Moving towards a Common Approach on Green Growth Indicators

Green Growth Knowledge Platform Scoping Paper

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Green Growth Knowledge Platform

The Green Growth Knowledge Platform (GGKP) is a global network of researchers and development experts that identifies and addresses major knowledge gaps in green growth theory and practice. Through widespread consultation and world-class research, GGKP provides practitioners and policymakers with better tools to foster economic growth and implement sustainable development. The GGKP was officially launched in Mexico City in January 2012 by the Global Green Growth Institute (GGGI), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), and World Bank.

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Contents

I. Introduction

1. Green growth and green economy have been subject to various definitions but those currently being used by international organisations have a lot in common. Green growth seeks to fuse sustainable development's economic and environmental pillars into a single intellectual and policy planning process, thereby recasting the very essence of the development model so that it is capable of producing strong and sustainable growth simultaneously (Samans, 2013). It aims to foster economic growth and development, while ensuring that natural assets are used sustainably, and continue to provide the resources and environmental services on which the growth and well-being rely (OECD, 2011). It is growth that is efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts and resilient in that it accounts for natural hazards (World Bank, 2012). Green economy aims for improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). The concept of green economy rests on the economy, the environment and the social pillars of sustainable development. A broader concept of 'inclusive' green growth or sustainable development incorporates fully the social sustainability aspects, in particular enhancing human development and the conditions for the poor and vulnerable.

2. Greening growth (GG) and moving towards a greener economy (GE) is complex and multidimensional. It entails (i) pricing externalities and valuing natural assets for the long-run services they provide and pricing externalities; (ii) innovation as a means of breaking with unsustainable growth paths; (iii) the creation and dissemination of new, more environmentally sustainable technologies, goods, and services; and (iv) sectoral shifts and changes in comparative advantage that inevitably imply winners and losers. If GG/GE is to help move countries towards more sustainable development, the social consequences and local contexts of the transition to a greener economy must be central to managing change.

3. GG/GE policies need solid, evidence-based foundations. Assessing and communicating the need for policies and whether they achieve their stated goals requires proper monitoring of the underlying developments, progress, and potential opportunities and risks. GG/GE indicators can serve to improve the level of debate on GG/GE and inform the wider public.

4. At the 2012 UN Conference on Sustainable Development ("Rio+20"), the Heads of State and Government and high-level representatives recognized the indicators as a necessary means to assess progress towards the achievement of the sustainable development goals, while taking into account different national circumstances, capacities, and levels of development. Green economy has been proposed as a means for catalysing renewed national policy development and international cooperation and support for sustainable development.[1] And the relevant bodies of the UN system were requested to support collecting and compiling integrated and scientifically based information from national sources (UN 2012: The Future We Want).

[1] Source: UN Sustainable Development Knowledge Platform website.

5. Measuring progress on a complex and multi-dimensional change and identifying relevant indicators are challenging tasks. No agreement exists yet on an analytical framework or a set of indicators to monitor GG/GE. Data for natural capital is notoriously poor and efforts are needed to both collect and harmonise it. Different institutions are relying on different indicators (see Annex 1). Different national circumstances, capacities and levels of development add to the complexity of a common approach on indicators. And no single indicator will suffice to capture the many dimensions on which progress is needed. Yet, from a communication—and policy action—viewpoint, too many indicators can be confusing. Thus, further efforts to converge on an internationally agreed set of indicators are necessary.

6. This report is a first step towards developing a framework to monitor progress on GG/GE and is a joint effort by the OECD, UNEP, the World Bank, and GGGI as part of their collaboration on the Green Growth Knowledge Platform (GGKP). GGKP's mission is to enhance and expand efforts to identify and address major knowledge gaps in green growth theory and practice, and to help countries design and implement policies to move towards a green economy. The goal of this publication therefore is to propose a framework that provides a common basis for further developing GG/GE indicators, with a special focus on the economy-environment nexus.

7. The report is organized as follows. It first offers a conceptual framework to help select and organize indicators, and presents key principles for achieving high quality GG/GE indicators. Applying this framework and principles, it then proposes a "long list" of indicators selected from among the multitude of indicators that are currently used. But while a long list is necessary to monitor progress, it does not lend itself to easy communication or conclusions on whether progress is being achieved—which is why the report then explores a proposed dashboard of headline indicators. Wealth accounting, which can enable policymakers to move "beyond GDP" and look at whether growth is coming at the expense of asset depletion, is also reviewed as a complementary approach, albeit one that offers the advantages and inconveniences common to composite indicators. The final section looks at the limitations of these approaches (such as the assumption of substitutability between different type of assets), the challenges ahead (notably regarding data quality and availability), and sets out an agenda for further progress.

II. What is the role of measurement in the progress towards green growth and a green economy?

8. Indicators that measure either social or economic or environmental performance are broadly available and used effectively in capturing and communicating many developments associated with GG/GE. But the idea of specific GG/GE indicators is to go a step further in capturing the economy-environment nexus—that is, the extent to which economic activity is being "greened." Analysing the contribution of the environment to socio-economic development is complex because of the omission or

inadequate reflection of "environmental services"[2] as production inputs in the traditional national accounts' measurement of production. This can in turn be due to knowledge gaps regarding the role of environmental services, the lack of markets and prices for many natural assets and environmental services, and the externalities associated with public goods and services. This section reviews the motivation for the measurement agenda for GG/GE and the criteria that can guide the selection of workable sets of indicators.

a. A production framework can capture the nexus between the economy and the environment

9. The environment can be thought of as *natural capital*, and like other forms of capital, it delivers essential inputs into production and consumption (Hallegatte *et al*., 2012). But, as explained above, many of these inputs and the amenity services that support a broader notion of wellbeing are often not traded and hence not sufficiently well captured by standard economic and environmental indicators. Still, the notion of natural assets as a critical input into a production function can help illustrate many elements of GG/GE. A production function provides one such framework to organise thinking around indicators to measure progress on GG/GE (Figure 1).

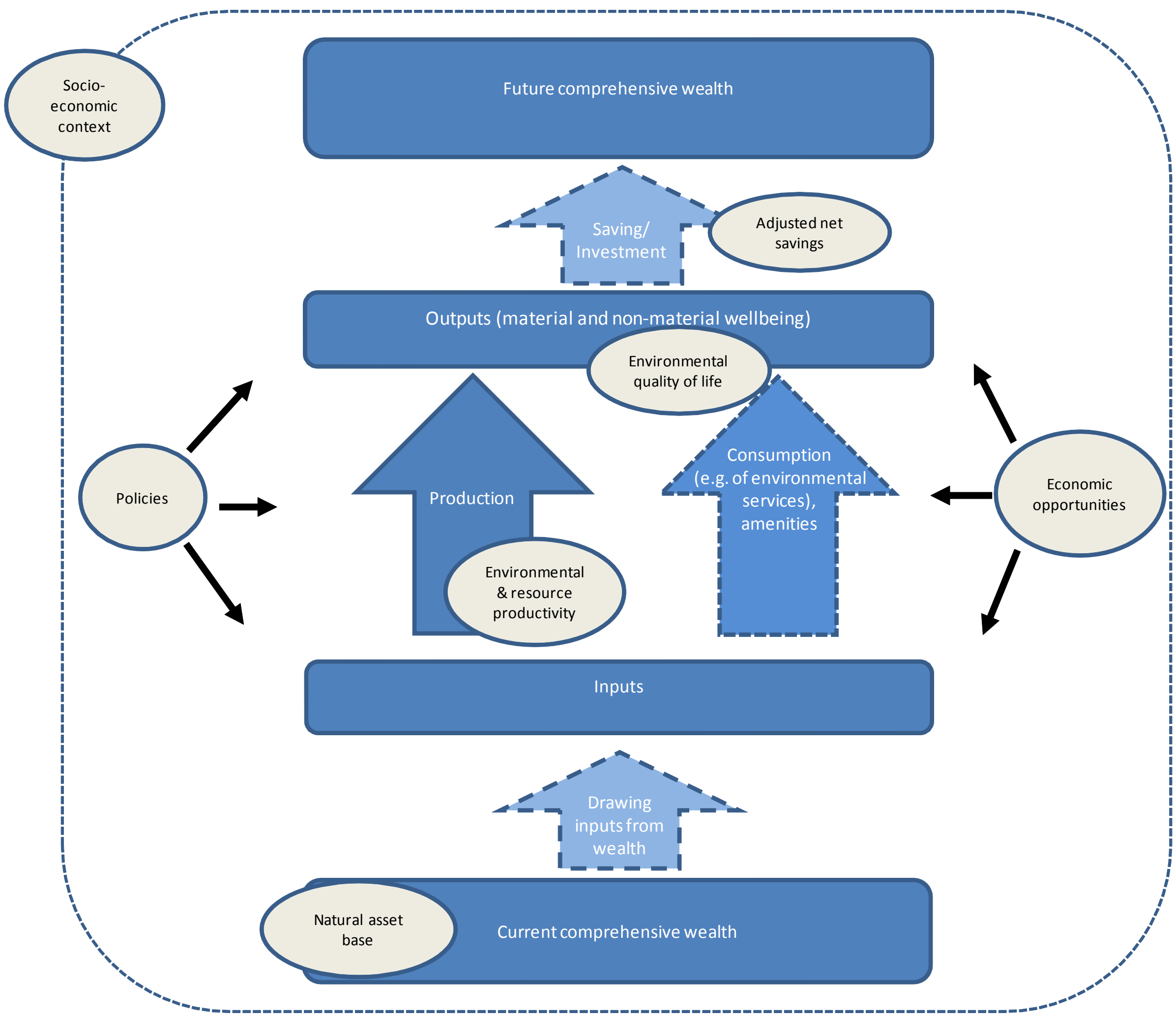
10. A coherent approach, mimicking the setup of a production sphere of a macroeconomic model, whereby inputs are transformed into outputs—as illustrated in Figure 1—can be used to classify GG/GE indicators by their main characteristics (OECD, 2011):

- *Inputs: the natural asset base.* Natural capital provides both services (including sink services for pollution) and natural resources, which constitute crucial inputs into production or directly affect wellbeing. Reducing the natural asset base need not necessarily contradict green growth given that the importance of assets may change owing to recycling, higher productivity, or substitution. But there is a need to monitor risks related to possible overuse and depletion, and there are limits to substitutability, particularly in the short term - hence depletion may lead to bottlenecks or threaten future prosperity. Indicators capturing the state of the natural asset base are crucial for identifying such risks.
- *Production: intensity/productivity*. This category comprises measures focusing on environment-related "productivity," or its inverse, "intensity." GG/GE indicators can measure progress in producing and consuming more while using fewer environmental *s*ervices and natural assets by linking a volume of measure of economic activity (such as GDP, value added, or consumption) to volumes of environmental services or natural resource inputs. Progress can also be captured by measures of product-life environmental footprints or various proxy measures of innovation—a key driver of GG/GE.

[2] For the purpose of this report, environmental services refer to the qualitative functions of natural non-produced assets of land, water and air (including related ecosystems) and their biota. There are three basic types of environmental services: (a) disposal services which reflect the functions of the natural environment as an absorptive sink for residuals, (b) productive services which reflect the economic functions of providing natural resource inputs and space for production and consumption, and (c) consumer or consumption services which provide for physiological as well as recreational and related needs of human beings. Throughout this report, the concept of "inputs" used is a broad one and includes services provided by the environment, such as sink functions of the atmosphere (UN Glossary of Environmental Statistics, 1997).

- *Outputs: material and non-material wellbeing.* Output refers to a broad notion of wellbeing to capture aspects that are not reported by conventional macroeconomic measures. Hence a category of indicators attempts to capture the *environment-related aspects of the quality of life*—that is, indicators related to the quality and availability of certain environment-related services and amenities. Many of the quality of life aspects measured also impact economic processes directly (for instance, by affecting labour productivity through effects on population health).

Figure 1. The production framework for GG/GE indicators and wealth accounting



Note: White ovals represent indicator categories.

11. The production function approach needs to be seen in the context of government policies, economic opportunities and the socio-economic background:

- *Policies and economic opportunities*. Policies affect the behaviour of economic agents and can distort or correct the incentives for economic decisions (for example, by ensuring that environmental considerations are factored in). This broad category of indicators looks at two types of indicators: indicators of GG/GE policies, and indicators of the transformation of the economy and the associated opportunities. It comprises policy measures that promote progress towards a resource-efficient economy and improve the management of natural assets. Because human development and innovation are key drivers of growth, the indicators should capture policies that tackle related market and government failures (for example, those that encourage human capital investment and foster innovation). Major policy issues relate to levying environmental taxes and reducing harmful subsidies that can facilitate fiscal consolidation, lower the burden of some of the more distortive taxes, and potentially create economic opportunities in terms of investments and jobs.
- *The socio-economic context*. Improvements in the environmental sustainability of economic growth should be assessed in the context of important social goals, such as poverty reduction, social equity and inclusion effectively linking the three pillars of sustainable development.The *economic context*, such as industrial structure or infrastructure endowments, affects the design and timing of GG/GE policies with sunk costs and path dependencies. The *social context*, including the interrelations within society and the distribution of specific groups across the economic and environmental systems, captures the social challenges and opportunities, and the potential tradeoffs or synergies related to particular developments or policy interventions. Many important indicators already exist, but important challenges remain, including relatively poor data availability, for instance on the precise contribution of amenity services to human well-being across income strata. Moreover, many social aspects and their relationship to economic and environmental aspects are even more difficult to capture in an integrated way. Identifying and assessing social implications in a well-defined and precise manner often requires the disaggregation of relevant indicators across income strata or associated proxies.

b. Standard criteria can help ensure that indicators of green growth/green economy are relevant for policy-making

12. The key rationale for GE/GG indicators is the need to provide evidence for monitoring, analysis, benchmarking, and communication. To accomplish this in domestic and international contexts, the setup for indicator selection needs to (i) be dynamic and flexible, with due regard to the need for continuity of surveillance; (ii) offer a balanced coverage of areas of greatest concern or relevance for GG/GE at a global level, while preserving the potential to adapt to countries' specific circumstances (such as a country's natural resource endowment or its social or institutional characteristics); and (iii) allow for the evolution of indicators (for example, the as new scientific evidence becomes available).

13. Selecting a limited set of quality GG/GE indicators does not pose challenges that vary markedly from those encountered in most other measurement domains. What matters is that the indicators are based on transparent criteria. Ideally indicators would fulfil the following criteria (OECD, 2011):

- *Policy relevance:* the indicator needs to address issues that are of (actual or potential) public concern relevant to policy-making. In fact, the ultimate test of any single indicator's relevance is whether it contributes to the policy process.
- *Analytical soundness:* ensuring that the indicator is based on the best available science is a key feature to assure that the indicator can be trusted.
- *Measurability:* the need to reflect reality on a timely and accurate basis and be measurable at a reasonable cost, balancing the long-term nature of some environmental, economic and social effects and the cyclicality of others. Definitions and data need to allow meaningful comparison both across time and countries or regions.
- *Usefulness in communication:* the ability to provide understandable, easily interpretable signals for the intended audience.

14. Some of the identified indicators, even if promising, may not be currently available. Still, identifying a particular concept as in need of measurement can provide an incentive to improve the data gathering and coverage across time and countries or stimulate further work on issues related to methodology or construction.

15. Of the five typical stages of public policy: agenda setting, policy formulation, decision-making, policy implementation, and (ideally, though in practice often not adequately) monitoring and evaluation, indicators are mainly relevant to agenda setting, policy formulation, and ex post monitoring and evaluation (UNEP, 2012). Decision-making and policy implementation are undertaken on the basis of the information embodied in indicators used in the policy formulation stage and policy implementation is to be monitored and evaluated with the indicators used for assessing policy options.

16. A number of themes are central in the work on GG/GE, as for example greenhouse gas emissions, natural assets including biodiversity, the environmental quality of life including access to clean water, and related policies concerning cost-effective management of natural resources. Still, there is no single green growth model and GG/GE strategies must be tailored to country conditions (OECD, 2011, World Bank 2012, UNEP, 2012). Poorer countries facing pressing issues of poverty and exclusion, weak institutional capacity, food and water insecurity, and poor infrastructure will pursue different policies than richer ones. Countries with abundant natural resources will face different policy options than those scarce in resources. Therefore, the measurement framework presented here gives countries flexibility to incorporate the green growth agenda in national plans to monitor progress with tackling the main environmental, economic and social concerns as identified in existing national plans. In this light, the current indicators being used by international organizations are being applied in various contexts in both developed and developing countries (see Box 1).

17. A final caveat, however, on selecting GE/GG indicators is that as in most other domains of measurement, indicators are often proxies or tend to simplify the underlying reality. Even the most

widely accepted measures have their weak points (OECD, 2013a). Transparency regarding the characteristics of indicators can assure that they are interpreted and used correctly and that policy makers and the wider public understand what exactly the indicators show.

Box 1. Applications of GG/GE indicators

Putting indicators to use allows evidence-based decision-making and is a prerequisite for mainstreaming the green growth agenda in policymaking. Reporting and measurement play a significant part in the policy work of the OECD, World Bank, GGGI, and UNEP.

OECD green growth measurement framework. The OECD's work on green growth measurement is part of a broader agenda on measuring well-being and sustainability. The *Towards Green Growth: Monitoring Progress* report was launched along with the Green Growth Strategy, and using OECD GG indicators has become part of member country initiatives on green growth (such as in the Czech Republic, Denmark, Germany, Korea, Mexico, the Netherlands, the Slovak Republic, and Slovenia). Other developed, emerging, and developing countries have approached the OECD to support their practical applications of green growth indicators. In the Latin American and Caribbean (LAC) region, Colombia, Costa Rica, Ecuador, Guatemala, Paraguay, and Peru are developing green growth indicator-based reports as well. A few countries in the Eastern Europe, Caucasus, and Central Asia (EECCA) and the East-Asian regions are also working on applying OECD indicators.

Feedback from countries shows that the adaptability of the OECD green growth measurement framework to various contexts and interests of developed, emerging, and developing countries has been the key. Countries have set priorities around its four main themes according to their specific circumstances and policy needs. For example, the OECD countries have generally found the "production-function" approach useful for measuring green growth. In the LAC region, countries have perceived the green growth indicators as a powerful tool to shape the national policy agenda primarily around the living standards of people related to the environment and opportunities from green growth. Long-term prospects for a commercially viable exploitation of natural assets have been the priority in the EECCA region, while economic opportunities were emphasised in the East Asian region.

World Bank-led WAVES Partnership. The World Bank-initiated Wealth Accounting and Valuation of Ecosystem Services (WAVES) Global Partnership provides technical support for implementing the System of Environmental and Economic Accounting (SEEA)—Central Framework, which the UN Statistical Commission adopted in 2012 as an international standard. The UN Statistical Commission has also endorsed a draft strategy for implementing the SEEA that will provide extensive technical support. These efforts, along with other initiatives (The Economics of Ecosystems and Biodiversity (TEEB), and Green Economy/Green Growth) provide global platforms for further technical support .

GGGI green growth indicators. These include several categories of indicators, each corresponding to a specific step and purpose in the standard process of country programs and projects supported by GGGI's flagship program, Green Growth Planning (GGP). The GGP aims to help developing countries create green growth plans and strategies by incorporating green economic considerations into economic development plans and growth strategies at the national and local levels. Diagnostics Indicators (DIs) are designed to assess the overall sustainability of the country and to identify key issues that should be considered in the GGP process. Planning Indicators (PIs), which are structured in accordance with the Pressure-State-Response approach, are designed to support the development of alternative green growth scenarios by constructing the cause-effect linkages between the sustainability issues highlighted by DIs and their pressures and impacts. Monitoring and Evaluation Indicators (MEIs) are designed to help track green growth progress and performance achieved by the GGP programs and projects.

UNEP green economy indicators. These fall into three major categories: (i)) indicators of issues and targets to be addressed by green economy policies, (ii) indicators of policy interventions, and (iii) indicators of impacts for ex ante assessment and ex post monitoring and evaluation of adopted policies. In December 2012, UNEP published a framework document "Measuring Progress towards an Inclusive Green Economy," and it is preparing a manual on using indicators to develop green economy policies. The manual is to be applied in all the countries where UNEP provides advisory services.

III. Converging on a set of indicators

18. The broad and complex nature of GG/GE is likely to require a range of monitoring tools. This section presents a possible set of indicators which are designed to help countries monitor progress towards GG/GE. This presentation is organised along the production function framework described earlier. It then suggests a complementary approach, focused less on monitoring and more on communication purposes, which involves selecting a handful of headline indicators to capture key areas of GG/GE. Comprehensive wealth accounting provides an additional lens for monitoring sustainability of overall economic developments.

An indicator set for monitoring of green growth/green economy

19. Using the framework and selection principles presented above, concrete indicators focused on the economy–environment nexus can be identified. This classification is largely based on OECD (2011).

a. Natural Asset Base

20. Indicators of the natural asset base can flag and hence help avoid or minimise risks of unsustainable future developments in growth and wellbeing by identifying the potential threats that arise from unwarranted natural asset depletion and/or degradation. Progress can be monitored by looking at stocks of environmental assets along with flows of environmental services. The main measures concern the availability and quality of renewable natural resource stocks including freshwater, forest, fish; the availability and accessibility of non-renewable natural resource stocks in particular mineral resources, including metals, industrial minerals and fossil energy carriers; and biological diversity and ecosystems including species and habitat diversity as well as land and soil resources (see Table 1).[3]

[3] The SEEA Central Framework guides the selection of topics for the natural asset base theme. Given that the SEEA excludes cultivated biological and land resources, a further distinction could be foreseen between cultivated and natural biological resources. The indicators for the strategic plan for biodiversity adopted at CBD COP 11 motivate the choice of biodiversity indicators in Table 1.

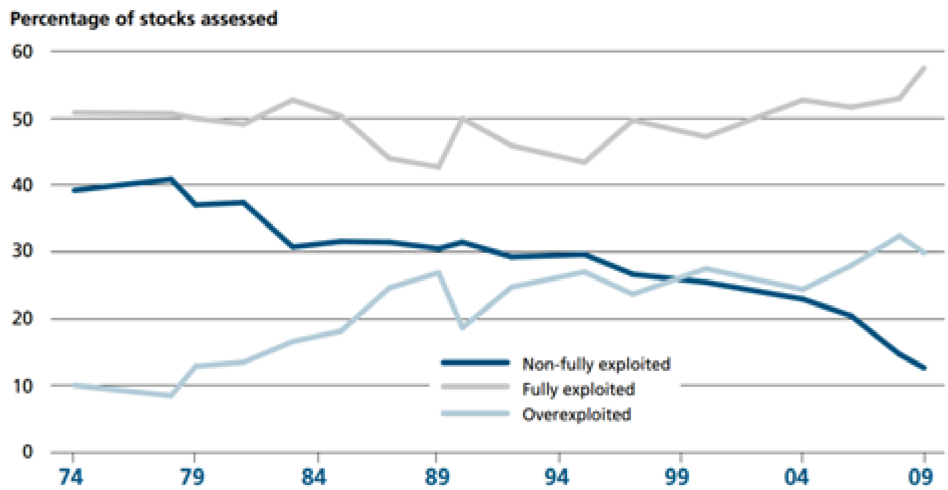
Table 1. Examples of natural asset indicators

(see Annex 1 for a more detailed list)

Theme	Indicators
Aquatic resources	• Proportion of fish stocks within safe biological limits
Forest resources	• Areas and volume of forests • Area restored or re/afforested • Forest area brought under management
Minerals and energy resources	• Available stocks/reserves of minerals • Volume and value of natural resource stocks
Land and soil resources	• Land cover types, conversions, and cover changes • Degree of top soil losses on agricultural land, other land • Land area where sustainable land management practices have been adopted
Water resources	• Volume and quality of available renewable resources
Biodiversity	• Area under effective protected area status (including marine protected areas) • Areas of forest, agricultural and aquaculture ecosystems under sustainable management • Trends in abundance and extinction risk of selected species

21. Depletion is not necessarily in contradiction to sustainable growth and essentially depends on how easily one type of asset can be substituted for another. In the case of mineral resources, this will depend on recycling, changing consumption patterns, and improvements in technologies allowing for rising productivity and use of other inputs. Overall, however, the efficient management and sustainable use of resources and environmental services are key to securing economic growth and environmental quality. Indicators can signal unsustainable developments, tipping points and limits to substitutability of resources. An example of assets in need of surveillance, are global fish stocks, which can lose the ability to renew themselves when heavily exploited (Figure 2).

Figure 2. Global state of world marine fish stocks, since 1974



Source: FAO, The State of World Fisheries and Aquaculture.

b. Environmental and Resource Productivity / Intensity

22. Indicators of environmental and resource productivity and intensity aim at measuring whether growth or output and consumption are achieved with fewer natural resource inputs, including less pollution and a lower reliance on environmental services. They include proxy indicators of innovation which is a key driver of productivity and efficiency improvements and hence of GG/GE. Examples are data on patents and R&D, overall, and specifically in GG/GE areas. Other measures can include carbon productivity/intensity, non-energy material productivity/intensity, energy efficiency, water or waste intensity or the nutrient intensity of agriculture (see Table 2).

Table 2. Examples of environmental and resource productivity/intensity indicators

(see Annex 1 for a more detailed list)

Themes	**Indicators**
Innovation	• R&D expenditure of importance to GG • Patents of importance to GG • Environment-related innovation in all sectors • R&D investment • Multifactor productivity, traditional and "green"
Energy	• GDP per unit of TPES (or the inverse) • Energy consumption per capita • Energy productivity
Material	• Domestic material productivity (GDP/DMC) • Material productivity at appropriate level of aggregation
Carbon	• GDP per unit of energy-related CO2 emitted (or the inverse) • Renewable energy (share of electricity power generation)
Water	• Water productivity
Waste	• Waste collection • Waste recycling and reuse • Waste generation or landfill area

23. Developments in productivity or intensity indicators require cautious, in-context interpretation:

- Improvements in such measures may come from substitution with other inputs, which can hide increasing use of other scarce environmental inputs. Improvements may also come from changes in industry structure that may or may not be in line with green growth.

- In the case of cross-border or global environmental goods, such as climate, changes owing to carbon leakage would also show up as improvements in the national carbon productivity/intensity indicator, while in fact no progress with respect to GG/GE would have been achieved at a global level.

- Further, productivity measures risk being strongly driven by cyclical and short-term factors—for instance, a housing or infrastructure investment boom would likely strongly affect non-energy material resource intensity.

- Some indicators, at least for the time being, rely on a simple aggregation by tonnes of material may not reflect the different levels of scarcity nor the individual environmental effects of different materials.

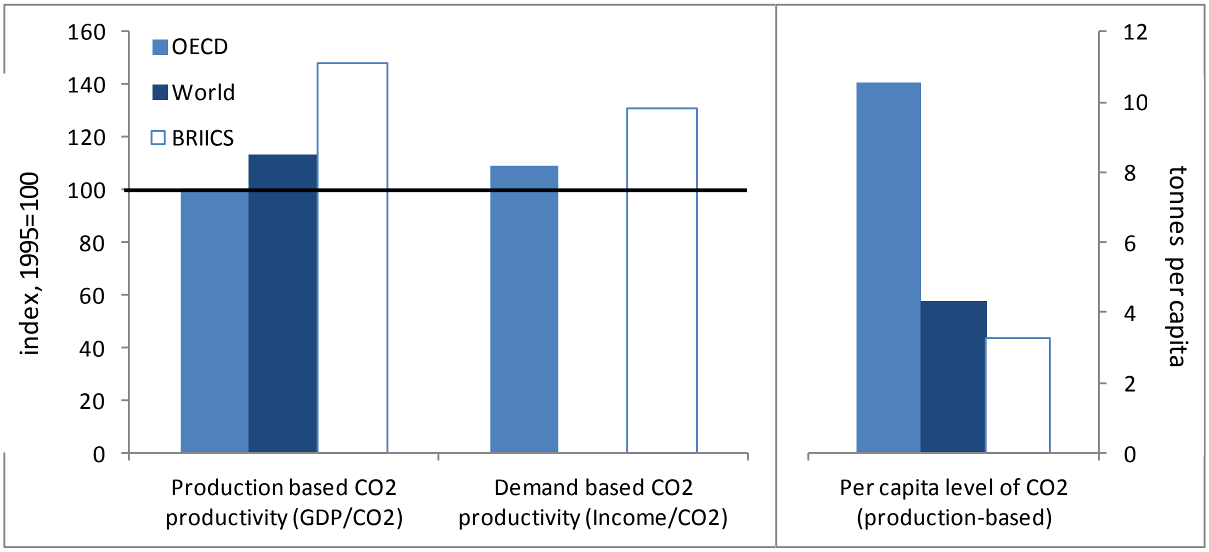
- Simple ratio indicators will not provide information on relative versus absolute decoupling, or the position relative to environmental thresholds related to significant increases in risks to growth.

- Finally, productivity or intensity indicators need to be gauged in the specific (country) context regarding the country's level of development or endowment of natural assets.

24. Production-based measures can be usefully complemented by demand-based measures to yield insight on the underlying nature of developments. Take the case of the cross-border shifts of environmental effects involved in CO2 productivity. Production-based measures capture the total amount of CO2 emitted during production processes relative to produced GDP, while demand-based measures capture the CO2 footprint (the CO2 embedded in final domestic demand, taking into account the effects of international trade) relative to income (Figure 3). Here, the context is key. If the shifting environmental effects abroad are observed, it may be problematic in terms of GG/GE. For example, if goods are produced with more CO2 intensive technologies as a result, but can also potentially be beneficial—possibly through exploiting natural comparative advantages, such as when water intensive activity is shifted away from water stress regions.

Figure 3. Carbon productivity: production and demand side measures can complement each other

Average 2006-2009



Note: Production based CO2 productivity is the GDP generated per unit of CO2 emitted - gross direct emissions, emitted within the national territory and excluding bunkers, sinks and indirect effects. Demand based CO2 productivity is the real disposable income generated per unit of CO2 emitted - CO2 emitted during all of the various stages of production of the goods and services consumed in domestic final demand, irrespective of where the stages of production occurred. The figure for demand based CO2 productivity is for 2005 due to data availability.

Source: OECD Green Growth Indicators database

25. Some of the problems common to partial productivity measures can be addressed in a more comprehensive fashion by deriving a measure of multi-factor productivity (MFP) that is adjusted for the use of environmental services and natural resources—which are usually hardly accounted for in a traditional growth accounting framework (see Box 2).

Box 2. A green productivity measure

Common indicators of economic performance, such as multi-factor productivity (MFP) do not typically account for the environment in production because of two key omissions:

- *Omitting inputs.* The underlying production function generally includes only labour and produced capital as inputs, but not natural capital and environmental services. Yet, income generated through the use of natural capital (including, for example, minerals, fossil fuels, timber and water) is captured in gross domestic product (GDP).

- *Omitting environmental 'bads'.* The traditional growth accounting framework does not factor in the environmental 'bads' generated by production (such as pollution and degradation). The benefits of investing in reducing pollution may hence be reflected in GDP only to a very limited extent, while the total costs in terms of inputs (labour and capital) will be captured.

By omitting these developments, traditional MFP estimates provide an incomplete picture of the economy—which may lead to erroneous assessments of future productivity developments and hence potential growth, and lead to wrong policy conclusions.

In response to this problem, Brandt, Schreyer and Zipperer (2013) are proposing ways to adjust the productivity growth measurement to explicitly capture the environment's role. This work, currently in progress, builds on the literature on productivity measurement with undesirable outputs (Pittman, 1983; Repetto et al. 1997) by integrating natural capital inputs and selected pollutants (carbon dioxide, sulphur, and nitrogen oxides) in the production function. The main challenge is finding suitable data on natural resources and prices.

Source: Brandt, Schreyer and Zipperer (2013); Pittman (1983); Repetto *et al.* (1997).

c. The Environmental Quality of Life

26. Environmental conditions affect people's health and wellbeing, and degraded environmental quality can both cause and result from unsustainable development patterns. They can have substantial economic and social consequences, from health costs and potentially associated lower labour productivity (Graff Zivin and Neidell, 2011) to reduced agricultural output, impaired ecosystem functions and a generally lower quality of life.

27. Indicators in this category capture various aspects of environmental life quality and safety—including access to environmental and related services and amenities (clean water, sanitation and nature); exposure to air pollution, water pollution, hazardous substances, and noise; transformations in the water cycles; biodiversity loss; and natural disasters that affect the health of ecosystems and damage the property and life of people (see Table 3). One example of environmental quality of life indicators is the population exposure to harmful levels of particulate air pollutants – calculated as share of population living in areas exceeding certain concentrations, identified as thresholds which can impact health negatively (Figure 4).

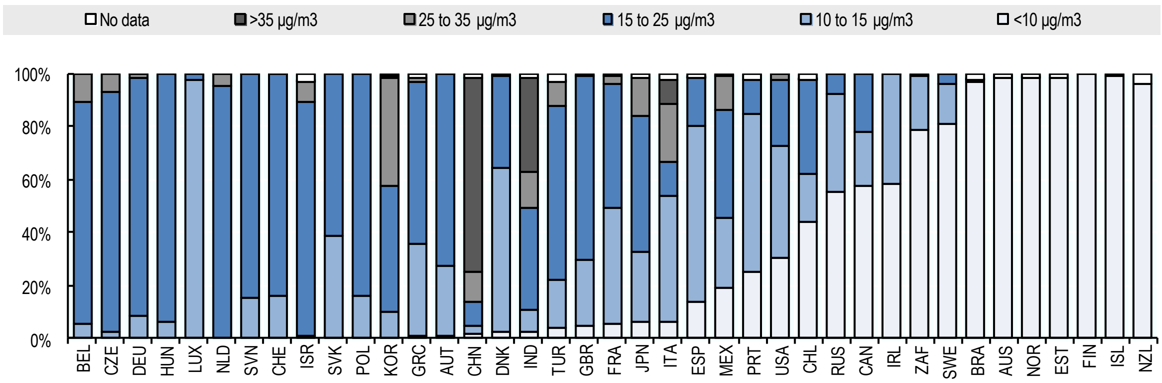
Table 3. Examples of environmental life quality and safety indicators

(see Annex 1 for a more detailed list)

Theme	Indicators
Health	• Population exposure to harmful levels of air pollution • Number of people hospitalised due to air pollution
Risks	• Exposure to natural or industrial risk and related economic losses
Water	• Proportion of total freshwater resources used • Proportion of the population using improved water services • Water quality in aquatic ecosystems used for drinking water provision • Population connected to sewage treatment • Population with sustainable access to safe drinking water • Level of harmful chemicals in drinking water • Volume (mass) of BOD pollution loads removed by the treatment plant supported
Ecosystem services	• Trends in benefits that humans derive from ecosystem services

Figure 4. Population exposed to harmful levels of air pollution

WHO $PM_{2.5}$ thresholds, average 2001-06, OECD and BRIICS countries



Notes: Internationally comparable measures of air quality in regions are derived from satellite-based measurement of particulate matter finer than 2.5 micrometers ($PM_{2.5}$). Population exposure to air pollution is calculated by taking the weighted average value of $PM_{2.5}$ for the grid cells present in each region with the weight given by the estimated population count in each cell. Source: OECD, Regions at a Glance 2011: Satellite-Derived Surface $PM_{2.5}$ map derived by Van Donkelaar et al. (2010).

d. Policies and Economic Opportunities

28. This category combines two types of indicators – of policies of importance to GG/GE and of economic opportunities and transformation linked to GG/GE. The categories are treated together, as they can be relevant for all elements of the proposed GG/GE framework: the natural asset base, productivity, environmental quality of life and comprehensive wealth (Figure 1).

29. Governments have an important role in fostering GG/GE by setting coherent framework conditions that (i) stimulate sustainable production and consumption; (ii) encourage the development and use of new technologies and innovations; (iii) improve competition and responsiveness to environmental policies; and (iv) improve access to information (such as on good practices or environmental consequences of actions). Indicators of GG/GE policies and opportunities—which the OECD is now constructing, with initial results due in 2014—aim to assess the use, scope for use, and some of the outcomes of GG/GE policies (see Box 3). These indicators should also help to identify potential synergies and tradeoffs among different policy objectives and among green and growth goals.

Box 3. Indicators of environmental policies

As the OECD tries to construct indicators of policies, it must contend with conceptual and data related issues because the underlying information is often of a qualitative nature and difficult to compare across countries. Three challenges stand out.

Collecting data. The OECD maintains a database of selected environmental policy instruments, which has detailed coverage of environmentally related taxation for OECD and several partner countries. It also covers tradable permit schemes, deposit and refund schemes, environmentally motivated subsidies, and voluntary approaches, although the coverage on these is less complete. Ongoing OECD work is supplementing this database with information on command and control measures (in particular standards and environmental licenses).

Quantification and aggregation. The information on policies can be turned into indicators building on the OECD experience in quantifying regulatory information, such as in the Product Market Regulation indicator (Nicoletti et al., 2000).

Interpretation. An extensive coverage of both market and non-market based policy instruments is required to provide better understanding of environmental policies, along with the use and economic effects of different instrument mixes across countries. Once such indicators are compiled, empirical analysis using cross-country evidence can allow a better understanding of how policies affect growth, productivity, and innovation.

30. The list of possible indicators includes those on environmentally-related taxation and pricing schemes (Table 4 and Figure 5). Similarly, it includes subsidies – on the one hand environmentally-harmful subsidies which can undermine the effectiveness of GG/GE policy action as they reduce incentives for cleaner production and consumption (Box 4), on the other hand measures of subsidies to specific "green" goods or services.

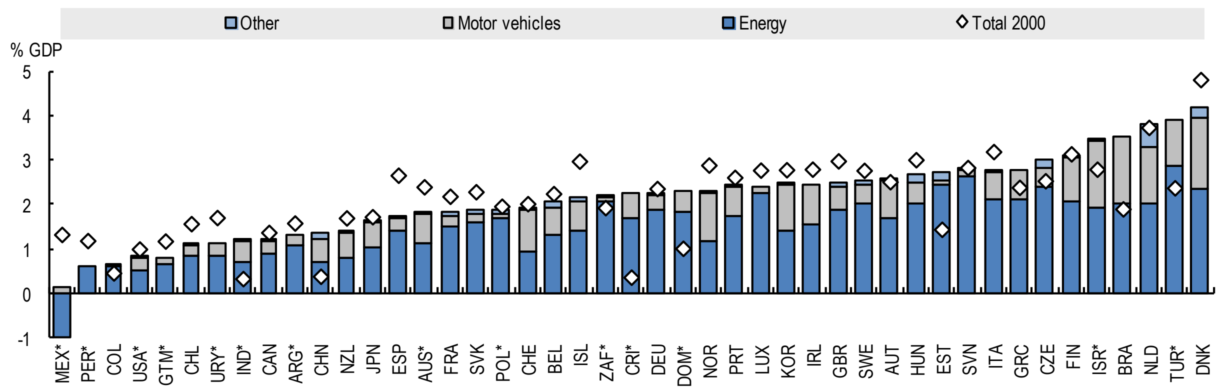
Table 4. Examples of GG/GE policies and opportunities indicators

(see Annex 1 for a more detailed list)

Theme	**Indicators**
Employment	• Green job skill training expenditure • Number of people trained
Policy Instruments	• Level of environmentally related tax revenues • Energy pricing (share of taxes in end-use prices) • Water pricing and cost recovery • Environmentally related subsidies • Fossil fuel, agricultural, water and fishery subsidies • Fossil fuel taxation • Renewable energy incentives
International cooperation	• International financial flows of importance to GG (ODA, carbon market financing, FDI)

Figure 5. Environmentally related taxation revenues

2011, as % of GDP



Note: * denotes 2010 data. Since 2000 Mexico has applied a price-smoothing mechanism. If petrol and diesel prices are higher than international reference prices, the differential effectively represents an excise duty. If they are lower, this represents an implicit subsidy.

Source: OECD\EEA Environmental Policy Instruments Database.

Box 4. Indicators of potentially environmentally harmful policies

A multitude of subsidies can have undesirable environmental consequences, but fossil fuel subsidies are likely the highest on the reform agenda, backed by G20 support. Reducing and reforming fossil fuel subsidies requires their accurate measurement and monitoring, especially given that policymakers will need to deal with challenges related to social exclusion and poverty in a manner that is more efficient and less environmentally harmful.

International organisations have responded with quantifying fossil fuel subsidies globally and tracking progress on their reduction. Even in this respect, country-specific circumstances need to be taken into account. Inventories based on the price-gap method, where prices faced by end-users are related to global “competitive” market prices, are mainly relevant for developing countries. They are put together by the IEA (IEA, OECD, OPEC and WB, 2010). For developed countries, the subsidies are largely implicit, particularly via foregone revenues from energy-related tax expenditures. They are estimated using government budget statistics (OECD, 2013b). The IMF has also recently published a comprehensive database including consumer subsidies for petroleum product, gas, coal, and electricity (both pre-tax and post-tax) (IMF, 2013).

Measuring producer subsidies to agriculture is also relevant for promoting GG/GE, though their effects on the environment may be more related to the details in their design. However, to the extent that they increase output and the use of environment-related inputs (directly or indirectly), they can result in greater pressures on environmental sustainability. A detailed inventory of such support, allowing distinctions for potentially more and less environmentally harmful categories, is being collected, primarily for OECD and selected large emerging economies.

Source: IEA, OECD, OPEC and WB, 2010, IMF (2013), OECD (2013b), OECD (2012a).

31. Indicators of policies must be used with particular care, as they offer only a partial view of the policy framework. They face challenges arising from the lack of a straightforward counterfactual and the related difficulty in estimating and presenting the opportunity cost of particular policies. They also need to be interpreted in light of the potentially high cost of government failure (for example, owing to inadequate pricing or regulation of environmental externalities) and the difficulty of setting policies in the absence of accurate information (for instance the estimates of the value of negative effects associated with pollution).

32. Because green growth is also about taking advantage of the economic and social opportunities arising from the greening, there is a desire to measure and demonstrate these opportunities. A fairly common approach is to use indicators of "green business." Several indicators have been proposed—such as measuring the size, employment, investments, and trade in the "green economy." The International Labour Organization (ILO, 2012) defines jobs as "green" when "they help reduce negative environmental impact ultimately leading to environmentally, economically and socially sustainable enterprises and economies. More precisely green jobs are decent jobs that: a) Reduce consumption of energy and raw materials; b) Limit greenhouse gas emissions; c) Minimise waste and pollution; d) Protect and restore ecosystems."

33. As such, "green business" indicators are potentially informative of some developments in the economy. Similarly, patent counts in the area of energy efficiency can proxy for innovation in that area. Still, they can potentially be misunderstood and misused, hence the need to consider carefully the use of such indicators, so as not to overstate (or underestimate) positive or negative developments and raise erroneous expectations. Key questions to be kept in mind are:

- *What is really "green"?—The question of definitions.* The ILO definition attempts to avoid a separation between "good and green" and "not green and bad" economic activities, starting from the premise that all economic activities can contribute to greening; either by preventing, reducing and eliminating the pollution and other forms of degradation of the environment or by making more efficient use of natural resources. Green jobs are intended to capture jobs in production of environmental goods and services for consumption outside the producing unit, and/or thorough the greening of the production process. However, practical applications, such as the Environmental Goods and Services Sectors (EGSS) jobs,[4] which is captured in the SEEA, de facto rely on an implicit valuation of "green" (or "environmentally friendly") and "non-green" activity. Still, many of the sectors defined as "green" can carry negative environmental impacts that need to be carefully managed (for example, renewable energy sectors and electric cars), while many activities in 'non-green' sectors may actually contribute to improved sustainability—depending on how production is organised and on technological innovation. And, in the presence of complex and increasingly global production chains, it is extremely difficult to credibly label an activity as "green" (Norden, 2012). Furthermore, measurement of "green" activities can implicitly favour "pollute first, clean-up later"

[4] The Eurostat and UN framework Environmental Goods and Services Sector (EGSS) proposes a method for identifying environmental activities, that is, "those economic activities whose primary purpose is to reduce or eliminate pressures on the environment or to make more efficient use of natural resources" (UN 2011; 1.110).

growth models because it is much easier to quantify jobs or investment in clean-up sectors, whereas measuring the effects of improvements in material or waste efficiency of the economy as a whole is more challenging. As a result, countries often regarded as leading in GG performance tend to have low shares of employment in "green" jobs (OECD, 2013a).

- *A "free lunch" or at least a "cheap lunch"?—The issue of counterfactuals.* Are we measuring visible effects versus indirect and dispersed developments? Measuring green jobs or green patents that result, for example, from public support (explicit or implicit) disregards the fact that they have an opportunity cost—with effects that may be harder to quantify. GG/GE is likely to lead to significant shifts in employment and income, with gains and losses both within and among economic sectors. All implications of this transition (both positive and negative) should be taken into consideration (ILO, 2013). The size of the transition can be indicated by gross employment gains, but it is the net employment effects, which take into consider the number of other jobs that are destroyed or created elsewhere in the economy (for example, through higher prices or taxation or because of structural changes caused by GG/GE policies)—especially given that some of these jobs may be equally or even more important for green growth. Similarly, R&D spending or patent counts in certain "green" sectors (such as environment or energy) may overlook the fact that true green innovation is likely to originate from a wide range of scientific fields (OECD, 2011).

- *Should we want "green" activity?—The Issue of incentives*. Increasing employment in specific green sectors is unlikely to be an overall policy objective. "Green" activity indicators can lead to "picking winners"—which may be unavoidable in the case of some policies, but is associated with lobbying and rent-seeking. It must be acknowledged that the same applies for environmentally burdensome activities (such as fossil fuel or automotive industries) that often do not pay the marginal costs of the environmental damage they impose while in many cases attracting substantial government support.

e. The Socio-Economic Context

34. Indicators of the socio-economic context are an essential component of a GG/GE policy making for a variety of reasons.

- They can guide the choice and design of adequate GG/GE policies and track their social and economic outcomes.
- They can help to ensure that the GG/GE strategy makes the best out of the available opportunities, minimises trade-offs, and is phased in and timed appropriately to improve wellbeing and engage stakeholders.
- They can flag transitional developments that may require prompt policy action—such as signalling the need for more flexible labour markets (for example, reducing barriers and segregation on the labour market, improving education, and training) or stronger social safety nets to complement GG/GE policies (for example, if fossil fuel subsidies are removed).

- They can help assess the capacity of a population to adapt to and benefit from GG/GE and the need for structural policies to improve this capacity.
- They can flag the need for investment in skills, education, or infrastructure to enhance the ability of the economy to shift to a greener growth path.
- They can complement indicators of the environmental quality of life, which are more directly related to the environment (Section IV).

35. The list of possible indicators includes: (i) standard macroeconomic variables; (ii) labour market variables; (iii) measures of equity and social inclusion; and (iv) broader measures of wellbeing (objective and subjective) such as access to services (for example, health, education and transportation); and (v) indicators of trade openness, competition and product market regulation (see Table 5).

Table 5. Examples of socio-economic indicators

Theme	Indicators
Macroeconomy, Trade and Regulation	• GDP growth and structure • Net Disposal income • Relative importance of trade • Product market regulation
Distribution	• Income inequality: GINI coefficient
Labour market	• Labour productivity • Labour force participation & unemployment rates
Education	• Education attainment: level of and access to education
Health and Sanitation	• Health adjusted life expectancy • Access to sanitation • Access to health care • People provided with access to improved sanitation facilitates
Development	• Access to transportation • Access to electricity

Headline indicators are needed for communication purposes

36. Effective communication on the need for and progress towards GG/GE requires focusing on a small number of key indicators. In practice, while a potentially large number of well-designed indicators at the economic—environment nexus are necessary for providing the background information, they are unlikely to resonate with policy makers and the wider public. Thus , the challenge is to synthesise the main messages in a way that is clear and easily interpretable. Two possible approaches stand out.

37. ***Constructing a single composite indicator***. Such a composite number would aggregate the information present in a set of GG/GE indicators in an environmental sustainability/wellbeing index. Like all composite indicators, this would face a number of challenges. In the absence of prices, as is the case with many environmental services and amenities, aggregation requires crucial decisions on the choice of units (or weights) to combine very different measures with varying relevance across countries. Social valuations are often uncertain, highly non-linear, location, time, and state-dependant and possibly weakened by poor information and awareness. Many of these problems are linked to knowledge gaps surrounding the interactions between the economy, the environment, and policies, and the long-term nature of many of the effects and problems related to comparing them across time (such as the choice of a discount rate). While at least some of the aggregation issues can be dealt with in an acceptable fashion (Nardo *et al*. 2005), for the moment, no single indicator of GG/GE has been widely accepted.

38. ***Assembling a small number of headline indicators.*** To facilitate communication, OECD (2013a) is working on a small set of headline indicators that are chosen for their ability to capture progress on GG/GE by linking relevant environmental areas with current or future economic performance and wellbeing (**see Table 6**). While countries will still often wish to focus on specific issues, the proposed set provides a balanced coverage of the main GG/GE concerns at the global level. This proposal is at a preliminary stage, and indicators may be dropped, added, or adjusted.

Table 6. A set of headline indicators, as proposed by OECD (2013a)

Proposed Headline Indicator	Definition	Strength	Weakness
Natural asset base			
Index of natural resource use	Aggregated index of the changes in stocks of resources	+ in line with SEEA concepts, will be facilitated by its implementation. + In principle, easy to communicate (index).	- Work in progress - data availability problems to be resolved (pricing, stocks and flows of resources) - discount rate issues can hide away sustainability problems
Change in land use and coverage	land use by category as share of total	+ potential use of satellite immagery, can proxy for biodiversity	- Communication - currently no single index. -Interpretation in light of different levels of development, geography and population density.
Environmental and resource productivity/intensity			
Carbon productivity	GDP/CO2 emitted & Income/CO2 in consumption	+ Widely used and accepted. + Data availability. + Area of major concern and policy relevance.	- Global interactions - displacement/ leakage issue (demand side measures can help, but more data issues) -Interpretation (levels of development, resource endowment, industrial structures, substitutibility, cyclicality),
Non-energy material productivity	GDP / Domestic Material Consumption & GDP/Raw Material Consumption	+ Policy-maker interest. + Presentation (index) + RMC can account for materials embedded in trade.	- Currently environmentally meaningless aggregation (by tonnes of materials, regardless of scarcity or env. effects). - Problems of interpretation due to cyclicality, substitutibility, development. - data availability
"Green" MFP measure	MFP adjusted for natural resource inputs and env. "bads"	+ Promising way to incorporate the omitted environmental aspects into looking at productivity/efficiency.	- Questions on interpretation and direct policy relevance (as in trandtional MFP). - Data availability problems to be resolved (pricing, stocks and flows of inputs and outputs). - Work in progress.
Environmental quality of life			
Population exposure to air pollution	Share of population exposed to health-threatening levels of $PM_{2.5}$	+ Area of key concern and policy relevance for GG/GE and wellbeing. + Country coverage & comparability (satellite image data). + Easily interpretable thresholds.	- Questions on updating (satellite image data). - coverage and comparability (monitoring station data) - cannot distinguish natural causes from human-activity related causes.
Policies and opportunities			
Indicator of environmental policies	Placeholder - not yet selected	+ Increasing amount of data on policies available.	- Data collection on comparative policies (ongoing) is a challenge.

Source: based on OECD (2013a).

39. In particular, in the case of some developing countries, there may be more suitable headliners for the quality of life – such as for example access to clean water. Countries can also choose from an

array of headline indicators on biodiversity (CBD, 2012).[5] It should be noted though that those in the current set are at various stages of usability, often requiring further work and a transparent approach to their strengths and weaknesses. In particular, a suitable indicator on policies has not yet been identified and a data collection exercise is ongoing to gain a sufficiently wide coverage of policies. That said, the proposed indicators constitute a concrete starting point in focusing the GG/GE measurement debate.

Wealth accounting can complement a dashboard of indicators

40. Wealth accounting offers an alternative to a single composite indicator and can complement a small set of headline indicators. There has been a growing movement in recent years to move "beyond GDP" towards measures that would give a more comprehensive picture of the sustainability and quality of growth (World Bank, 2011; Stiglitz, Sen and Fitoussi, 2009, OECD's Better Life Initiative).[6] GDP is a flow measure that proxies current income well. But it does not capture the key factors that determine whether this flow is sustainable, such as whether growth is coming at the expense of an unsustainable use of the asset base (which would include factors such as the depreciation of produced capital; the depletion of natural resources like minerals, energy, forests and fisheries; the degradation of the ecosystem, or future losses from damage due to greenhouse gas emissions or pollution). This subsection presents a wealth accounts approach to capture the inter temporal aspects of the economy—that is, extending a country's national balance sheet to include natural resources and intangible forms of wealth.

a. Measuring wealth and what it means for policy

41. In the medium to longer-term, monitoring economic performance requires both an indicator of total income, measured by GDP, and an indicator of how a country's real comprehensive wealth is changing—which includes *produced capital* (buildings, machinery, and infrastructure); *natural capital* (minerals and forests and the capacity of sinks); and *social and human capital*. This wealth indicator also alerts governments to whether policy, broadly conceived, is producing increases in both current and future wellbeing. When per capita wealth is increasing, the capacity to maintain or increase wellbeing increases. But if per capita wealth declines, the ability to sustain current levels of income and wellbeing into the future will be compromised.

42. One strand of work in wealth accounting, undertaken by the United Nations University and UNEP, estimated wealth for 20 countries from 1990 to 2008 (*The Inclusive Wealth Report 2012*). It found that health capital (estimated as a separate form of capital) dwarfed all other assets, accounting for an average 95 percent of total wealth.

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[5] At the 11th conference of the parties to the Convention on Biological Diversity (CBD COP-11), the parties adopted an indicator framework for the Strategic Plan for Biodiversity 2011-2020, which contain headline indicators as well as most relevant operational indicators (CBD, 2012).

[6] In a broader context of wellbeing, the OECD's Better Life Initiative follows the Stiglitz et al. (2009) approach and distinguishes between today's wellbeing and the sustainability of wellbeing over time. The first strand of wellbeing indicators integrates various aspects of wellbeing, both material and non-material and includes environment-related aspects (How's Life, 2011), but planned future work will also focus on the sustainability of the developments in wellbeing.

43. Another strand has been pursued for the past 15 years by the World Bank through a programme to systematically measure comprehensive wealth and related macroeconomic indicators. The World Bank constructs genuine savings or adjusted net savings (ANS) to assess the (un)sustainability of a country's growth path. ANS measures how wealth changes through savings—the amount that is used for investment rather than consumption every year. It begins with gross national savings and adjusts it for changes in all assets: depreciation of produced capital, net additions to human capital through education expenditures, depletion of natural resources, and future losses owing to carbon emissions and damages to human health from PM_{10} emissions. The World Bank also reports adjusted net national income (ANNI), which adjusts net national income (NNI) for depletion of natural resources (energy, minerals, and timber). Negative ANS generally indicate total comprehensive wealth is in decline - signalling an unsustainable path. Positive ANS only provisionally signals sustainability, owing to the potential limits on the substitutability of different forms of capital.[7] A *comprehensive* ANNI can provide measure the greening of policy.

44. A database of comprehensive wealth, based on publicly available data, has been constructed for 150 countries for 1995, 2000, 2005, and 2008 (an update is planned for 2013), and published in two reports. The World Bank's wealth accounts include:

- Total national wealth: calculated as the present value of a sustainable stream of future consumption. This approach makes sense if one thinks of an individual household. If the household permanently lost all capacity to earn income, then its future consumption would be constrained by the current total value of its (non-human capital) assets.
- *Produced capital:* machinery and structures, urban land.
- *Natural capital:* energy (oil, natural gas, hard coal, lignite), minerals (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc), crop land, grazing land, forests (timber and non-timber values), and protected areas.
- *Net financial assets.*
- *Intangible capital:* measured as a residual after subtracting from total national wealth the sum of produced capital, natural capital, and net financial assets. It implicitly includes measures of human, social, and institutional capital, which includes factors such as the rule of law and governance that contribute to an efficient economy.[8]

45. The World Bank's wealth accounts show that there is a clear tendency for natural capital to shrink as a share of total wealth as countries become wealthier, while there is a corresponding increase in the share of intangible capital. The striking result, however, is that intangible capital constitutes 50–80 percent of total wealth across all income classes (see Table 7).

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[7] ANS would ideally be augmented by physical indicators of what Pearce and Atkinson (1993) term 'critical' natural capital.

[8] By construction it also includes any mis-measured or missing natural capital such as fisheries and water.

Table 7. Shares of wealth by income aggregate, 2005

	Intangible	Produced	Natural
Low income	50%	14%	36%
Lower middle income	50%	24%	25%
Upper middle income	67%	17%	17%
High income: OECD	81%	17%	2%

Source: World Bank (2011).

46. This is a rather wide range, but the World Bank and OECD have recently tried to narrow it by combining total wealth estimates (World Bank, 2011) with new estimates of the value of human capital in a range of OECD and middle income countries (Hamilton and Liu, 2012).[9] Work under way to measure knowledge-based capital (KBC) shows that the share of investment in KBC is now higher than that in physical capital in many OECD countries (OECD, 2012b).

b. The statistical framework for implementation

47. A parallel effort has been underway over the past 25 years to develop the statistical methodology to expand the national balance sheet in the System of National Accounts (SNA) to include natural capital (EC et al. 2009). The result is the System of Environmental and Economic Accounting (SEEA), which, after several revisions, now stands as an international statistical standard (see Box 5), although there are still many data complexities to contend with (see Box 6). One problem is that specific natural resources are included in the database only when they meet two criteria: (i) reliable data (price and volume) are available on a regular basis; and (ii) data are available for a large number, if not all, countries. As a result, some natural resources (like fisheries, some minerals, and certain water services such as hydropower) are not included, which understates the value of natural capital—a significant omissions for some countries.

[9] Hamilton and Liu find that, for a broad range of high-income OECD countries, human capital makes up about 55 percent of total wealth. This leaves a "residual of the residual" in the order of 25 percent of total wealth in these countries. While this is a crude estimate of the remaining stock of intangible wealth, it is still a sizable amount. This is arguably the "stock equivalent of MFP," because it augments the capacity of produced and natural capital to support a future income stream.

Box 5. Greening the National Accounts

The System for Integrated Environmental and Economic Accounts (SEEA) is a multipurpose conceptual framework for describing the interactions between the economy and the environment. Subscribed by the EC, FAO, IMF, OECD, UN, and World Bank, the system combines national accounts and environmental statistics in a statistical framework with a consistent set of concepts, definitions, classifications, accounting rules and tables. The Central Framework of the SEEA was adopted in 2012 by the UN Statistical Commission. It will be supplemented with the second volume on experimental ecosystem accounts in 2013, and the third volume on SEEA applications and extensions.

Once implemented broadly across countries, the SEEA can improve the analysis of GG/GE—especially by facilitating analysis in an internationally comparable manner. The SEEA facilitates further breakdown of national indicators, which is often needed to focus on a selected area of interest or to better understand the broader context of GG/GE.

- S*patial disaggregation* helps to understand the relationships between the location of natural resource stocks, settlement areas, and economic activities.
- *Social disaggregation* helps to understand the distributive aspects of environmental policies and economic instruments, and the environmental dimensions of life quality.
- *Sectoral disaggregation* helps to demonstrate structural changes over time, to analyse environmental pressures by different industries, and to distinguish effects of government actions (policies affecting incentives or restricting choices) from those of actions of the business sector or households (for example, policy-induce, behavioural, or voluntary).

The SEEA can also help integrate additional information at the corporate level into the traditional national accounts framework. (For more information on SEEA, see: https://unstats.un.org/unsd/envaccounting/seea.asp)

48. In addition, some components of natural capital—ecosystem services and environmental damages—do not appear explicitly in wealth accounts. However, many of these services are already included in the value of land assets. For example, the value of natural pollinators or groundwater is incorporated in the value of agricultural land. But by focusing on agricultural land, the wealth accounts may miss other ecosystem services such as aesthetic and cultural values, or the protection against natural hazards provided by landscapes such as wetlands, coral reefs and mangroves. Under the UN Statistical Commission, an experimental methodology for the compilation of ecosystem accounts is being developed, and the WAVES Partnership is contributing to this process, particularly in the area of monetary accounting.

Box 6. Challenges of wealth accounting

Practical applications of wealth measures suffer from the limitations common to many composite indicators. In principle, social valuations of different forms of natural as well as produced and human capital should reflect their marginal substitutability—that is, a resource that is difficult to substitute would be attributed a high relative price. In practice however, obtaining accurate social valuations can prove extremely challenging. Moreover, marginal social valuations can often be highly state and time dependant, meaning they may fail to convey the very real limits to substitutability, impending thresholds for natural capital or possible irreversibilities and catastrophic events.

Although the value of comprehensive wealth may be similar for countries, the wellbeing of the citizens may be quite different owing to factors that cannot easily be incorporated in economic values. Nor can comprehensive wealth provide information about distributional concerns, such as poverty or inequality. Finally, wealth accounting being a comprehensive and broad exercise is a resource intensive task, and it may be challenging for countries to collect the relevant data and implement the accounts. Even so, comprehensive wealth and Adjusted Net Savings can indicate the sustainability of economic performance, usefully complementing the set of GG/GE indicators.

As with many other indicators, the applicability and reliability of wealth accounting should improve, as GG/GE knowledge and data gaps are filled in, allowing for the lifting or adjusting of some of the restrictive assumptions currently employed such as those relating to valuation or the inclusion or exclusion of particular types of capital or effects. Other assumptions, such as those related to the calculation of total wealth may be more judgmental, but are necessary to make wealth accounting operational.[10]

IV. Outstanding challenges and way forward

49. The proposed set of green growth indicators is neither exhaustive nor final. The selection is based on the work and experience of the OECD, UNEP, World Bank, GGGI, and other international organisations, as well as in individual countries. This report can be seen as a step in multilateral cooperation towards greater convergence and harmonisation across indicators to reduce the statistical burden on countries and increase the clarity of information signals. Many of the indicators are a work in progress so they may not yet be fully measurable or available. But gradual convergence on GG/GE concepts and flagging areas of particular importance to measuring GG/GE can give a strong signal to improve the methodology and coverage of particular indicators. This section explores the challenges related to measurement, interpretation, and implementation of GG/GE indicators in practice. While many of them are not specific to measuring GG/GE, they are often reinforced by the combination of challenges related to economic and environmental statistics.

[10] World Bank (2011) states that "the underlying growth theory assumes an infinite lifetime for the analysis. As a practical matter, we [i.e. World Bank, 2011] have chosen to carry out the wealth accounting on a generational basis, assuming a maximum lifetime for all assets of 25 years. Our total wealth estimates are therefore calculated as the present value of the current level of consumption (held constant), taken over 25 years and discounted at the pure rate of time preference, 1.5 percent. We assume an optimistic future rate of per capita consumption growth of 2.5 percent (historical values are typically less than 1.5 percent), so that our calculated interest rate using the Ramsey formula is 4 percent." As mentioned, current consumption is adjusted with ANS, in case deemed unsustainable (negative ANS).

a. Progress towards international harmonisation of definitions and measurement

50. Comparability across countries and time requires indicator definitions to be harmonised globally and the underlying data to be collected and reported using standard methodologies and instruments across countries, regions, agencies, and time. In reality, comprehensive harmonised underlying data across countries and sectors are often unavailable. On the other hand, there are various international harmonised databases providing pieces of the overall picture, such as the International Energy Agency (IEA)'s energy database, the Food and Agriculture Organization of the United Nations (FAO) databases on land use, water use, and agricultural production, and the United Nations Framework Convention on Climate Change (UNFCCC) greenhouse gas emission inventories. Along with these, there are various ongoing large research projects on data modelling and comparison, but these often lack a formal status.

51. A general obstacle is the poor integration of economic and environmental data owing to differences in classifications and terminology, timeliness, and significant gaps in environmental-economic data at the industry or resource level. A first and crucial step to facilitate combining such data is the adoption of the SEEA standard frameworks (see Box 7). As SEEA is implemented, it should facilitate the compilation and improve the comparability of a number of measures (such as the OECD natural resource use index and green productivity indicator or World Bank wealth accounts). The research agenda identified for the SEEA highlights a number of further challenges. In particular, accounting for ecosystems and ecosystem services poses many conceptual challenges, from agreed classifications to techniques for valuation, indentified in the SEEA volume 2 Experimental Ecosystem Accounts.

52. Better use of modern technology, such as information and communication technologies (ICTs) provides an opportunity to standardise and improve data and information by regularly providing analysis and better data in an internationally consistent format. Examples include satellite imagery, which is already used for instance in the exposure to air pollution indicator, land-use indicators or access to nature indicators, or satellite positioning systems.

53. Data are often derived from different sources, including monitoring systems, official statistics and accounting systems, business surveys, and from associated analytical approaches. Often a combination of several sources may be necessary to produce indicators or verify information. Hence, amassing a set of indicators of reasonable comparability across countries and periods may require some flexibility on definitional details.

54. Looking forward, convergence on identifying the main GG/GE concepts can help improve the indicators' and data quality, thereby gradually alleviating some of the data issues. Agreement on underlying common definitions can help improvements in data-collection to support a wide range of background indicators and improve their comparability.[11] More generally, this is an area where the Green Growth Knowledge Platform (GGKP), and in particular its research theme on "Measurement" can generate significant value added.

[11] The OECD/World Bank initiative towards a joint natural capital stock database can be one example.

b. Coping with limited capacity and engaging the private sector

55. Data collection can be costly. At the same time statistical offices and other bodies producing data underlying indicators will have limited capacity to monitor, compile and analyse data.

56. In developing countries, weaker statistical systems, limited capacity, and restricted resources are additional obstacles to establishing a monitoring framework for GG/GE. Capacity challenges for implementing complex accounting frameworks, such as natural capital accounting, can be overwhelming for advanced economies making them prohibitive for developing countries that may even struggle to compile national accounts. More generally, selected issues may not be equally relevant or important for all countries even though they may be of broader or global concern. In this light, internationally co-ordinated efforts can help develop local capacity for data collection, analysis, and communication.

57. The business sector need not be limited to a passive provision of basic data. Recently there have been signs of greater corporate participation in data collection when accounting for environmental considerations, mostly done on a voluntary basis by private enterprises. Corporations are increasingly encouraged towards greater disclosure of environment-related reporting owing to branding, legislation, or other requirements (such as labelling, reporting, or schemes related to extended corporate responsibility). At the same time, some investors are becoming interested in such information to enable them to form a view about the value that may be at risk as a result of resource degradation and environmental damage, as well as policy risk. The emergence of “green” investment funds and the development of policy measures designed to influence the destination of investment capital indicate a growing ‘bottom-up’ demand for better quality measures.

58. Accounting for the environment in corporate balance sheets can potentially facilitate external and internal accountability of companies as well as incentivise corporate performance and help secure supply chains. For public data collection agencies, such initiatives can potentially signal important areas of concern, areas in which data gathering may be relatively easy and potential areas of cooperation and coordination among private and public initiatives. However, the intercept between public and private initiatives is still very much characterised by knowledge gaps. In this respect, the theme of the 2013 Annual GGKP conference “Greening global value chains and green growth measurement” is an important step to compare experiences and yield policy-relevant insight on the intercept between private and public measurement initiatives.

59. Reporting requirements can be burdensome, especially for small or young firms or new entrants into the market. To maximise the net benefits of gathering information, there is a need to limit the economic burden of data collection, both in terms of the concepts covered and in terms of the process. Convergence in measurement concepts of GG/GE can help focus on key measurement issues and improve the quality of data collected.

c. Practical challenges regarding the construction of indicators

60. There is a need to improve the conceptual aspects of GG/GE indicators. Many of the background issues are more or less directly related to the issue of valuation (of natural assets or environmental

services) and are often common to both low level indicators, as well as more aggregate level composite indicators (including green MFP and indicators derived from wealth accounts) (see Box 7).

Box 7. The measurement agenda for green growth and green economy

The measurement agenda identifies the most prominent gaps in terms of measurement of components underlying GG/GE indicators. One specific challenge is the poor coverage of many of the GG/GE aspects in developing countries. More generally the most significant gaps and areas for progress include:

- Physical data for ***key stocks and flows of natural assets*** and their quality—such as information on land and land use changes—for indicators of land use, natural resource use, and wealth accounts. Similar challenges arise in respect of fishery stocks and ground water resources. Data on mineral resources is often of better quality, but still far from perfect.
- Physical data on the ***availability of sinks*** for absorbing waste to better describe critical limits to resource use.
- Physical data on ***material flows***. Improving such data would help undertaking material flow analyses at a more granular level and enable the extension from domestic material consumption to raw material consumption (RMC). This indicator converts trade flows into their "primary resource extraction equivalent," thus accounting for indirect flows of materials embodied in trade. The indicator could also be expanded to account for the unused flows of materials (domestic and embodied in imports) and to calculate the total material consumption (TMC) of the economy.
- ***Monetary values*** for natural assets. Such valuations constitute vital inputs in wealth accounts and growth accounting approaches, as well as weights aggregation, in many composite indicators. They also can help prioritise GG/GE actions.
- Data on (environment-related) drivers of ***innovation in companies***.
- Data on ***biodiversity***, especially species and ecosystem diversity, and species abundance. Improving valuation of protected areas would also benefit wealth accounts, where proxies based on value of agricultural land are currently used.
- Objective and subjective measures of the **quality of life***,* especially environmentally induced health problems and risks and related costs; and public perceptions of the environmental quality of life that provide insight into citizens' preferences and sense of wellbeing.
- Measurement of GG/GE related ***economic opportunities*** and the transformation of the economy.
- Measures on environmentally-related ***policy tools***. Thought should be given to how indicators on economic instruments can be complemented by indicators on environmental regulation (such as standards) so as to balance the picture of international comparisons of policy responses.

Source: OECD (2013a), Updated 2013 Report on Green Growth Indicators; UNEP, (2011), Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.

Knowledge gaps concerning valuation

61. Further research is needed to better understand the impacts of environmental developments on economic activity, of economic activity on the environment, and of policies (in particular GG/GE policies), on economic, social, and environmental outcomes. In a world of perfect measurement, perfect information and perfect markets with no "free" environmental services, asset prices should reflect resource and environmental service values, reflecting their scarcity, societies' preferences, and future vision. Since in practice well-functioning markets for many natural assets and environmental services do not exist, filling in such knowledge gaps is crucial for adequate monetary (social) valuation of environmental damages and depletion, as well as improvements.

62. In turn, adequate valuation can be the basis for meaningful aggregation of information into more composite indicators. It also provides information supporting interpretation of states and trends depicted by indicators and relevant policy actions. A better feeling for interactions among environmental, economic, and social issues is crucial for inclusive and more equitable outcomes of GG/GE policies.

Substitutability

63. A key related question for constructing and interpreting many GG/GE indicators is to understand the degree to which one type of asset can be substituted for another. This concerns both the substitutability of natural assets for other types of assets (such as human or produced capital) and the substitutability among natural assets themselves. Substitutability can be dynamic, and it will change with the time horizon—technological progress or changes in consumption patterns may improve the substitutability of certain inputs and reduce scarcity-related risks with time.

64. The actual degree of substitutability among assets is a key issue in the case of many indicators (both low-level and composite). For instance, many composite indicators (such as standard measures for material productivity, natural resource use indexes, wealth, or adjusted net savings) pose practical problems in capturing limits to substitutability among various categories of assets (including between natural, human, and produced capital). On the other hand simple partial productivity-type indicators, if viewed out of their relevant context, can mask potential substitution from one scarce or environmentally harmful input to another. Another example is that of aggregating among different uses of water (direct and indirect, more and less polluting), which means placing equal weights on them, thereby blurring the message about the environmental impact of consumption.

65. In a similar vein, resource productivity indexes, natural asset use, and natural capital stock estimates in wealth accounting encounter issues related to the data on natural capital stocks. Even if information on existing capital stocks was perfect, the sole existence of certain assets may have only a vague relationship with their accessibility. Costs and environmental effects of extraction, use, or transport can vary immensely and change with time. It may also be cumbersome to account for the resources that are already extracted or used but can be reused or recycled.

Thresholds and non-linearities of effects

66. Many environment-related effects are recognised to be non-linear and often associated with some thresholds, above which the nature of such effects changes significantly. Even when non-linearities or threshold effects are relatively well identified and recognised, it is often difficult to account for them in indicators. Non-linearities mean that the effects are state and time dependent, while indicators often tend to be viewed abstracting from the detailed context, with their construction often based on simplified assumptions, such as use of linear weights, based on prices, and quantities. Examples can range from wealth accounts to various types of aggregate indexes or more disaggregated indicators such as CO_2 emissions. Incorporating thresholds into indicators is challenging, especially given the uncertainty surrounding the threshold values. But there are cases where thresholds are well-established and can be incorporated in indicators —for example, for population exposure to air pollution (see Figure 4).

Global or local nature of effects

67. The treatment of global or trans-border effects poses yet another challenge. Global aspects can have various levels of priority or various monetary values for local populations, in particular among countries with various pressing issues. For example, in developing countries access to clean water can, understandably, be more important than general global warming concerns, and failure to account for such a hierarchy in aggregate indexes may result in underplaying issues of vital concern.

68. In addition, common pool resource sustainability requires that the common environmental burden—for example, greenhouse gas emissions or fish catches—be under control, while the distribution among countries is less relevant, at least from the environmental viewpoint. This implies that emission reductions are not strictly necessary in each country, and some countries may have, or develop, a competitive advantage in emission-intensive production, within the limits of the overall sustainable environmental burden. In fact, from an overall economic efficiency perspective, reductions should occur where they are least costly, although this may require compensation. Trying to account for such aspects is a challenge for GG/GE indicators such as CO2 productivity/intensity or wealth accounts derived aggregate indicators.

69. National indicators can also be problematic for dealing with the local nature of some GG/GE aspects. The use of footprinting for water use is a case in point. Water use in a water-rich environment will have very different effects on nature than water use in a water-scarce environment.

Discounting and accounting for uncertainty

70. Comparing current and future developments requires assumptions on how to discount future events. This is a necessary input for the valuation of environmental effects—as the effects of economic activity on the environment and vice-versa will materialise at different time horizons. Choosing rates to discount future effects allows their comparison, but is largely a social and political choice, encompassing questions on policy priorities and intergenerational equity. As a result, discount rate choices may differ across countries and time, reflecting the weight of particular priorities and influencing the policy

agenda. Discount rates also constitute crucial assumptions in wealth accounting derived measures. Outcomes and indicator values may be highly dependent on the choice of discount rate.

71. The future conditions that will shape GG/GE (such as climate change, demographic patterns, land use, and socioeconomic development) are highly uncertain. Thus, one approach is to assess indicators of future outcomes under many combinations of future conditions, and to determine the key sets of conditions that lead to outcomes that are either acceptable or desirable, or those that are unacceptable or undesirable. There are a number of methods useful for managing uncertainty that can operationalise this concept (Rand, 2013; Hallegatte *et al.*, 2012).

d. Transparency is key for appropriate use of GG/GE indicators

72. Many of these challenges related to measurement are unlikely to have a straightforward answer. Further work can improve our understanding of the nature of trade-offs involved in constructing and using particular indicators. In this sense GG/GE is not different from more mainstream areas of economic measurement, though it is certainly complex and at an earlier stage of development. Ongoing work should aim for better indicators that target more widely acceptable simplifying assumptions and improved usefulness for communication and policy purposes.

73. The level of aggregation plays a role when interpreting outcomes. More detailed information may be needed when indicators are meant to support sub-national or sectoral decision making. Take the case of indicators describing the productivity of material resources used. At a highly aggregated level, this measure suffers from problems related to weights (by mass for the moment), whereby the relative importance of toxic and scarce inputs can be negligible owing to the importance of bulky but less-environmentally burdensome and more abundant materials. On the other hand, the more disaggregated the presentations, the more prone they are to problems of neglecting substitution between inputs, changes in production patterns, and more general structural changes in the economy.

74. If indicators are to be understood and trusted by policymakers, the media, the business community, and the public at large, they need to be based on publicly available data and transparent definitions and data collection methodologies. Such requisites are particularly challenging for composite indicators (such as ratios, scores or aggregates), in cases when interpretation can be difficult or uncertain. Underlying data and assumptions (especially on aggregation) must be made publicly available in a clear and accessible manner.

e. Interpretation and communication challenges for policy-making

75. Indicators are a prerequisite for GG/GE to play a more mainstream role in the policy agenda. They are needed to focus attention and provide benchmarks against which to measure the adequacy of policy responses. That said, their explanatory power will vary by country and by context. Interpretation is complicated in the presence of potential trade-offs, or interpretation issues among cross-border and local-level environmental issues, or short- and long-term considerations. For demand-based measures (such as CO_2 intensity of consumption), policy implications are further complicated by a host of factors at play—including issues related to international trade and transport and the interaction between trade

and environmental policies. Many of these caveats can be overcome by reporting and interpreting indicators in the appropriate context, along with taking into account country-specific ecological, geographical, social, economic, structural, and institutional features. However such qualifications can be at odds with the need to communicate simple, straightforward messages.

76. It is important for communication to account for the uncertainty of future developments by testing indicators under many combinations of future conditions. There may also be uncertainty about current conditions (possibly because of measurement limitations). For indicators to support sound decision making, decision makers and stakeholders need to understand the uncertainty in any set of indicator values. This involves clearly communicating the assumptions under which indicator values were developed, providing guidance on what can and cannot be inferred from the indicators, and communicating the nature of uncertainties, identifying those that which could be reduced with better information and those that are essentially irreducible (Institute of Medicine, 2013; US CCSP, 2009).

77. A further challenge is to use indicators in a way that can stimulate and support cross-border cooperation—especially in cases where GG/GE challenges are global or regional (such as climate change, fishery management, and water basin quality) and hence may not be efficiently addressed with national policy tools.

78. Finally, there may be a challenge in presenting more balanced messages. When it comes to the environment-economy nexus, many indicators tend to focus on challenges—be it to future growth, wellbeing, environment, or to minimise future risks—while the indicator coverage of opportunities is much poorer both in terms of quantity and quality of indicators, and are often cumbersome to interpret. While indicators of challenges do reflect the realties and are of the utmost importance in GE/GG policy making, the corollary is that policy messages tend to be centred around (avoiding) risks and damages.

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Annex 1: Lists of Indicators Used by the International Organisations (Supporting Section III)

GGGI Set of Diagnostic Indicators for assessing country sustainability in green growth planning

	Themes	Sub-themes	Indicators
Country Profile		Demographic	• Population (age 65 and above) • Population growth rate
		Geography	• Land area • Arable land • Population Density
		Institutional	• Net ODA received • International homicides • Current account balance • Remittances
To Develop	Well-being	Poverty	• Population living on degraded land • GINI index • Proportion of population below $1 per day (ppp int.$) • Employment to population ratio (age 15 and above)
		Access	• Access to electricity • Access to improved water source • Proportion of population with access to improved sanitation • Water coverage (access to tapped water within the service area) • Sewage coverage (access to sewerage system within the service area)
		Health	• Life expectancy at age 60 • Mortality rate under five • Hospital beds • Malnutrition prevalence (underweight)
		Education	• Literacy rate, adult total (age 15 and above) • Primary school enrollment • Secondary school enrollment • Tertiary school enrollment
	Economy	Income	• GDP (PPP) • GDP per capita (PPP) • GDP growth
		Industry	• Agricultural; Manufacturing; Service share • International tourism, receipts • Foreign direct investment, net flows
		Infrastructure	• Road density • Road paved • Cellular subscribers • Internet users

		SCP	• Material consumption • Generation of waste • Ecological footprint
To Sustain	Ecosyste m	Biodiversity	• Endangered species • Terrestrial and marine areas protected to total territorial area • Living planet index • GEF benefits index for biodiversity
		Ocean	• Coral reef • Marine area protected • Mangrove
	Resources	Energy & Mineral	• Energy supply (total primary energy supply) • Energy consumption (total final consumption) • Energy intensity • Energy use per capita • Electricity generated using non-fossil fuel
		Water	• Annual freshwater withdrawals, total • Water use intensity • Water scarcity index • Water stress index
		Fishery	• Total fisheries production
		Forestry	• Forest area • Deforestation • Change in forest area
	Climate	GHG Emission	• CO2 emission • CO2 emission per GDP • CO2 emission per capita • GHG intensity
		Air Emission	• NOx emission per capita • SOx emission per capita
		Vulnerability	• Droughts, floods, extreme temperatures • Vulnerability index

OECD Green growth indicators and themes

Group/theme	Proposed indicators
The socio-economic context and characteristics of growth	
Economic growth, productivity and competitiveness	**Economic growth and structure** GDP growth and structure; Net disposable income **Productivity and trade** Labour productivity; multi-factor productivity Trade weighted unit labour costs Relative importance of trade: (exports + imports)/GDP **Inflation and commodity prices**
Labour markets, education and income	**Labour markets** Labour force participation & unemployment rates **Socio-demographic patterns** Population growth, structure & density Life expectancy: years of healthy life at birth Income inequality: GINI coefficient Educational attainment: Level of and access to education
Group/theme	**Proposed indicators**
Environmental and resource productivity	
Carbon & energy productivity	**1. CO_2 productivity** 1.1. Production-based CO_2 productivity GDP per unit of energy-related CO_2 emitted 1.2. Demand-based CO_2 productivity Real income per unit of energy-related CO_2 emitted **2. Energy productivity** 2.1. Energy productivity (GDP per unit of TPES) 2.2. Energy intensity by sector (manufacturing, transport, households, services) 2.3. Share of renewable energy in TPES, in electricity production
Resource productivity	**3. Material productivity (non-energy)** 3.1. Demand based material productivity (comprehensive measure; original units in physical terms) related to real disposable income • Domestic material productivity (GDP/DMC) - Biotic materials (food, other biomass) - Abiotic materials (metallic minerals, industrial minerals) 3.2. Waste generation intensities and recovery ratios By sector, per unit of GDP or VA, per capita 3.3. Nutrient flows and balances (N,P) • Nutrient balances in agriculture (N, P) per agricultural land area and change in agricultural output **4. Water productivity** VA per unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated)
Multi-factor productivity	**5. Multi-factor productivity reflecting environmental services** Comprehensive measure
Technology and innovation	**6. R&D expenditure of importance to GG** 6.1. Renewable energy (in % of energy related R&D) 6.2. Environment-related technologies (in % of total R&D, by type) 6.3. All purpose business R&D (in % of total R&D) **7. Patents of importance to GG** in % of country applications under the Patent Cooperation Treaty 7.1. Environment-related and all-purpose patents **7.2.** Structure of environment-related patents
Natural asset base	
Natural resources	**8. Index of natural resources** Comprehensive measure

Renewable stocks	**9. Freshwater resources** Available renewable resources (groundwater, surface water, national, territorial) and related abstraction rates **10. Forest resources** Area and volume of forests; stock changes over time **11. Fish resources** Proportion of fish stocks within safe biological limits (global)
Non-renewable stocks	**12. Mineral resources** Available (global) stocks or reserves of selected minerals (tbd): metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates
Biodiversity and ecosystems	**13. Land resources** Land cover types, conversions and cover changes State and changes from natural state to artificial or man-made state • Land use: state and changes **14. Soil resources** Degree of top soil losses on agricultural land, other land • Agricultural land area affected by water erosion by class of erosion **15. Wildlife resources** • Trends in farmland or forest bird populations or in breeding bird populations • Species threat status: mammals, birds, fish, vascular plants in % species assessed or known • Trends in species abundance
Environmental quality of life	
Environmental health and risks	**16. Environmentally induced health problems & related costs** (e.g. years of healthy life lost from degraded environmental conditions) • Population exposure to air pollution **17. Exposure to natural or industrial risks and related economic losses**
Environmental services and amenities	**18. Access to sewage treatment and drinking water** 18.1. Population connected to sewage treatment (at least secondary, in relation to optimal connection rate) 18.2. Population with sustainable access to safe drinking water
Economic opportunities and policy responses	
Environmental goods and services	**19. Production of environmental goods and services (EGS)** 19.1. Gross value added in the EGS sector (in % of GDP) 19.2. Employment in the EGS sector (in % of total employment)
International financial flows	**20. International financial flows of importance to GG** (in % of total flows; in % of GNI) 20.1. Official Development Assistance 20.2. Carbon market financing 20.3. Foreign Direct Investment
Prices and transfers	**21. Environment-related taxation** - Level of environment-related tax revenues (in % of total tax revenues) - Structure of environment-related taxes (by type of tax base) **22. Energy pricing** (share of taxes in end-use prices) **23. Water pricing and cost recovery** *To be complemented with indicators on:* • *Environment-related subsidies* • *Environmental expenditure: level and structure (pollution abatement and control, biodiversity, natural resource use & management)*
Regulations and management approaches	*24. Indicators to be developed*
Training and skill development	*25. Indicators to be developed*

UNEP indicators for green economy policy making

Dimension	Theme	Indicators
Environmental	Climate change	• Carbon emissions (ton/year) • Renewable energy (share of power supply) (%) • Energy consumption per capita (Btu/person)
	Ecosystem management	• Forestland (ha) • Water stress (%) • Land and marine conservation area (ha)
	Resource efficiency	• Energy productivity (Btu/$) • Material productivity (ton/$) • Water productivity ($m^3$/$) • CO_2 productivity (ton/$)
	Chemicals and waste management	• Waste collection (%) • Waste recycling and reuse (%) • Waste generation (ton/year) or landfill area (ha)
Policy	Green investment	• R&D investment (% of GDP) • EGSS investment ($/year)
	Green fiscal reform	• Fossil fuel, water and fishery subsidies ($ or %) • Fossil fuel taxation ($ or %) • Renewable energy incentive ($ or %)
	Pricing externalities and valuing ecosystem service	• Carbon price ($/ton) • Value of ecosystem services (e.g. water provision)
	Green procurement	Expenditure in sustainable procurement ($/year and %)$CO_2$ and material productivity of government operations (ton/$)
	Green job skill training	• Training expenditure ($/year and % of GDP) • Number of people trained (person/year)
Well-being and equity	Employment	• Construction (person, %) • Operation and management (person, %) • Income generated ($/year) • Gini coefficient
	EGSS performance[12]	• Value added ($/year) • Employment (jobs)
	Natural and human capital	• Value of natural resource stocks ($) • Net annual value addition/removal ($/year) • Literacy rate (%)
	Access to resources	• Access to modern energy (%) • Access to water (%) • Access to sanitation (%) • Access to health care (%)
	Health	• Level of harmful chemicals in drinking water (g/litre) • Number of people hospitalized due to air pollution (person) • Road traffic fatalities per 100,000 inhabitants (transport related)

[12] EGSS performance reduces environmental pressure, which would support improvement in human well-being (UNEP, 2012).

World Bank framework for measuring potential benefits from green growth policies[13]

Type of benefit	Channels	Examples of indicators
Environmental	Improved environment	Indicators specifically developed for the domain in question (for example, reduction in greenhouse gas emissions, natural area protected from development, air or water quality).
Economic	Increase in factors of production (physical capital, human capital, and natural capital)	Measured by the additional production from increased capital (potentially measured by the value of ecosystems or renewable resources), or by the value of additional capital.
	Accelerated innovation, through correction of market failures in knowledge	Measured by productivity indicators (for example, efficiency of photovoltaic panels used to produce electricity) or dissemination indicators (for example, the fraction of the population with access to photovoltaic electricity).
	Enhanced efficiency, through correction of non-environmental market failures	Measured by indicators for resource efficiency (for example, the material or energy intensity of production, reduction in the time of in the value of time lost from congestion), or by additional production.
Social	Increased resilience to natural disasters, commodity price volatility, and economic crises	Measured by metrics related to the project, from avoided disaster losses (in monetary terms) or number of people at risk from floods to a measure of the vulnerability to oil price volatility.
	Job creation and poverty reduction	Measured by the number of jobs created or an indicator of the impact on the poor (for example, reduction in the number of people without access to drinking water and sanitation).

[13] See World Bank (2012).