure (in %): non-durable and durable goods	0.7	3.8
Structure of private consumption expenditure (in %): services	0.1	0.2
Capital stock (price adjusted, index, 2000=100): equipment	3.6	2.1
Capital stock (price adjusted, index, 2000=100): construction	3	2.1
Unemployment rate in %	-0.3	-8.2
Public debt: debt-GDP ratio in %	-4.7	-6.7

Source: own calculations.

5 CONCLUSION AND OUTLOOK

If environmental policies are to stop the trend of lagging behind the permanent problem generation by production and consumption processes, a transformation of the existing economy into a green economy will be a promising strategy. This transformation requires (1) a longer transitional phase in which social, political and economic learning processes can take place, (2) processes of readjustment, realignment and restructuring as well as (3) consideration of the consequences for the foreign trade relations in a green economy and foreign policy.

Such a complex process needs systematic, accompanying information systems for policy and administration not only in Germany. The strategic importance of an indicator system to measure a green economy arising from these considerations implies that a periodical reporting for an appropriate accounting has to be undertaken on a regular basis, which is the only way for a recording and discussion of positive and negative trends.

As Germany considers itself as a pioneer of environmental policies, the progress on the way to a green economy should be presentable in the national context, at first primarily on the macroeconomic level. Later on, given better data availability, progress by sectors, regions or certain stakeholders in the context of the further development towards a green economy can be identified and reported.

The international compatibility of the concept results inter alia from activities of the Federal Statistical Office of Germany (2013) that has provided core elements for the indicator system. Despite the concentration on the national development, the international perspective has also been partly considered, for example in the selection process of the concept categories (e.g. natural capital accounting), the evaluation of the existing international indicator systems and the inclusion of specific indicators.

As a conclusion it could be stated that it is sensible to develop an elaborated, national green economy indicator set at first that should definitely pose a challenge to the currently available data. Afterwards, this broad concept can be put up for discussion with other countries or internationally to seek or rather ensure a closer connection and mutual exchange.

Currently, several international organizations are looking for an application of measurement concepts such as the practical test reported in section 4, which could entail good possibilities for their use in an international context. In doing so, sufficient communicability and transferability of the concept that has been focused on Germany so far are important requirements.

To begin with, the suggested indicator system is a complex measurement concept that may appear to be abstract. However, it offers concrete possibilities to separate specific elements for a policy action field and hence to quickly provide an indicator set relevant for this policy field. An example could be the transport sector, for which some important indicators could be chosen from the set in the measurement concept, especially energy consumption, the increase of the area for settlement and transportation as well as the domestic material consumption from the category “physical resource utilization”.

It is apparent that an indicator system for the measurement of socioeconomic changes towards a green economy has to be sufficiently complex, at least from a scientific point of view. The presented first version addresses central elements that are currently discussed in the context of a green economy, especially against the background of an expected positive contribution to the increase of social welfare by a green economy.

This legitimizes the expenses for the creation and periodical updating of such an indicator set especially given the significant effort put into the design of a green economy that will not always be entirely free from controversy as the energy transition in Germany has already shown (see e.g. Schreurs & Ohlhorst 2015). Hence, an appropriate account for achieved progress, its documentation and presentation to politics, economy and society is all the more important. Based on long experience, one of the essential conditions for success for an indicator system is that it must be adequate regarding the issue that is to be

captured. Moreover, this insight is supported by the notion of evaluations with desirable indicators, which, in principle, could increase the informative value of the indicator system in the future.

A second important condition for a successful indicator system concerns the informative value for the users. Normative guidelines and general principles of a sustainable development that should be realized politically are found behind this concept. An indicator system has to be "target adequate" at the same time, so that the documented developments need to be interpretable (Jänicke & Zieschank 2004). Informational compression and communication of the results are supposed to exist as two linking building blocks between the numerous individual indicators on the one hand and the social relevance of the information on the other hand. The question of communication is strongly dependent on the type of target group, which can consist of experts, policymakers or the interested public. Communicative steps that use compressed, aggregating statements as a support, are to be incorporated between the information platform and policymakers or the interested public.

Based on experiences, it is important to initiate an iterative process where the development of a new information system results in an additional benefit for policymakers or economic decision makers as well as interested social groups – although there are yet conceptual gaps and empirical data is missing in parts. Based on such an interest and a "demand" in recognizable future, the propensity to eventually improve the data bases themselves increases. Subsequently, they increase the statement quality of the information system in another turn of the "supply and demand spiral".

Usually, this kind of process needs time, but it also leads to a certain acceptance or at least habituation to a new indicator system (Zieschank & Diefenbacher 2010). However, an administrative and, preferably, political support is a precondition; otherwise new indicators remain in the stadium of a study.

The opportunities of an extension and utilization of the given measurement concept make clear that different activities can be based on the previous studies on the measurability of sustainable welfare. Additions and extensions are particularly suitable with respect to the indicator set itself, the practical test, the development of policy recommendations and the communication of the results.

The gaps in the indicator set can be filled in the research areas concerning ecosystem services, the accounting of natural capital or social investments in nature and ecosystems, the development of "governance indicators" or environmental cost estimations referring to quality of life or costs of illness caused by air pollutants and in the field of social indicators, e.g. by the evaluation of ongoing studies. A comparison of results over a specific period can also be promising. While the practical test presented in section 4 concerning the energy transition including its modeling was applied ex-ante, an advanced ex-post comparison is conceivable, too.

As a final result, 'the state of the art' of a new green economy indicator set still reflects the ability of a country to deal with arising transformation processes in the economy, which results from a new welfare concept on the one hand (by preferring qualitative growth instead of rising GDP) and from the risks of overriding planetary boundaries and other Sustainable Development Goals (UNEP 2014, Martens & Obenland 2015) on the other hand.

In order to extend the measurement concept to sustainable welfare further economic and social sectors, financial capital, human capital and social capital, advanced international aspects will have to be included in the consideration. The flexibility of the approach presented here paves the way to its extension by these aspects, however. If the modernization and innovation impulses emanating from the environment protection sector influence other economy sectors positively through a "mainstreaming" of technologies and projects oriented towards resource management (see e.g. Jänicke & Zieschank 2012, Jänicke 2012), this transformation of the economy is to be understood as an important contribution to sustainable welfare, as environmental and social objectives are explicitly targeted here too.

REFERENCES

Ahlert, G., Meyer, B., Zieschank, R. & Diefenbacher, H. (2014): Basic Structures and Political Implications of a Sustainable Welfare Model, Journal of Environmental Science and Engineering, A3, pp. 189-203, ISSN 1934-8932.

Barbier, E. B. (2011): The policy challenges for green economy and sustainable economic development, Natural Resources Forum 35, pp. 233–245.

Barbier E. B. (2012): The green economy Post Rio+20, Science 338, pp. 887–888.

Barker, T., Lutz, C., Meyer, B., Pollitt, H. & Speck, S. (2011): Modelling an ETR for Europe. In: Ekins, P. & Speck, S. (ed.): Environmental Tax Reform (ETR) - A Policy for Green Growth, New York, pp. 204-235.

Bartelmus, P. (2015): Do we need ecosystem accounts?, Ecological Economics, forthcoming. doi:10.1016/j.ecolecon.2014.12.026

Bina, O. (2013): The Green Economy and Sustainable Development: An Uneasy Balance?, Environment and Planning C: Government and Policy, December 2013, v. 31, iss. 6, pp. 1023-1047.

Bina, O. & La Camera, F. (2011): Promise and shortcomings of a green turn in recent policy responses to the 'double crisis', Ecological Economics 70, pp. 2308–2316.

Blazejczak, J., Edler, D. & Schill, W.-P. (2014): Improved Energy Efficiency: Vital for Energy Transition and Stimulus for Economic Growth, DIW Economic Bulletin 4 / 2014, pp. 3–15.

Bosello, F., Portale, E., Campagnolo, L., Eboli, F. & Parrado, R. (2011): Sustainability index analysis, FP7 ENV 2007.1 – WP6: Costs of sustainability (general equilibrium analysis) – Deliverable 6.5.

Brockington, D. (2011): A Radically Conservative Vision? The Challenge of UNEP's Towards a Green Economy, Development and Change 43(1), pp. 409–422.

Conseil d'Analyse Économique (CAE) & German Council of Economic Experts (SVR) (2010): Monitoring economic performance, quality of life and sustainability. Joint Report as requested by the Franco-German Ministerial Council, Paris & Wiesbaden.

Daly, H. E. & Cobb, J. B. (1994): For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future, 2nd ed., Boston.

Dasgupta, P. (2008): Nature in economics, Environmental and Resource Economics 39(1), pp. 1–7.

Diefenbacher, H., Zieschank, R., Duewell, M., Leggewie, C., Petschow, U., Philips, J., Pissarskoi, E. & Sommer, B. (2014): Konzepte gesellschaftlichen Wohlstands und ökologische Gerechtigkeit. Studie im Auftrag des Umweltbundesamtes, Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit: Schwerpunkt 12. Übergreifende umweltpolitische Forschungsfragen. Forschungskennzahl 3711 11 103. In: Umweltbundesamt Reihe Texte 14/2014. URL: http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_45_2014_konzepte_gesellschaftlichen_wohlstands.pdf

Diefenbacher, H., Zieschank, R., Held, B. & Rodenhäuser, D. (2013): NWI 2.0 –Executive Summary. Heidelberg, Berlin.

Diefenbacher, H. & Zieschank, R. with contributions from Rodenhäuser, D. (2010): Measuring Welfare in Germany. A suggestion for a new welfare index. On behalf of the Federal Environment Agency (Germany), ISSN 1862-4804.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2012): Green Economy. New Impetus for Sustainability, Berlin.

Federal Office for the Environment (FOEM) (2011): Environmental Impacts of Swiss Consumption and Production. A combination of input-output analysis with life cycle assessment, Bern.

Federal Statistical Office of Germany (2013): Test of the OECD Set of Green Growth Indicators in Germany, Wiesbaden.

German Advisory Council on the Environment (SRU) (2012): Environmental Report 2012 – Responsibility in a finite World. Summary for Policy Makers, Berlin.

GWS, EWI & Prognos (2014): Gesamtwirtschaftliche Effekte der Energiewende. Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie, Osnabrück, Köln, Basel. URL: http://www.bmwi.de/DE/Mediathek/publikationen,did=662814.html

Hayer, M., Nilsson, M., Raworth, K. et al. (2015): Beyond Cockpitism: Four Insights to Enhance the Transformative Potential of the Sustainable Development Goals, Sustainability 2015/7, pp. 1651-1660; doi: 10.3390/su7021651.

Hertwich, E. G. & Peters, G. P. (2009): Carbon Footprint of Nations: A Global, Trade-Linked Analysis, Environ. Sci. Technol. 43 (16), pp. 6414–6420.

IEA (2014): Capturing the Multiple Benefits of Energy Efficiency, Paris.

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

Jänicke, M. (2012): ‘‘Green growth’’: From a growing eco-industry to economic sustainability, Energy Policy 48, pp. 13-21.

Jänicke, M. & Zieschank, R. (2011): Environmental Tax Reform and the Environmental Industry. In: Ekins, P. & Speck, S. (eds.): Environmental Tax Reform (ETR) – A Policy for Green Growth, Oxford, pp. 313-319.

Jänicke, M. & Zieschank, R. (2004): Zielbildung und Indikatoren in der Umweltpolitik. In: Müller, F & Wiggering, H. (Hrsg.): Umweltziele und Indikatoren - Wissenschaftliche Anforderungen an ihre Festlegung und Fallbeispiele. Gesellschaft für Umwelt-Geowissenschaften, Berlin, Heidelberg, pp. 39-62.

Kallis G., Gómez-Baggethun, E. & Zografos, C. (2013): To value or not to value? That is not the question, Ecological Economics 94, pp. 97-105.

Kubiszewski, I., Costanza, R., Franco, C., Lawn, P., Talberth, J., Jackson, T. & Aylmer, C. (2014): Beyond GDP: Measuring and achieving global genuine progress, Ecological Economics 93, pp. 57-68.

Kuckshinrichs, W., Kronenberg, T. & Hansen, P. (2010): The social return on investment in the energy efficiency of buildings in Germany, Energy Policy 38, pp. 4317-4329.

Lehr, U., Lutz, C. & Ulrich, P. (2013): Gesamtwirtschaftliche Wirkungen von Klimaschutzmaßnahmen und -instrumenten: Politikszenarien für den Klimaschutz VI, Climate Change 21/2013, Dessau-Roßlau.

Lutz, C., Lindenberger, D., Schlesinger, M. & Tode, C. (2014a): Energy Reference Forecast and Energy Policy Targets for Germany. Die Unternehmung, Swiss Journal of Business Research and Practice 3/2014, pp. 154-163.

Lutz, C., Lehr, U. & Ulrich, P. (2014b): Economic Evaluation of Climate Protection Measures in Germany, International Journal of Energy Economics and Policy 4(4), pp. 693-705.

Lutz, C. & Lehr, U. (2014): Macroeconomic Effects of Renewable Energy and Energy Efficiency Policies with a Focus on Germany. In: Bernhard. L., Semmler, W. (eds.): The Oxford Handbook of the Macroeconomics of Global Warming, Oxford University Press, pp. 477-496.

Lutz, C. (2011): Energy scenarios for Germany: Simulations with the model PANTA RHEI. In: Mullins, D, Viljoen, J, Leeuwner, H. (eds.): Interindustry based analysis of macroeconomic forecasting. Proceedings from the 19th INFORUM World Conference, Pretoria, pp. 203-224.

Lutz, C., Meyer, B., Nathani, C. & Schleich, J. (2005): Endogenous technological change and emissions: The case of the German steel industry, Energy Policy 33, 1143-1154.

Lutz, C., Zieschank, R. & Drosdowski, T. (2015): Green Economy: Measuring sustainable welfare using System of Environmental and Economic Accounting (SEEA) data, Federal Environment Office (UBA), forthcoming.

Maier, T., Mönnig, A. & Zika, G. (2015): Labour demand in Germany by industrial sector, occupational field and qualification until 2025 - model calculations using the IAB/INFORGE model. In: Economic Systems Research Vol. 27/1, pp. 19-42. DOI: 10.1080/09535314.2014.997678

Markaki, M., Belegri-Roboli, A., Michaelides, P., Mirasgedis, S. & Lalas, D.P. (2014): The impact of clean energy investments on the Greek economy: An input–output analysis (2010–2020), Energy Policy 57, 263–275.

Martens, J. & Obenland, W. (2015): Gut leben global. Neue Ansätze der Wohlstandsmessung und SDGs für Deutschland. Eds.: Global Policy Forum Europe and Terre des Hommes, Bonn/Osnabrück.

Matthes, F., Busche, J., Döring, U., Emele, L., Gores, S., Harthan, R., Hermann, H., Jörß, W., Loreck, C., Scheffler, M., Hansen, P., Diekmann, J., Horn, M., Eichhammer, W., Elsland, R., Fleiter, T., Schade, W., Schlomann, B., Sensfuß, F. & Ziesing, H. (2013) [Öko-Institut et al. 2013]: Politikszenarien für den Klimaschutz VI - Treibhausgas-Emissionsszenarien bis zum Jahr 2030, Climate Change 04/2013, Dessau-Roßlau. URL: http://www.umweltbundesamt.de/publikationen/politikszenarien-fuer-den-klimaschutz-vi

Meyer, B., Ahlert, G., Zieschank, R. & Diefenbacher, H. (2013): Eckpunkte eines ökologisch tragfähigen Wohlfahrtskonzeptes. Studie III im Rahmen des Projektes "Eckpunkte eines ökologisch tragfähigen Wohlfahrtskonzepts als Grundlage für umweltpolitische Innovations- und Transformationsprozesse" für das Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), GWS Research Report 2013/1, Osnabrück/Heidelberg/Berlin.

Meyer, B., Distelkamp, M. & Wolter, M.I. (2007): Material Efficiency and Economic-Environmental Sustainability. Results of Simulations for Germany with the Model PANTA RHEI, Ecological Economics 63(1), pp. 192-200.

Meyer, B., Meyer, M. & Distelkamp, M. (2012): Modeling green growth and resource efficiency: new results, Mineral Economics 24(2), pp. 145-154.

Millennium Ecosystem Assessment 2005 (2005): Ecosystems and Human Well-being: Synthesis, Washington, DC.

Musango, J.K., Brent, A.C. & Bassi, A.M. (2012): Modelling the transition towards a green economy in South Africa, Technological Forecasting & Social Change 87, pp. 257-273.

Nagl, S., Fürsch, M., Paulus, M., Richter, J., Trüby, J., Lindenberger, D. (2011): Energy Policy Scenarios to Reach Challenging Climate Protection Targets in the German Electricity Sector until 2050, Utilities Policy 19, pp. 185-192.

OECD (2011a): Towards Green Growth, Paris. URL: http://www.oecd.org/greengrowth/48224539.pdf.

OECD (2011b): Towards Green Growth. Monitoring Progress: OECD Indicators, OECD Publishing, Paris.

O'Neill, D.W. (2012): Measuring progress in the degrowth transition to a steady state economy, Ecological Economics 84, pp. 221-231.

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., de Wit, C. A., Hughes, T., van der Leeuw, S., 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, pp. 472–475.

Schreurs, M. & Ohlhorst, D. (2015): NIMBY and YIMBY: Movements for and Against Renewable Energy in Germany and the United States. In: NIMBY is Beautiful: Local Activism and Environmental Innovation in Germany and Beyond. Edited by Carol Hager and Mary Alice Haddad (forthcoming).

Statistics Netherlands (2011): Green growth in the Netherlands. The Hague/Heerlen, URL: http://www.cbs.nl/en-GB/menu/themas/macro-economie/publicaties/publicaties/archief/2011/2011-green-growth-pub.htm

Stiglitz, J., Sen, A. & Fitoussi, J.-P. (2009): Report by the Commission on the Measurement of Economic Performance and Social Progress, Paris.

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E. et al. (2015): Planetary boundaries: Guiding human development on a changing planet, Science Vol. 347 no. 6223. DOI: 10.1126/science.1259855. URL: http://www.sciencemag.org/content/347/6223/1259855.full

TEEB Report (2010a): The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations (edited by Kumar, P.), London.

The Federal Government (2012): National Sustainable Development Strategy. 2012 Progress Report.

UNEP (2011): Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. URL: http://www.unep.org/greeneconomy.

UNEP (2012): Measuring Progress towards an inclusive Green economy. URL: http://www.unep.org/greeneconomy.

United Nations (1992): Convention on Biological Diversity. URL: https://www.cbd.int/doc/legal/cbd-en.pdf

United Nations (2014): Synthesis Report of the Secretary-General on the Post-2015 Agenda: The Road to Dignity by 2030: Ending Poverty, Transforming All Lives and Protecting the Planet, New York.

Wiedmann, T., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J. & Kanemoto, K. (2013): The material footprint of nations. Proceedings of the National Academy of Sciences of the United States of America, August 2013. URL: www.pnas.org/cgi/doi/10.1073/pnas.1220362110

WBCSD (2011): A vision for sustainable consumption: Innovation, collaboration, and the management of choice.

World Bank (2011): The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium. Environment and Development.

World Steel Association (2012): Sustainable Steel. At the core of the green economy. Brussels. URL: http://www.worldsteel.org/dms/internetDocumentList/bookshop/Sustainable-steel-at-the-core-of-a-green-economy/document/Sustainable-steel-at-the-core-of-a-green-economy.pdf

Zieschank, R. & Diefenbacher, H. (2010): Jenseits des BIP: Der 'Nationale Wohlfahrtsindex' als ergänzendes Informationsinstrument, Wirtschaftspolitische Blätter 57. Jg. H4/2010, pp. 481-493.

Zieschank, R. & Diefenbacher, H. (2012): The National Welfare Index as a Contribution to the Debate on a More Sustainable Economy, FFU-Report 02-2012, Forschungszentrum für Umweltpolitik, FU Berlin.

APPENDIX

Table A: Indicators of the category resource management and emission abatement

Dimension D: green economy: economic dimension and fields of action **Category: resource management and emission abatement**	
Indicator/Index:	Sectoral energy use
	Energy productivity
	Share of renewable energies in total energy use
	Share of renewable energies in electricity consumption
	CO_2 productivity
	Waste treatment
	Recycling
	Utilization of harmful substances
	Material productivity
	Water productivity
	Transport volume in personal transportation
	Transport volume in freight transportation
	Modal split in personal transportation
	Modal split in freight transportation
	Organic farming
	Integrated environmental protection
	Diffusion of "green" management systems in companies