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MEASURING THE GREEN TRANSFORMATION OF THE ECONOMY

GUIDE FOR EU EASTERN PARTNERSHIP COUNTRIES

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DISCLAIMER

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FOREWORD

Green growth policies aim at fostering economic development and human well-being by preserving and making sound use of natural capital, i.e. the natural resources and ecosystems that provide the raw materials, energy, water and a wide range of other services on which well-being relies (OECD 2011a, 2011b). These policies need to be founded on a good understanding of the determinants of green growth and of related trade-offs or synergies. They also need appropriate information and indicators to monitor progress and gauge results. Indicators to monitor progress towards green growth need to be embedded in a conceptual framework and should be selected according to well-specified criteria. Ultimately, they need to be capable of sending clear messages to policy makers and the public at large. When used in international work, they further need to be based on internationally comparable data.

The OECD has supported global efforts to promote and monitor green growth and facilitates the exchange of experience and good practice on developing indicators and applying a coherent and consistent green growth measurement framework. The practical application of this set is now being extended to countries of the European Union Eastern Partnership (EaP) (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine) as part of the EU-funded "Greening Economies in the Eastern Neighbourhood" (EaP GREEN) project that helps the EaP economies to move towards a green economy.

The objective of this guide, developed under the EaP GREEN project, is to help governments in the EaP countries in establishing national frameworks for monitoring and analysing the transition towards green growth and to support them in producing green growth indicators (GGIs). The guide presents the concept of green growth, shares practical experience available from the frontrunners of green growth measurement, and combines it with experience from ongoing work of EaP countries and other transition economies of Eastern Europe, the Caucasus and Central Asia in producing green growth and environmental indicators. It uses OECD's work on green growth measurement as a starting point, and describes how it connects to other relevant international work.

The guide is principally addressed to the management and technical personnel in Statistical Agencies, Ministries of Economy, Finance, and Environment of the EaP countries. At the same time it may be useful for sectoral ministries, including ministries of energy, industry and agriculture, and other stakeholders, for example from NGOs, academia, and the private sector, involved in setting up a national framework on measuring green growth. While the guide primarily targets the EaP countries, it is relevant to any emerging and transitional economy.

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LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
BRIICS	Brazil, Russian Federation, India, Indonesia, People's Republic of China and South Africa
CAF	Latin American Development Bank
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CEPA	Classification of environmental protection activities
CPIs	Consumer price indices
CREMA	Classification of resource management activities
CRS	Creditor Reporting System
DAC	Development Assistance Committee
DEU	Domestic extraction used
DIs	Diagnostics Indicators
DMC	Domestic material productivity
EaP GREEN	Greening Economies in the EU's Eastern Neighbourhood
EaP	EU Eastern Partnership
ECLA	European Classification System
EEA	European Environmental Agency
EFTA	European Free Trade Association
EGS	Environmental goods and services
EI	Environmental indicators
EPR	Environmental Performance Reviews
ETS	Emission Trading Scheme
EU	European Union
FAOSTAT	Food and agriculture organisation corporate statistical database
FRA	Forest Resource Assessments
GALI	Global Activity Limitation Indicator
GBAORD	Government budget appropriations or outlays for R&D
GBD	Global Burden of Disease
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GGI	Green Growth Indicators
GGKP	Green Growth Knowledge Platform
GHG	Greenhouse gas
GNI	Gross national income
HLY	Healthy Life Years
ICES	International Council for the Exploration of the Sea
ICT	Information and communications technology
IDHP	International Human Dimensions Programme
IEA	International Energy Agency
IHME	Institute for Health Metrics and Evaluation
ILO	International Labour Office
INEGI	National statistical and geographical institute
IPC	International Patent Classification
ISIC	International Standard Industrial Classification of All Economic Activities
IUCN	International Union for the Conservation of Nature
IWI	Inclusive Wealth Index
JMP	Joint Monitoring Programme

MDB	Multilateral development banks
MDG	Millennium Development Goal
MEIs	Monitoring and Evaluation Indicators
MFA	*Material flow accounting and analysis*
MFP	Multifactor productivity
MRIO	Multi-regional input-output
NGO	Non-governmental Organisation
NNI	Net national income
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PEI	Poverty and Environment Initiative
PIs	Planning Indicators
PPP	Purchasing power parities
PSE	Producer support estimates
PSR model	Pressure-state-response model
PV	Photovoltaic
R&D	Research and development
SDG	Sustainable Development Goals
SEEA	System of integrated environmental and economic accounting
SEIS	Shared Environmental Information System
SELA	Latin American and Caribbean Economic System
SME	Small and medium-sized enterprises
SNA	System of national accounts
TPES	Total primary energy supply
ULC	Unit labour cost
UNCED	United Nations Conference on Environment and Development
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNSD	United Nations Statistics Division
UNU-IHDP	United Nations University International Human Dimensions Programme on Global Environmental Change
UNW-DPC	United Nations Water Decade Programme on Capacity Development
USD	US-Dollar
VOC	Volatile organic compounds
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WGEMA	UNECE Working Group on Environmental Monitoring and Assessment
WHO	World Health Organisation
WIPO	World Intellectual Property Organization
WSSD	World Summit on Sustainable Development

EXECUTIVE SUMMARY

The concept of *green growth* is based on the idea that economic and environmental policies can foster economic growth and increase carbon, energy and material productivity, maintaining the natural asset base and improving people's quality of life.

A number of countries embarked on a challenge of greening their economic growth in order to enhance the performance of production processes and new, improved products, drive innovation and structural changes in the economy, promote fiscal consolidation through reviewing the composition and efficiency of public spending and increasing revenues from the pricing of pollution, build investor confidence through greater predictability and stability, generate more balanced macroeconomic conditions and reduced resource price volatility.

To ensure effective policy design supporting green growth, sound information and data on the environment and economy nexus are needed. Not only does tracking and assessing progress in green growth contribute to a better understanding of the determinants of green growth but can also point out further synergies between the environment and the economy. Knowing the natural asset base and possible economic opportunities as well as monitoring the environmental dimension of quality of life contributes to defining policy priorities. It is also important to have a solid information base to better communicate progress on green growth with the public.

A wide range of partners work together at the international level to provide and implement a framework for measuring the green transformation of the economy. The OECD has supported these efforts by facilitating the exchange of experience and good practice on developing green growth indicators (GGI) and applying them in a coherent and consistent manner. The practical application of this set is now being extended to countries of the European Union Eastern Partnership (EaP) (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine) as part of the EU-funded "Greening Economies in the Eastern Neighbourhood" (EaP GREEN) project that helps the EaP economies to move towards a green economy.

The present document, which was developed as part of the EaP GREEN, serves as a guide for interested countries, supporting them in applying and adapting the OECD framework in their country. The guide draws on lessons learned from the application of the green growth measurement framework and environmental indicators in OECD and EaP countries and other transition economies of Eastern Europe, the Caucasus and Central Asia. This Guide addresses questions such as:

- Why should green growth be measured?
- How could a measurement framework be structured?
- Which indicators are relevant for monitoring the different aspects of green growth?
- What needs to be considered when a national green growth measurement framework is developed and implemented?

A framework to measure the green transformation of the economy

The OECD green growth measurement framework is structured along the key objectives of green growth:

- ensuring that the economy is low-carbon and resource efficient through the environmental and resource productivity of the economy,

- maintaining the natural asset base,

- improving the environmental dimension of quality of life, and

- seizing economic opportunities and implementing policy responses to green growth.

The four groups are complemented by a section on the socio-economic context and the characteristics of growth in the country studied.

Under each of the groups, the framework suggests concrete indicators that were selected according to their policy relevance, analytical soundness and measurability. The present document discusses all proposed indicators in terms of potential data sources and data availability for EaP countries and beyond and summarises the definitions as well as the methodology for their calculation proposed by OECD. With this, it serves as a starting point and orientation aid for interested countries that are composing their own national set of indicators. Not all proposed indicators are equally relevant to all countries and the list will have to be adjusted depending on national contexts and priorities.

Lessons learned from the application of the green growth measurement framework

The practical application of the OECD set of GGIs started in 2011, when the Netherlands issued its first report of this kind. Soon, the Czech Republic, Germany, Denmark, Slovenia, the Slovak Republic and the Republic of Korea followed this initiative and produced GGI-based reports adapting the OECD framework to their own national context.

While the original grouping of GGIs is adjusted only marginally, countries attach different importance to individual indicators of the OECD set. In some cases, certain indicators were excluded and new ones added, depending on national circumstances and policy priorities.

The most challenging practical application of the GGI concerns gathering data. Data sources used to construct the indicators include primarily official national statistics, but also data from administrative sources and in some cases from research studies. Collecting data for the policy response indicators is the most problematic part for almost all countries. Lack of coherent data over longer periods was another challenge. These factors tend to limit the indicators' usefulness for assessing progress in greening the economic development and the role of policies in this process.

The process of identifying national green growth indicators has commonly been done in a collaborative way among the relevant institutions. But the experience show that several countries face challenges at the indicator identification phase when a lack of information exchange between departments and governmental agencies slows down progress.

Compiling and testing a national green growth measurement framework

The experience from applying green growth measurement allowed identifying key steps for deriving a national set of GGIs and relevant products for the use in making information on green growth available to the decision-makers and the general public.

First, the measurement framework should be applied in parallel to the development of a Green Growth Strategy. For countries that do not have agreed on such a strategy yet, the launch of a pilot study on green growth measurement at the national level may be a useful way to take stock of the current situation and help to devise such a strategy.

Second, awareness and demand for such an exercise should be determined. Where the awareness and demand is still nascent, a pilot application of the OECD set of GGI can in fact catalyse the development of green growth policies.

Third, it is crucial that the involved bodies have a clear agreement on milestones and division of responsibilities for developing a green growth strategy and related indicators for the national measurement framework. While the Ministry of Economy may assume leadership in the process, the major environmental authority and statistical agencies should have a strong voice in the process. The involved ministries may wish to establish an inter-ministerial supervisory group for a regular exchange during the process that can ensure political support for the project and is able to decide on follow up policy action. Stakeholders from academia, non-governmental organisations (NGO), and actors of the private sector may wish to contribute to the process.

Finally, the experience show that the pilot testing of a national green growth measurement framework could result in two complementary products: an *expert paper* addressing the needs and feasibility for a regular measurement of progress towards green growth in the country and a *data-based publication* resulting from the pilot application of the OECD set of GGIs based on currently available data. Stakeholders can then develop a communication strategy and discuss steps to be taken towards a regular measurement practice.

CHAPTER 1: A FRAMEWORK FOR DEVELOPING AND APPLYING GREEN GROWTH INDICATORS

1.1 Green growth policies –fostering economic performance and preserving natural capital

Green growth policies aim at fostering economic development and human well-being by preserving and making sound use of natural capital, i.e. the natural resources and ecosystems that provide the raw materials, energy, water and a wide range of other services on which well-being relies (OECD 2011a, 2011b). Thus, a central idea is that "green" can promote "growth". This can be achieved by designing and applying a green growth policy framework that is setting price signals and regulatory actions that provide incentives towards substituting away from scarce environmental resources, and by fostering innovation, productivity and human capital.

Box 1.1. Key elements of green growth

Economic growth is conventionally thought of as the process through which workers, machinery and equipment, materials and new ideas and technologies contribute to producing goods and services that are valuable for individuals and society. The concept of green growth builds on this with four additional elements:

Capturing the importance of changes in the comprehensive wealth of an economy, meaning paying attention to all types of capital: natural (e.g. ecosystems), human (e.g. education and skills), physical (e.g. machinery and equipment), and the intangible assets, which are so crucial to human progress like ideas and innovation. This comprehensive approach captures some important aspects of growth including the nature of trade-offs, which arise at the frontier of production possibilities. For example, substituting environmental assets in production or consumption is not necessarily a smooth process: critical thresholds can be crossed after which assets that are renewable cease to be so (e.g. fisheries or soil) or assets that are non-renewable are depleted to a point that substitution with other inputs or goods and services becomes impossible (e.g. climate or biodiversity), potentially short-circuiting growth in well-being. This introduces uncertainties about thresholds, irreversible outcomes and discontinuities that complicate policy design. Different considerations will apply for different environmental assets (e.g. renewables and non-renewables); there is no single rule for determining whether assets should be preserved or not.

Incorporating the dual role played by natural capital in this process, being both sources and sinks for the economy. Natural capital contributes to production by providing crucial inputs, some of which are renewable and others, which are not. It also influences individual and social welfare in various ways, through the effect that the environment has on health, through amenity value and through provision of ecosystem services.

Acknowledging that investment in natural capital is an area in which public policy intervention is needed because market incentives are weak or non-existent. This is largely because the contribution of natural capital to production and to individual welfare is often not priced nor appropriately valued. The lack of proper valuation and market incentives or signals can affect behaviour and truncate the foresight of households and firms in ways that set the economy on trajectories that are unsustainable (or conversely that miss growth opportunities) or that are not necessarily maximising well-being.

Recognising that innovation is needed to attenuate trade-offs that arise between investing in (depleting) natural capital and raising consumption or investing in other forms of capital. Indeed, once resource productivity is raised and inefficiency eliminated, a "frontier" is reached along which these trade-offs become more pronounced. Through innovation, the frontier at which trade-offs start to bind can be pushed outwards; essentially greening growth. Most importantly, policies that aim to push out the frontier of economic growth need to grapple with existing incentives to innovate which are heavily biased towards improving the efficiency of currently dominant production techniques (e.g. in energy and transport) due to the tendency of innovation to build on previous innovations and existing technologies. Overcoming this kind of "path dependency", which contributes to inhibit the development of green technology (other factors are learning-by-doing effects and economies of scale) through appropriate innovation policies is therefore crucial for green growth.

Besides increasing the resilience of ecosystems and boosting the environmental quality of life and ensuring the sustainability of agro-food systems, green growth policies can result in a wide range of economic benefits (OECD 2014a), such as:

- Enhanced performance of production processes and new, improved products;

- Innovation and structural changes in the economy, which would be accompanied by the emergence of new industries, products, services, and new business opportunities more generally, and overcoming technological lock-in, especially in relation to infrastructure;

- Fiscal consolidation through, for instance, reviewing the composition and efficiency of public spending and increasing revenues through the pricing of pollution;

- Investor confidence through greater predictability and stability of how governments deal with major environmental and development issues;

- More balanced macroeconomic conditions and reduced resource price volatility.

Integrating these elements into policy is at the heart of green growth. In terms of well-being, policy decisions need to reflect the relative value to households of services from natural capital relative to other goods, and thus the trade-offs that occur at the frontier. Trade-offs need to be evaluated and re-evaluated over time to weigh the impacts of a decline in natural capital for current and future generations. These trade-offs vary geographically depending on available technologies, the natural resource base and on households' and societal preferences; hence, policies have to be adapted to different circumstances.

In order to be politically appealing, green growth policies need to address equity concerns up front by identifying and building in measures that would correct eventual adverse social impacts of certain policy interventions, such as reforming environmentally harmful energy subsidies. Matching objectives of green growth and poverty reduction policies is particularly important in emerging and developing economies. Complementarities between green growth and poverty reduction include, for example, providing more efficient water and transport infrastructure, and alleviating poor health associated with environmental degradation.

Though green growth is relevant to all countries, policies and approaches used to anchor this new model in everyday behaviour have to be tailored to specific regional and national circumstances and stages of development. The choice of such policies and approaches, and their mixes, may be influenced by a number of factors, for instance the weight put on environmental well-being, market conditions (*e.g.* the share of informal economy or the maturity of financial markets), or specific governance conditions (*e.g.* weak capacity in policy design or implementation).

Given their economic and environmental angles, green growth strategies involve two broad sets of policies:

- ***Framework policies.*** These include, essentially, fiscal and regulatory settings, as well as competition, trade and innovation policies, which, if well designed and executed, maximise the efficient allocation of resources;
- ***Environmental policies.*** These policies further incentivise the efficient use of natural resources and ecosystems and correct market distortions. Putting a price on pollution and natural resource use should be a central element of any policy mix to support green growth notwithstanding differences in national circumstances. The responsiveness of businesses and consumers to price signals can, in many situations, be further strengthened through better regulation and information-

based measures (i.e. non-market policy instruments). Unfortunately, the value of the natural capital is in general not yet sufficiently captured by prices therefore decisions related to its management may be badly affected by this market failure.

In addition, education, labour, and social protection policies are essential for facilitating the green growth transition. Policy coherence is a key ingredient of success.

1.2 The OECD green growth measurement framework and its indicators

1.2.1 The OECD conceptual framework

To ensure effective policy design supporting green growth, sound information on physical characteristics of the natural capital and its interactions with other forms of capital is needed. In order to develop and maintain a system that can measure progress in this regard, governments need to adopt relevant measurement frameworks and ensure that the necessary data are collected, analysed and their quality assured. Experiences from OECD's work on green growth indicators can help countries to implement such a framework underpinned by sound data.

At the OECD Ministerial Council Meeting in June 2009, Ministers asked the OECD to develop a Green Growth Strategy to support countries' effort to achieve economic recovery and environmentally and socially sustainable economic growth. Since then, the OECD has been working with a wide range of partners from across government and civil society to provide a policy framework for how countries can achieve economic growth and development while at the same time combating climate change and preventing costly environmental degradation and the inefficient use of natural resources.

The OECD's approach to measure progress towards green growth was presented in the 2011 report, "Towards Green Growth: Monitoring Progress" (OECD 2014a). It involves a conceptual measurement framework that combines the main features of green growth with the basic principles of accounting and the pressure-state-response (PSR) model[1] used in environmental reporting and assessment.

The OECD green growth measurement framework takes the economy and its production function and the associated consumption facet as a starting point (the economic lens) and then dwells upon the natural asset base on which it relies, and on the policy responses and opportunities generated (Figure 1.1.). It is intended to structure the analysis of the sources of green growth, and to help identify indicators that are relevant for decision-makers and the public.

The measurement framework addresses a set of key questions that relate to the following dimensions of green growth:

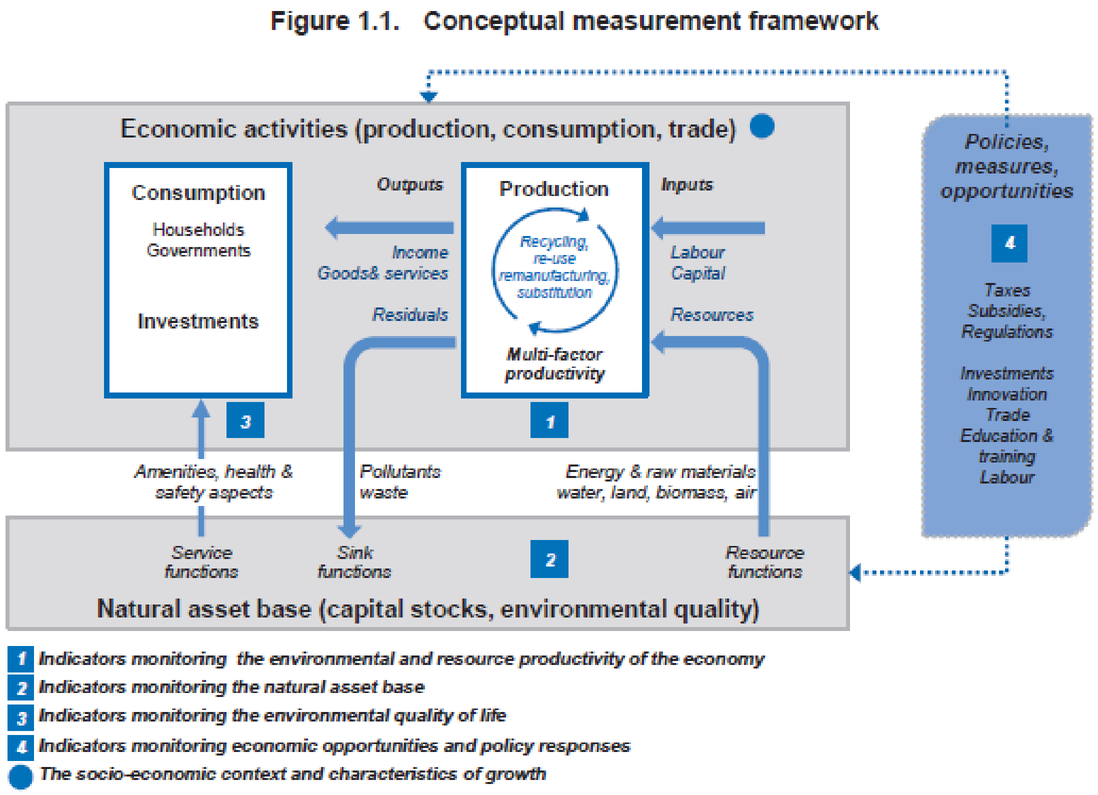
- ***Characteristics of the natural capital itself:*** Is there a risk of qualitative and quantitative alterations of the natural asset base and ecosystem services, which would trigger shocks to future growth and social development? Is the natural capital used within the limits of its resilience?

- ***The nexus between the natural and manufactured capital:*** Do production and consumption patterns improve in terms of environmental productivity? Is the manufactured capital used and disposed of more effectively? How does this affect the productivity of the economy? Are measures to open up new sources of growth and promote green growth effective?

[1] The PSR model is based on the concept of causality: human activities exert pressures on the environment and change its quality and quantity of natural resources (state). Society responds to these changes through environmental, general economic and sectoral responses. For more information on the PSR model see OECD (2003, Annex II).

- ***The nexus between the natural and human capital:*** Do green growth policies result in a better quality of life for all?

Figure 1.1. OECD's conceptual measurement framework for green growth

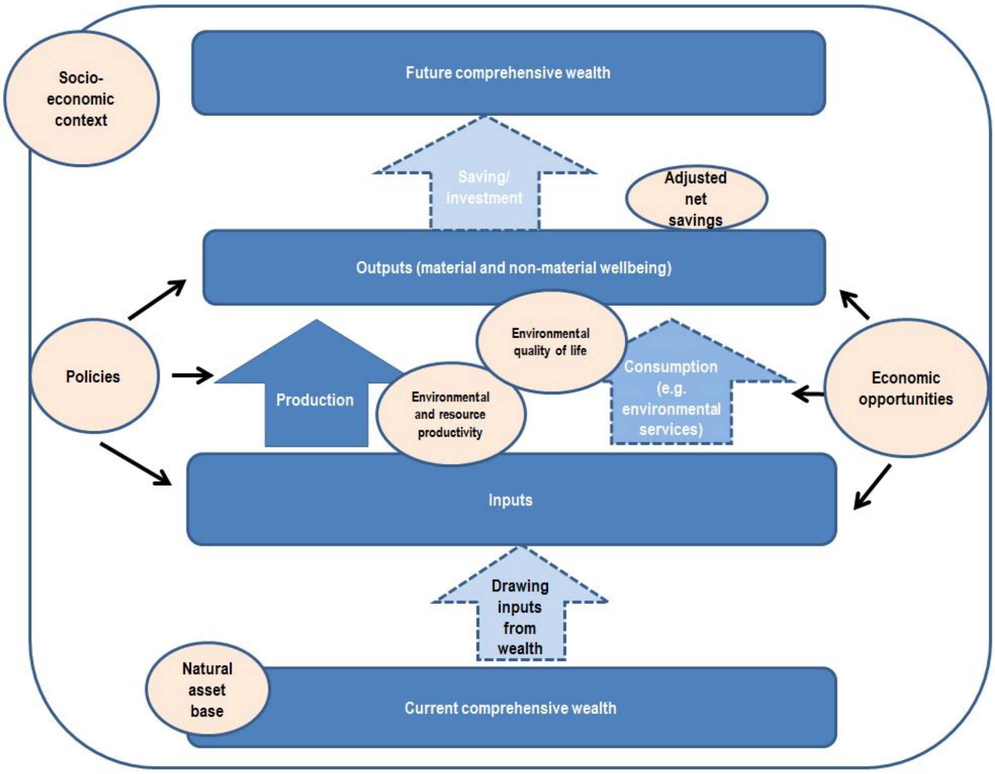


Source: OECD (2014a). *Green Growth Indicators 2014*, OECD Publishing, Paris

The questions above relate to a range of inputs, such as natural, human, and manufactured capitals, which, after being engaged in production and consumption, result in either positive or negative changes in material and non-material well-being. All forms of capital can be integrated into a single input-output model (Figure 1.2.) that shows their linkages and contribution to human well-being and wealth evolution. Maintaining the inter-generational flows of capital intact and avoiding the deterioration of the individual well-being constitutes the essence of sustainable development.

Within this input-output model, one distinctive characteristic of the natural capital is its limited substitutability with other forms of capital. Eroding natural capital will first result in increased costs of substituting it with other forms of capital. Bypassing the limits of its erosion can have consequences that do not necessarily follow a smooth, foreseeable trajectory. They can lead to changes that would be irreversible both for the environment and economy. Therefore a diverse and resilient “living planet” is important from an economic point of view, beyond representing a value as such.

Figure 1.2. Input-output model of green growth



Source: GGKP (2013), Moving towards a common approach on green growth indicators

1.2.2 Rationale behind and structure of the OECD set of green growth indicators

Indicators can be defined as measurable information (parameters, or value derived from parameters) that describe a phenomenon/environment/area and possess a synthetic meaning. A composite indicator measures multi-dimensional concepts (e.g. competitiveness, e-trade or environmental quality) which cannot be captured by a single indicator. Ideally, a composite indicator should be based on a theoretical framework/definition, which allows individual indicators/variables to be selected, combined and weighted in a manner, which reflects the dimensions or structure of the phenomena being measured. Data (parameters) are characteristics or information usually numerical that are collected through observation.

Indicators can serve different purposes and uses. The OECD identifies two major functions of indicators (OECD 2011a):

- Synthetic function: Indicators reduce the number of measurements and parameters that normally would be required to give an exact presentation of a situation. As a consequence, the size of an indicator set and the level of details contained in the set need to be limited. A set with a large number of indicators will tend to clutter the overview that it is meant to provide;

- Simplification and adaptation function: Indicators simplify the communication process by which the results of measurement are provided to the user. Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of “the best knowledge available”.

Within the policy-making and implementation cycle, uses of indicators are multiple and include:

- Baseline definition and target setting: Indicators can be used to clarify the need for policy interventions, by providing information on the current situation, and enabling the definition of desirable qualitative and quantitative changes;

- Performance monitoring: Indicators sets can enable the measurement of progress in relation to specific targets set in policies;

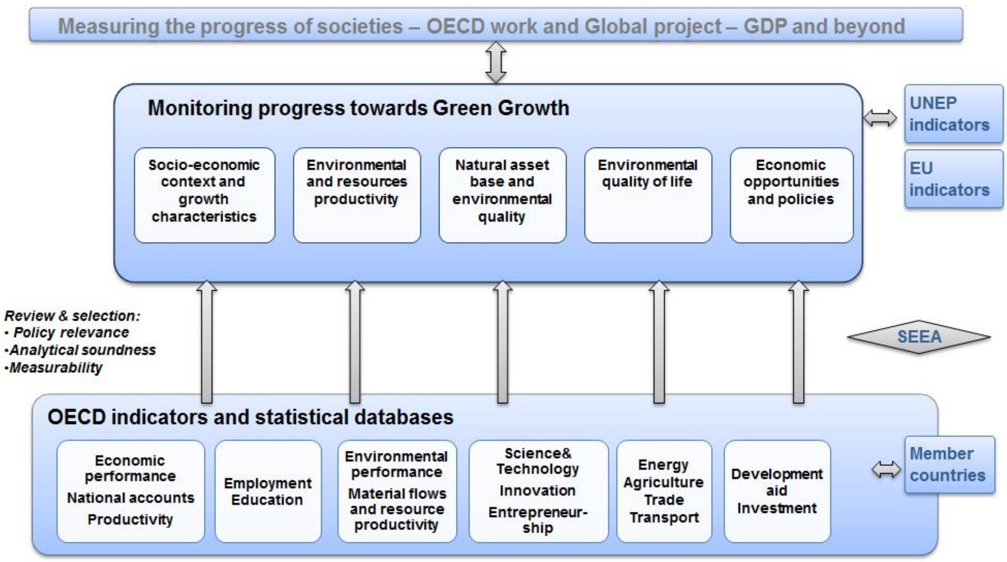
- Benchmarking: Indicators can serve comparison purposes nationally and internationally. This can contribute to limiting gaps in performance between countries or between administrative-territorial units within a country;

- Reporting on performance and awareness raising: Indicators can contribute to the broader objective of ensuring government transparency and accountability, and making the general public aware of the impact of policy interventions.

The set of GGIs proposed by the OECD (2014a) is the outcome of an intense inter-governmental and multi-stakeholder consultation process, involving environmental, economic and statistical communities from the 34 OECD member countries and several non-members (accession countries, BRIICS), and including NGOs, the business sector and academia. The approach adopted to develop the indicator set is, in part, based on the approach developed for the OECD's work on environmental indicators and environmental reporting that has been operational at the OECD for more than three decades (see section 1.3). Work continues to refine and further elaborate the indicator set as new data become available and concepts evolve. While the number of potentially useful indicators for measuring green growth is fairly large, the applied set should be concise and of a manageable size.

The OECD elaborated a set of GGIs in line with the main components of the measurement framework (OECD 2014a). The indicators were selected from a broad range of data and indicators that are already part of the work of OECD and partner organisations and supplemented with a few proposals for new indicators (Figure 1.3.).

Figure 1.3. OECD Green growth indicators - the foundations and the overall indicator architecture



Source: OECD presentation at Regional workshop for the countries of Eastern Europe, the Caucasus and Central Asia on the Shared environmental information system and green growth.

To guide the selection and identification of the most country-relevant indicators the following principles and criteria were applied:

- ***Policy relevance.*** The indicator set should:
  - provide a balanced coverage of the key features of green growth with a focus on those that are of common interest to OECD member and partner countries. This entails a coverage of the two dimensions of green growth – "green" and "growth" – and of their main elements, with particular attention given to indicators capturing the interface between the two;
  - be easy to interpret and transparent, *i.e.* users should be able to assess the significance of the values associated with the indicators and their changes over time;
  - provide a basis for comparisons across countries;
  - lend itself to being adapted to different national contexts, and analysed at different levels of detail or aggregation.
- ***Analytical soundness:*** The indicators should be analytically sound and benefit from a consensus about their validity. They should further lend themselves to being linked to economic and environmental modelling and forecasting.
- ***Measurability:*** The indicators should be based on data that are or that can be made available at a reasonable cost, that are of known quality, and are regularly updated.

These criteria, which remain relevant when a national set of GGIs based on the OECD framework is selected, describe the "ideal" indicator; not all of them will be met in practice.

For each of the proposed indicators it is assessed whether measurement at the country level is possible: i) in the short term (basic data currently available), ii) in the medium term (basic data partially available, but calling for further efforts to improve their quality), or iii) in the long term (basic data not available, calling for a sustained data collection and conceptual efforts) (Tables 2.1-2.14). In instances where the desired indicator is not currently measurable, proxy indicators can be proposed.

The proposed indicator set provides countries with a starting point for developing a national green growth indicator set building on the OECD measurement framework. The OECD set is neither exhaustive nor final, and has been kept flexible enough so that countries can adapt it to different national contexts. The conceptual measurement framework developed by the OECD is to be used to structure the thinking about the indicator set and to organise it in a way useful to decision-makers and the broader public. It does not replace international guidelines and statistical standards on which the underlying data series should be based, in particular the Framework for the Development of Environment Statistics (FDES) and the System of Environmental and Economic Accounting (SEEA). International statistical guidelines help to ensure that the underlying data are harmonised at the international level. In particular, the SEEA helps to structure and organise underlying data in a way that is relevant with the system of national accounts (SNA) and thus ensures coherence between data sets and breakdowns by industry (Box 1.2).

For the OECD measurement framework, 25 to 30 indicators were identified under four main headings: the environmental and resource productivity of the economy, the natural asset base, the environmental dimension of quality of life, and economic opportunities and policy responses to green growth. The four groups are complemented by indicators that describe the socio-economic context and the characteristics of growth. These can be used to interpret GGIs in the light of national socio-economic circumstances (Table 1.1.).

Table 1.1. OECD green growth measurement framework - indicator groups and topics covered

1	The environmental and resource productivity of the economy	Carbon and energy productivity Resource productivity: materials, nutrients, water Multi-factor productivity
2	The natural asset base	Renewable stocks: water, forest, fish resources Non-renewable stocks: mineral resources Biodiversity and ecosystems
3	The environmental dimension of quality of life	Environmental health and risks Environmental services and amenities
4	Economic opportunities and policy responses	Technology and innovation Environmental goods & services International financial flows Prices and transfers Skills and training Regulations and management approaches
5	Socio-economic context and characteristics of growth	Economic growth and structure Productivity and trade Labour markets, education and income Socio-demographic patterns

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris.

The proposed set has been selected on the basis of existing work and experience in the OECD, other international organisations, and member and partner countries. Gaps exist, and some of the selected indicators are not currently measurable. Therefore, the set includes: (a) main indicators and their components or supplements, and (b) proxy indicators when the main indicators are currently not measurable at the international level (Chapter 2).

To facilitate communication with policy makers, the media and citizens, six headline indicators were identified that aim at communicating central elements of green growth in a balanced way: carbon and material productivity, environmentally adjusted multifactor productivity, a natural resource index, changes in land use and cover, and population exposure to air pollution (OECD 2014a). As for the full indicator set, the proposed list of headline indicators is not necessarily final.

Box 1.2. The System of Environmental-Economic Accounting (SEEA)

International organisations including UNEP, UNSD, UNECE and the OECD recommend that countries use SEEA as the underlying framework for deriving indicators that reflect interrelations between the economy and the environment. Most data used for green growth measurement should, where possible, be produced in accordance with the SEEA framework (OECD 2011b).

The SEEA provides a consistent, coherent and comprehensive framework for producing integrated economic and environmental statistics (UN et al. 2014). It contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics that are in line with those of the SNA.

The methodology for producing a number of the indicators from the OECD green growth measurement framework can be directly obtained from the SEEA central framework (Table 2). Indicators for environmental efficiency and resource efficiency can be derived from the physical flow accounts. Combining physical information with monetary indicators from the SNA provides information on the interaction between environmental pressure and economic growth. The asset accounts provide the basis for indicators related to the natural asset base. Environmental activity accounts offer useful information on the application and efficiency of various policy instruments, such as environmental taxes and subsidies. Finally, data from the environmental goods and services (EGS) sector provide indicators for evaluation of economic opportunities that may be initiated by green growth.

By applying the SEEA framework, monetary and physical data can easily be combined in a consistent format, for example for calculating intensity and productivity ratios. And macro-level indicators can be broken down by economic sector and by industry, to show structural changes over time, to analyse environmental pressures exerted by different industries, and to distinguish government responses from those of the business sector or private households. This is important when the indicators address both the environmental effectiveness and the economic efficiency of policies, or when they are to support structural policy analyses.

Table 1.2. Overview of selected indicator types and relevant SEEA accounts

Topic or issue	Indicator examples	Examples of relevant SEEA accounts
Environmental efficiency	Pollutant emission or waste generation intensities and productivity ratios, relating the generation of residuals to economic output: Carbon productivity and air emission intensities Waste generation intensities Nutrient balance intensities	Physical flow accounts for water Physical flow accounts for materials: product flows, air emissions (including greenhouse gases), pollutant emissions to water
Resource efficiency	Resource use intensities and productivity ratios, relating resource inputs to economic output: Energy productivity Material productivity Water productivity	Physical flow accounts for materials: solid waste accounts, economy-wide material flow accounts. Physical flow accounts for water Physical flow accounts for energy
Natural assets	Intensity of use of natural resource stocks, relating resource extraction to available stocks: water, minerals, energy, timber, fish Index of natural resources Land use and cover changes Soil productivity	Asset accounts for: Water resources Mineral and energy resources; Timber resources; Aquatic resources Land and soil resources SEEA experimental ecosystem accounts
Environmentally-related activities and instruments	Share of environment-related activities in the economy: output, investments, trade, employment. Level and composition of environmental expenditure Environment related tax rate and revenue structure Environment-related support measures, e.g. fossil fuel subsidies	Environmental activity accounts and statistics: environmental protection and resource management expenditure, environmental goods and services Accounts for other transactions related to the environment: payments, transfers

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris.

1.3 Other OECD work on measuring progress in environment and well-being

1.3.1 OECD Environment indicators

For more than 30 years, the OECD has prepared harmonised international data and sets of indicators on many topics, including on the environment, and assisted countries to improve their environmental information systems. The main aims of this work have been to measure environmental progress and performance; monitor and promote policy integration, in particular, the integration of environmental considerations into policy sectors, such as transport, energy and agriculture, and into economic policies more broadly (OECD, 2013d).

The OECD approach to indicators is based on the view that:

- There is no unique set of indicators; whether a given set of indicators is appropriate depends on its use.
- Indicators are only one tool among others and generally should be used with other information in order to draw robust conclusions.
- OECD environmental indicators are relatively small sets of indicators that have been identified for use at the international level, and should be complemented by national indicators when examining issues at national level.

The programme builds on agreement by OECD member countries to:

- Use the pressure-state-response (PSR) model as a common reference framework.
- Identify indicators on the basis of their policy relevance, analytical soundness and measurability.
- Use the OECD approach and adapt it to their national circumstances.

The development of environmental indicators in OECD has been grounded in the practical experience of OECD countries. Their development has benefited from strong support from member countries, and their representatives in the OECD Working Party on Environmental Information. OECD work on indicators also benefits from close co-operation with other international organisations, notably the United Nations Statistics Division (UNSD) and United Nations regional offices, the United Nations Environment Programme (UNEP), the World Bank, the European Union (including Eurostat and the European Environment Agency), as well as international institutes.

1.3.2 Wealth accounting approaches

Methodological imperfections and a widespread lack of policy-useable information on the value of natural capital (and its depletion) has been a major factor impeding decision-makers to see future growth constraints related to natural resource use. Traditionally, Gross Domestic Product (GDP) has been applied to measure economic progress. This measure, however, fails to grasp the evolution in the value of a nation’s assets and to reveal the decline in its natural or social capital, which are indispensable for the sustainability of growth. As a gross measure, GDP takes no account of depreciation, depletion or degradation of assets, whether produced or natural. Recent years have seen an increasing awareness that macroeconomic statistics, including statistics on GDP do not provide policy-makers with a sufficiently detailed picture of the living conditions that people experience.

One of the possible approaches, which could complement the monitoring of GDP evolution, is to measure total wealth and its structure. The wealth accounting approach, as suggested by the World Bank (2006) and further developed by UNU-IHDP and UNEP (2012), presumes that development can be treated as a process of "…building and managing a portfolio of assets. The challenge of development is to manage not just the total volume of assets – how much to save versus how much to consume – but also the composition of asset portfolio, that is, how much to invest in different types of capital, including the institutions and governance that constitute social [intangible] capital" (World Bank, 2011).

Though the wealth accounting approaches are still under development, they can be a helpful for moving the discussion on the value of natural capital forward.

Explicitly introducing some of the key environmental services into growth accounting computations is a first step towards reviewing measures of the sources of economic growth without fundamentally altering the basic growth accounting methodology. Two complications have to be overcome, however:

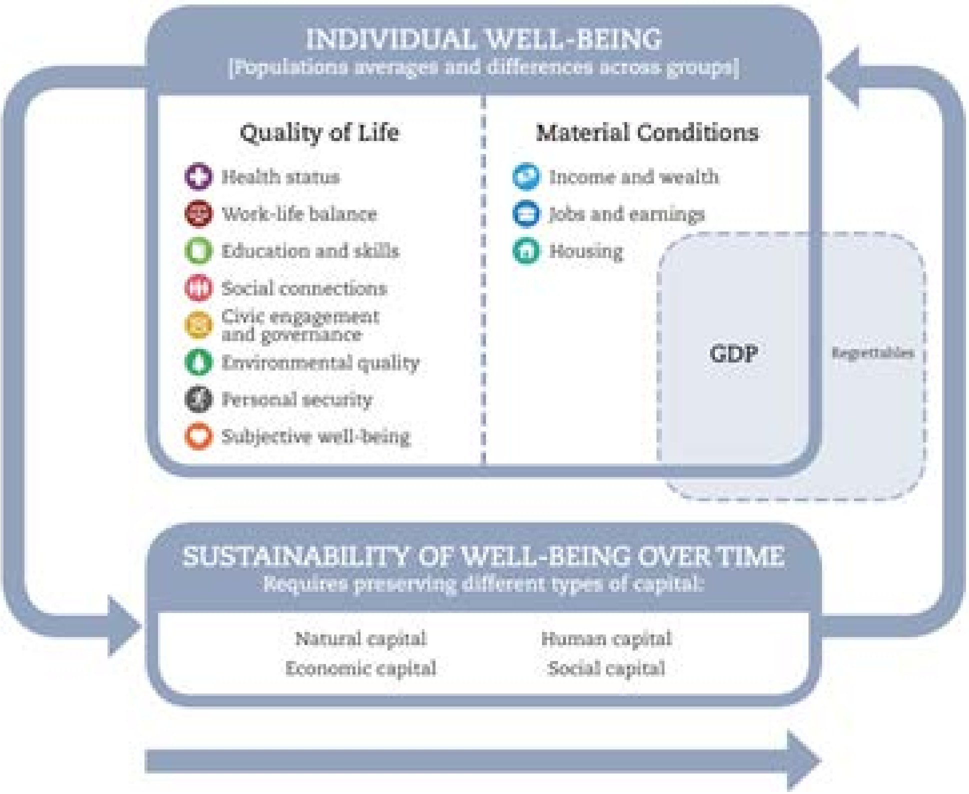
- Identifying the relevant environmental services: only those environmental services that have a bearing on sustainable use of natural capital should qualify as a relevant measure. A different way of putting it is that for environmental services to be relevant for inclusion in growth accounts, there has to be a social cost associated with them;

- Produce a reasonable estimate for the value of the environmental service: The scientific basis to value environmental inputs is unfortunately limited. The UN Handbook on Integrated Environmental and Economic Accounting (UN et al. 2014) provides detailed indications about the possibilities and techniques for such valuations.

A second step is building the bridge between environmental services and alternative measures of material well-being. With the two steps combined, it would be possible to track changes in material well-being (real income) back to the effects of changing uses of traditional inputs such as labour and capital, selected environmental services, and a modified rate of multi-factor productivity growth.

Looking at environmental quality, but also at other topics such as related to health and education, the OECD Framework for Measuring Well-Being and Progress (OECD, 2013b) (Figure 1.4.) is based on the recommendations made in 2009 by the Commission on the Measurement of Economic Performance and Social Progress – also known as the Stiglitz-Sen-Fitoussi Commission – and reflects earlier OECD work and various national initiatives in the field.

Figure 1.4. OECD framework for measuring well-being and progress



Source: OECD (2011), How's Life?: Measuring Well-being, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264121164-en

The Framework is built around three distinct domains: material conditions, quality of life and sustainability. Each of these domains includes a number of relevant dimensions. While the well-being of each person can be described in terms of a number of separate outcomes, the assessment of conditions for society as a whole requires aggregating these outcomes for broader communities, and considering both population averages and inequalities, based on the preferences and value judgments of each community.

The Better Life Index (www.oecdbetterlifeindex.org), released for the first time in May 2011, has been designed to involve people in the discussion on well-being and, through this process, to learn what matters the most to them. This interactive web-based tool enables citizens to compare well-being across countries by giving their own weight to each of the eleven dimensions explored in the OECD well-being framework.

1.4 Towards measuring the green transformation of the economy in EU Eastern Partnership countries

Over the last decade, statistical systems in the EaP countries have seen significant improvements. These include, for example, a widening coverage of data collection, gradual adoption of international statistical standards and the development of new statistical products, including online databases. Due to the transition drive, economic and social statistics have evolved most rapidly. Important efforts have being dedicated to the strengthening of sectoral statistics, including environmental statistics.

Such positive changes are a prerequisite for improving the analytical evidence in support to a green transformation of economies and societies at large and monitoring the pace of this transformation. Demand for such evidence from decision-makers is growing in all countries, particularly as drivers become stronger for moving towards an economy that is based on a sustainable and fair use of environmental resources and services.

While there are no commonly agreed green growth/green economy indicators in the pan-European region, a number of countries already use as a basis the set of GGIs developed by the OECD. To support this work the OECD facilitates the exchange of experience and good practice on developing and applying the green growth measurement framework under the EaP GREEN project funded by the European Union (OECD, UNECE, UNEP, EEA 2015).

The availability of coherent data over longer periods is essential to monitor progress towards green growth over time. To date, the consistency and completeness of time series vary greatly by issue and country, not always allowing a systematic and meaningful presentation of trends over longer periods. To improve the situation, many of the EaP countries are initiating the production of data on the environment and economy nexus in accordance with the SEEA framework (Box 1.2) and are working towards the implementation of a Shared Environmental Information System (SEIS) (Box 1.3).

The availability of time series data for the proposed indicators in EaP countries is assessed in the sections “data sources and availability” under each indicator (Chapter 2). The choice of a national set of indicators should be made in view of a detailed assessment of data availability in the respective country.

Box 1.3. The Shared Environmental Information System (SEIS) and green growth

To improve the collection, exchange and use of environmental data and information across the pan-European region, the European Environmental Agency (EEA) members and cooperating countries[2] as well as EU Eastern Partnership countries and other countries of Eastern Europe, the Caucasus, and Central Asia work towards the implementation of a Shared Environmental Information System (SEIS). With the support of technologies such as the internet, the approach would link all existing data and information flows relevant at the country and international levels in support of a regular environmental assessment process.

SEIS aims to enhance the availability of integrated, relevant, high quality, timely and easily accessible environmental information, which provides the means for assessing the environmental status and the foundation for meaningful and informed environmental governance. Through the implementation of SEIS and corresponding benefits, such as efficiency gain and cost savings, effective and meaningful governance, simplification, innovation and an informed public, development in every country of the pan-European region could be positively affected.

Across the pan-European region the process of establishing such national systems is led by the United Nations Economic Commission for Europe (UNECE) and European Environmental Agency in close cooperation with other organisations such as OECD and the United Nations Environment Programme (UNEP). The UNECE Working Group on Environmental Monitoring and Assessment (WGEMA) was mandated to review the progress in establishing SEIS and agreed on 67 priority dataflows underpinning SEIS[3] that could be used for a possible pan-European assessment cycle in 2016. The dataflows are based on the UNECE environmental indicators (EIs) on thematic areas such as air pollution, ozone depletion, climate change, water and biodiversity[4]. Information on the UNECE environmental indicators including definition, unit of measure, methodology of calculation, existing methodological standards and data sources is available for each indicator in UNECE (2007) *Environmental Monitoring: Guidelines for the application of environmental indicators in Eastern Europe, Caucasus and Central Asia*[5].

One of the principles of SEIS states that information should be collected once, and shared for multiple purposes. To this end, data collected as part of the national SEIS can be used for producing OECD GGIs. A recent study aiming at identifying matches and differences between those dataflows found that a number of the GGIs can be calculated based on dataflows under SEIS (OECD et al. 2015). Many indicators describing the environmental and resource productivity of the economy, the natural asset base, and the environmental quality of life are similar. At the same time, policy responses, the socio-economic context and demand-based indicators are not covered under SEIS, due to a different focus of the set.

For the respective cases, detailed information on how to use dataflows under SEIS for calculating GGIs is included in Chapter 2.

[2] http://www.eea.europa.eu/about-us/countries-and-eionet

[3] http://www.unece.org/fileadmin/DAM/env/documents/2015/ece/cep/ac.10/ece.cep.ac.10.2015.2_as_advance_copy.pdf

[4] http://www.unece.org/env/Indicators/

[5] http://www.unece.org/fileadmin/DAM/env/europe/monitoring/Belgrade/CRP1.Indicators.En%20edited.MK..pdf

CHAPTER 2: GREEN GROWTH INDICATORS – DETAILED DESCRIPTION

This chapter offers an in depth discussion of the green growth indicators proposed by the OECD (2014a). For each indicator, a discussion of the policy context is provided, followed by information on potential data sources and directions for the calculation of the indicator.

It is important to note that the selection of indicators discussed here is neither exhaustive nor final, but should rather be seen as a starting point and orientation aid for interested countries. Not all indicators proposed here are equally relevant to all countries and the list will have to be adjusted for the pilot testing of a national green growth indicators framework depending on national contexts and priorities. For the national sets of GGIs to be developed full alignment of definitions and calculation methods is not necessarily needed, but the methodology applied by OECD can serve as a reference.

2.1 The socio-economic context

Green growth indicators build on the interaction between economic growth and the environment. Indicators on the socio-economic context provide important background information, particularly with regard to economic growth, productivity and competitiveness, along with key features of the labour market that are important to sustain job creation and facilitate labour markets adjustments, and with information on demography, health, education and income inequality (Table 2.1).

Such information is useful to track the effects of green growth policies on growth, to establish links to social concerns such as poverty reduction, social equity and inclusion, to interpret GGIs in the light of national socio-economic circumstances, and complement them with additional details. For example, data on environmental pressures are rarely available by industrial activity, and consistent measures that combine environmental and economic information can only be constructed at the level of the entire economy. In such cases, it is important to supplement the economy-wide indicator with information on countries' industry structure (OECD, 2014a).

Table 2.1. The socio-economic context - proposed indicators

Proposed indicators			
Group/theme	Proposed indicators	Type	Measurability
The socio-economic context and characteristics of growth			
Economic growth, productivity and competitiveness	Economic growth and structure		
	-- GDP growth and structure	M	S
	-- Net disposable income (or net national income)	M	M
	Productivity and trade		
	-- Labour productivity	M	S
	-- Multi-factor productivity	M	M
	-- Trade weighted unit labour costs	M	M
	-- Relative importance of trade: (exports + imports)/GDP	M	S
	Inflation and commodity prices		
	-- Consumer price index	M	S
	-- Prices of food; crude oil; minerals, ores and metals	M	S
Labour market, education and income	Labour markets		
	-- Labour force participation	M	S
	-- Unemployment rate	M	S
	Socio-demographic patterns		
	-- Population growth, structure and density	M	S
	-- Life expectancy: years of healthy life at birth	M	M
	-- Income inequality: GINI coefficient	M	M
	-- Educational attainment: level of and access to education	M	S

Type: M = Main indicators
P = Proxy indicators when the main indicators are not available

Measurability (M): S = short term, M = medium term, L = long term

See Annex for a complete list of indicators.

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris.

2.1.1 Economic growth, productivity and competitiveness

DEFINITION AND CALCULATION OF INDICATORS

Economic growth and structure

- **Gross domestic product** (GDP) measures market and government production and the associated economic activity.

GDP relates to the sphere of production. As a “gross” measure, it takes neither account of the depreciation of produced assets nor of the depletion of natural assets. However, GDP is the most widely used measure of economic growth and remains a central variable for macroeconomic management and economic activity. For international comparisons, the GDP should be based on chained constant US-Dollar (USD) and constant purchasing power parities (PPPs[6]).

[6] OECD is currently using 2010 as a base year for PPP but the base year changes regularly and may be defined according to national preferences.

The GDP can be structured according to divisions of the International Standard Industrial Classification of All Economic Activities (ISIC)[7]. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

- **Net national income** (NNI) captures the average material well-being of individuals and households.

Unlike GDP, net national income takes into account the depreciation of produced capital and income flows between residents and the rest of the world. It is the aggregate value of the balances of net primary incomes summed over all sectors. Gross national income (GNI) less the consumption of fixed capital from GNI gives NNI at market prices. The aggregate net national disposable income should be based on chained constant USD and constant PPPs. Real income should be obtained through deflation with a consumer price index.

Productivity and trade

- **Labour productivity** is a key driver of economic growth and living standards.

Labour productivity is expressed as GDP per hour worked with GDP in national currency at constant prices, or in USD at constant prices and constant PPPs. Labour input is defined as total hours worked by all persons engaged.

- An important source of labour productivity is **multifactor productivity** growth. It represents the increase in economic output, that cannot be explained by increases in economic inputs, which raises the rate of output growth and therefore domestic income.

Multifactor productivity for the total economy is computed as the difference between the rate of change of output and the rate of change of total inputs (calculated as volume indices of combined labour and capital inputs for the total economy); shares of compensation of labour input and of capital inputs in total costs for the total economy are measured at current prices (compensation of labour input corresponds to the compensation of employees and self-employed persons and compensation of capital input is the value of capital services). The measure presented may only recognise labour and capital inputs and not primary inputs of natural capital that also feed into production.

- **Trade-weighted unit labour costs** (ULCs) in manufacturing is a proxy measure of international price competitiveness.

Trade-weighted unit labour costs (ULCs) (Competitiveness index) are defined as the average cost of labour per unit of output produced. Unit labour costs reflect the combined effects of wage development and labour productivity. Changes in unit labour costs approximate output price developments as labour accounts for a significant share of final output. Relative unit labour costs in manufacturing are calculated using overall weights (a system of weights based on a double-weighting principle, which takes account of the structure of competition in both export and import markets). Manufacturing ULCs are often seen as more representative for competition in tradable products, but they do not account for the increasing trade in services.

- The relative importance of **international trade** in countries' economies.

[7] http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27

The **Relative importance of international trade** is calculated as total trade flows, including exports and imports of goods and services, over GDP. This measure indicates exposure to international competition abroad and domestically.

Box 2.1. Trends in productivity and trade in OECD countries

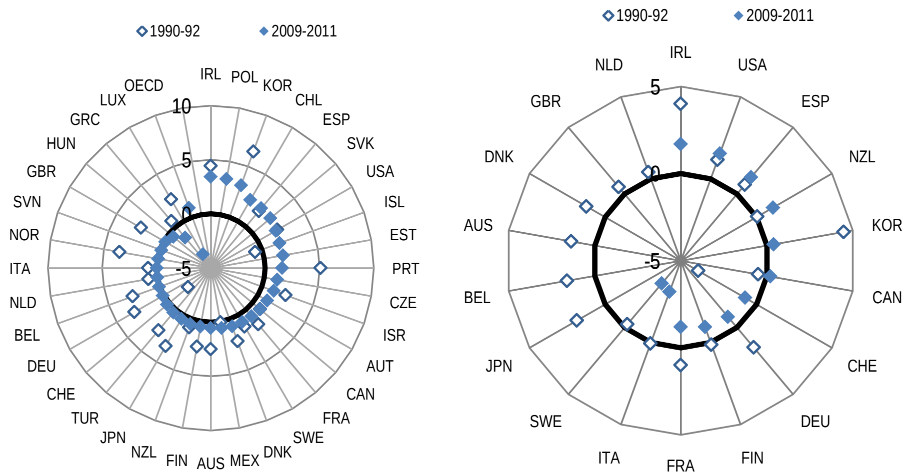
Trade is one of the key contributors to economic growth. It is closely associated with foreign investment, developments in the international chain of value added and trends towards greater specialisation and interconnectedness of producers and consumers. When environmentally intensive tasks concentrate in emerging economies, displacement effects may occur, showing up in lower environmental productivity in emerging economies than in OECD countries.

Multifactor productivity (MFP) grew more slowly in the 2000s than the 1990s in those OECD countries for which data are available, with a sharp fall in some countries after the economic crisis (Figure 2.1.).

Price competitiveness in international trade (as approximated by trade-weighted unit labour costs) has changed for most OECD countries since the 1990s. One factor in this development is productivity. While there were large differences among OECD countries, labour productivity growth has fallen significantly in most OECD countries during the 2008 economic crisis as the total hours worked were reduced less than output, and this decline is broadly spread across sectors (Figure 2.2.).

Figure 2.1. Labour and multifactor productivity

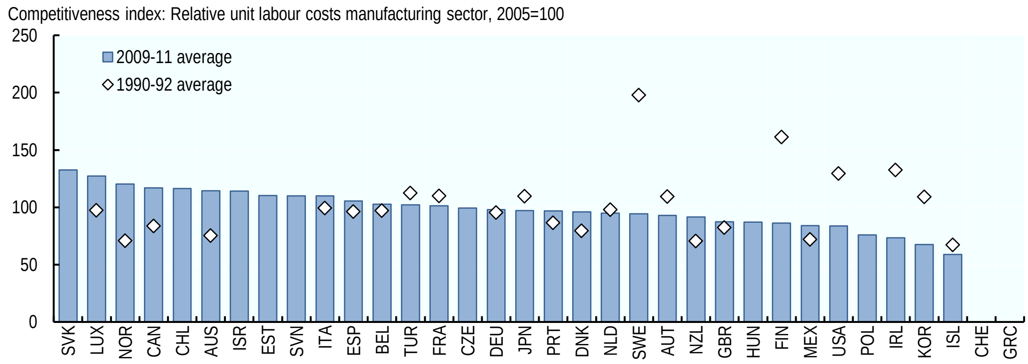
Labour (left) and multifactor (right) productivity, annual average growth, %



Source: OECD Productivity Statistics (database); http://dx.doi.org/10.1787/888932924989.

Figure 2.2. Competitiveness index

OECD countries, 1990-92 and 2009-11



Source:OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris using *OECD Economic Outlook: Statistics and Projections (database); http://dx.doi.org/10.1787/888932925008.*

Inflation and commodity prices

- **Commodity prices** are directly related to natural resources such as minerals or fossil fuels that are important inputs to the economy. Prices are powerful signals; the longer-term evolution of relative prices can signal scarcity or abundance and affect economic behaviour. Overly volatile price movements on the other hand tend to send unreliable signals that may or may not be conducive to more environment-friendly growth.

Consumer price indices (CPIs) measure the average changes in the prices of consumer goods and services purchased by households. **Commodity prices** refer to prices of primary commodities traded on the world market. The crude oil price index is based on the FOB Brent spot crude oil price. The S&P 500 stock market index is a market value weighted index and one of the most commonly used benchmarks for the overall US stock market; it is based on the common stock prices of 500 top publicly traded American companies. The FTSE Eurotop 100 is a tradable index designed to represent the performance of the 100 most highly capitalised blue chip companies in Europe. The Nikkei 225 is an equally weighed stock market index for the Tokyo Stock Exchange and is designed to reflect the overall market.

DATA SOURCES AND AVAILABILITY

Data on the proposed economic indicators are available across a wide range of countries and based on international statistical standards such as the System of National Accounts (SNA). Some uncertainty exists about all aspects of methodology for some EaP countries, although the basic indications arising from the data would seem to be robust. Further efforts are needed to improve the availability and comparability of productivity and competitiveness measures.

The World Bank, for instance, gathers information on GDP, adjusted net national income, consumer price index for EaP countries.

2.1.2 Labour market, education and health

DEFINITION AND CALCULATION OF INDICATORS

Labour markets

- The **labour force participation rate** measures the part of an economy’s working-age population that is economically active. Expressed as a ratio of the labour force to the working age population, it provides an indication of the relative size of the supply of labour available for the production of goods and services.

- **Unemployment rates** represent the share of people unemployed relative to the number of persons in the labour force. High and persistent unemployment rates signal underutilisation of an economy’s single most important resource, labour and human capital. The criteria for status as unemployed or employed are defined by the International Labour Office (ILO) (ILO 2013).

Socio-demographic patterns

- **Population density** is calculated as a country’s total number of inhabitants per square kilometre of total area. Population can be defined as all nationals present in or temporarily absent from a country, and aliens permanently settled in the country.

- **Ageing ratio** or ageing index is the ratio between population over age 64 years and population below age 15;

- **Life expectancy at birth** is the average number of years a new-born could expect to live if he or she were to pass through life exposed to the sex- and age-specific death rates prevailing at the time of his or her birth, for a specific year, in a given country, territory or geographic area.

- **Healthy Life Years** (HLY) can be calculated as the number of years spent free of activity limitation by gender. In Europe, HLYs are calculated annually by Eurostat for EU countries and some European Free Trade Association (EFTA) countries using the Sullivan method (Sullivan 1971). The corresponding disability measure is the Global Activity Limitation Indicator (GALI), which comes from the European Union Statistics on Income and Living Conditions (EU-SILC) survey. GALI measures limitation in usual activities due to health problems.

Education and income

- **Access to education** is an indicator of a country's investment in human capital, measured by university-level enrolment and by the graduation rate of men and women from tertiary-type A programmes.

Human capital development is a driver of growth in its own right. Education induces behavioural changes and raises skills, including in the adoption and adaption of environment-friendly processes, products and technologies.

Entry rates estimate the proportion of people who enter a tertiary-type A programme during their lifetimes. They also indicate the accessibility of tertiary education and the perceived value of attending tertiary programmes, and provide some indication of the degree to which a population is acquiring the high-level skills and knowledge valued by today's labour market.

Tertiary-type A programmes (ISCED 5A) are largely theory-based and are designed to provide sufficient qualifications for entry to advanced research programmes and professions with high skill requirements, such as medicine, dentistry and architecture. Tertiary-type A programmes have a minimum cumulative theoretical duration (at tertiary level) of three years' full-time equivalent, although they typically last four or more years. Information on the reading, mathematics and science performance may be given as complement.

- **Income inequality** is measured by the Gini coefficient which ranges from 0 to 1 (Box 2.2). The Gini coefficient equals zero when all people have the same level of income and equals one when one person receives all the income. Higher values thus indicate higher income inequality (UNECE 2011).

Box 2.2. Rising income inequality poses social and economic challenges

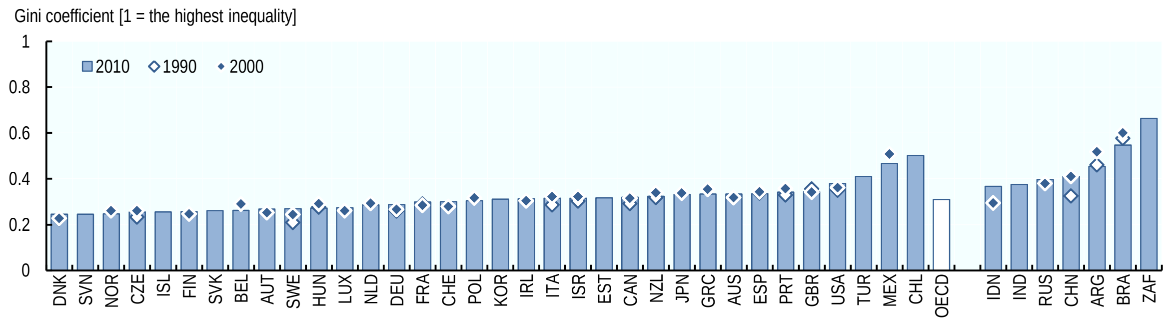
In the three decades prior to the economic downturn, wage gaps widened and household income inequality increased in a large majority of OECD countries.

In most countries, the household incomes of the richest 10% grew faster than those of the poorest 10%, so income inequality widened. Today in the OECD, the average income of the richest 10% of the population is about nine times that of the poorest 10%. However the ratio varies widely by country.

Income dispersion has increased across OECD countries. The Gini coefficient stood at an average of 0.29 in OECD countries in the mid-1980s. By the late 2000s, it had increased by almost 10% to 0.32. Important drivers of household income inequality are changes in the distribution of wages and salaries, influenced by the average level of educational attainment and skills of the work force.

Figure 2.3. Income inequality

OECD and BRIICS countries, 1990, 2000 and 2010



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using *OECD Social and Welfare Statistics (database)*; http://dx.doi.org/10.1787/888932925122.

DATA SOURCES AND AVAILABILITY

Data on the socio-economic context of green growth should be obtained from national economic, labour and social statistics. Comparable data on labour market conditions may be difficult to obtain for long time series. The OECD is working on the further development of measures of income dispersion, job creation and worker reallocation. Further efforts are needed to calculate and regularly update indicators on the number of years of healthy life expectancy for all OECD countries and the world, and to establish closer links with environment-related health issues.

The World Bank gathers data and estimates on both labour market indicators and socio-economic indicators for EaP countries.

2.2 The environmental and resource productivity of the economy

A central element of green growth is the environmental and resource efficiency of production and consumption, and how this changes with time, place and across sectors. Understanding these trends, together with the underlying factors, is an essential part of monitoring the transition to green growth.

Progress toward green growth can be monitored by relating the use of environmental services in production to the output generated. Environmental services include natural resources and materials, including energy, and pollutants and other residuals with their implied use of environmental services which are functional attributes of natural ecosystems such as land, water and air that are beneficial to humankind. Tracking trends in decoupling of inputs to production from economic and sectoral growth is an important focus for monitoring.

Box 2.3. Understanding the notion of productivity

Productivity is commonly defined as a ratio between the volume of output and the volume of inputs. In other words, it measures how efficiently production inputs, such as labour and financial capital, are being used in an economy to produce a given level of output. Understanding productivity provides an essential tool for policy makers to identify the underlying drivers for growth.

Economic growth can be increased either by raising the labour and capital inputs used in production, or by improving the overall efficiency in how these inputs are used together, i.e. higher multifactor productivity (MFP) growth. GDP per capita measures economic activity or income per person and is one of the core indicators of economic performance. Growth in MFP is measured as the residual growth, i.e., that part of GDP growth that cannot be explained by growth in labour or capital input. Both labour productivity (GDP per hour worked) and labour utilisation need to be measured.

Internationally comparable indicators of productivity are central for assessing economic performance. They help grasp the role played by labour, capital and multifactor productivity growth in driving economic growth. They can also show the contribution of individual industries or sectors to more aggregate labour productivity growth. Furthermore, they provide insights into the link between productivity and international competitiveness.

Source : OECD (2013c)

The OECD GGIs in this area focus on:

- **Carbon and energy productivity**, which characterises, among other things, interactions with the climate system and the global carbon cycle as well as the environmental and economic efficiency with which energy resources are used in production and consumption, and which informs about the results of policies that promote low carbon technologies and energy efficiency.

- **Resource productivity**, which characterises the environmental and economic efficiency with which natural resources and materials are used in production and consumption, and which informs about the results of policies and measures that promote resource productivity and sustainable materials management in all sectors. Higher resource productivity will minimise the amount of resources that the economy requires and reduce waste generation. Important resources and materials include mineral resources (metallic minerals, industrial minerals, construction minerals); biotic resources (food, feed, wood); water; and nutrients, which among other characteristics reflect interactions with nutrient cycles and food production systems.

- **Environmentally adjusted multi-factor productivity,** which accounts for the role of environmental services in productivity growth (provisioning services such as natural resource inputs; regulatory or sink functions of ecosystems that absorb pollutant emissions). This indicator is not yet fully measurable and is not further discussed here[8].

For most indicators on the environmental and resource productivity of the economy, a breakdown by industry (ISIC/NACE) is highly recommended (data availability permitting).

[8] For more information on the currently used methodologies for measuring environmentally adjusted multi-factor productivity please refer to: Cárdenas Rodríguez, M., I. Haščič and M. Souchier (2016), "Environmentally Adjusted Multifactor Productivity: Methodology and Empirical results for OECD and G20 countries", OECD Green Growth Papers, No. 2016/04, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jlr2z7ntkf8-en .

Table 2.2. The environmental and resource productivity of the economy - proposed indicators

Proposed indicators

Theme	Proposed indicators	Type	Measurability
Carbon & energy productivity	CO_2 productivity		
	Production-based CO_2 productivity GDP per unit of energy-related CO_2 emitted	M	S
	Demand-based CO_2 productivity Real income per unit of energy-related CO_2 emitted	M	S/M
	Energy productivity		
	Energy productivity (GDP per unit of TPES)	M	S
	Energy intensity by sector (manufacturing, transport, households, services)	M	S/M
	Share of renewable energy sources in TPES, in electricity production	M	S
Resource productivity	Material productivity (non-energy)		
	Demand-based material productivity (comprehensive measure; original units in physical terms) related to real disposable income	M	M/L
	Domestic material productivity (GDP/DMC) - Biotic materials (food, other biomass) - Abiotic materials (metallic minerals, industrial minerals)	P	S/M
	Waste generation intensity and recovery ratios By sector, per unit of GDP or value added, per capita	M	M/L
	Nutrient flows and balances (N, P)	M	L
	Nutrient balances in agriculture (N, P) per agricultural land area and change in agricultural output	P	S/M
	Water productivity Value added per unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated)	M	M
Multifactor productivity	Multifactor productivity reflecting environmental services (comprehensive measure; original units in monetary terms)	M	M/L

Type: M = Main indicators
P = Proxy indicators when the main indicators are not available

Measurability (M): S = short term, M = medium term, L = long term

See Annex for a complete list of indicators.

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris.

2.2.1 Carbon productivity

POLICY CONTEXT

CO_2 from the combustion of fossil fuels and biomass is a major contributor to greenhouse gas (GHG) emissions, which enhance the natural greenhouse effect, leading to temperature changes and other consequences for the earth's climate. Accounting for over 80% of global GHG emissions, CO_2 determines the overall trend in emissions and is a key component in countries' ability to deal with climate change.

Climate change is of global concern as regards its effects on ecosystems, human settlements and agriculture, and the frequency and scale of extreme weather events. It could have significant consequences for human well-being and socio-economic activities, which could in turn affect global economic output.

With current climate change mitigation policies, and increasing industrialisation of emerging economies, global emissions will likely continue to grow. Progress in stabilising the concentration of GHGs in the atmosphere therefore is dependent on the development and coordination of national and international strategies to further decouple CO_2 and other GHG emissions from economic growth.

Carbon productivity indicators inform about the relative decoupling between economic activity and carbon inputs into the atmosphere. They provide insight into how much carbon productivity has improved, as well as how much of the improvement is due to the implementation of domestic policies and how much to displacement or substitution effects.

Since reductions in national emissions can be achieved by offshoring certain activities of domestic production and thus related emissions, evidence of decoupling gained from production-based measures may reveal only part of the story. The demand perspective is an important addition to the debate on global environmental issues, and the related indicators help explain movements in production-based measures.

DEFINITION AND CALCULATION OF INDICATORS

- **Production-based CO_2 productivity (1.1)** represents the GDP generated per unit of CO_2 emitted in production.

Production-based emissions refer to gross direct CO_2 emissions from fossil fuel combustion, emitted within the national territory and excluding bunkers, carbon sequestration sinks and indirect effects. The emissions can be calculated using IEA energy databases and the 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006) (Box 2.4) [9].

[9] For further information on the calculation of consumption and production-based CO_2 emissions please refer to: http://www.oecd.org/sti/ind/47478124.pdf.

Box 2.4. Calculating consumption and production-based CO_2 emissions

The consumption-based emissions of country *j*'s resident are calculated as:

$$CBE_j = (e_1^1 \dots e_1^N | e_R^1 \dots e_R^N) B \begin{pmatrix} F_{1j}^1 \\ \vdots \\ F_{1j}^N \\ - \\ F_{Rj}^1 \\ \vdots \\ F_{Rj}^N \end{pmatrix} + \sum_{i=1}^{N} \sum_{p=1}^{R} (h_j^i F_{pj}^i)$$

The production-based emissions of country *j*'s resident are calculated as:

$$PBE_j = \sum_{i=1}^{N} (e_j^i X_j^i) + \sum_{i=1}^{N} \sum_{p=1}^{R} (h_j^i F_{pj}^i)$$

Legend:

hji = Emission factor of final consumption of the products of country j's sector i (hji=θji+φji),

eji = Industrial emissions intensity of country j's sector i (eji=εji+ρji+σji),

R = Number of countries,

B = Leontief inverse,

N = Number of sector and

F1ji = Final expenditure by country j for country 1's product of sector i.

For the calculation of the indicator, a country's real GDP (expenditure approach) should be divided by the country's total production-based CO_2 emissions.

Source: http://www.oecd.org/industry/ind/carbondioxideemissionsembodiedininternationaltrade.html.

- **Demand-based CO_2 productivity (1.2)** is the real national income per unit of CO_2 emitted. Demand-based emissions are production-based emissions plus emissions embodied in imports minus emissions embodied in exports.

The estimates of ***demand-based CO_2 productivity (1.2)*** should reflect the CO_2 emitted during the various stages of production of the goods and services consumed in domestic final demand, irrespective of where the various stages of production occurred.

For OECD countries, emissions embodied in final domestic demand are calculated using a combination of multi-country input-output tables, bilateral trade data and production-based CO_2 emissions from fossil fuel combustion. This provides a framework that can be used to allocate the flows of CO_2 emitted in producing a product to the final purchaser of that product, irrespective of how many intermediate processes and countries the product passes through before arriving at its final purchaser. The demand-based estimates use macro approaches that assume homogeneity in production processes and imports within relatively aggregated industry groupings, meaning they cannot differentiate between low and high emission companies allocated to the same sector. This limits the extent to which specific demand-based policy measures can be developed. Continued efforts are needed to keep the methodologies and underlying data up to date. Emissions from bunkers and fugitive emissions from fuel extraction are excluded.

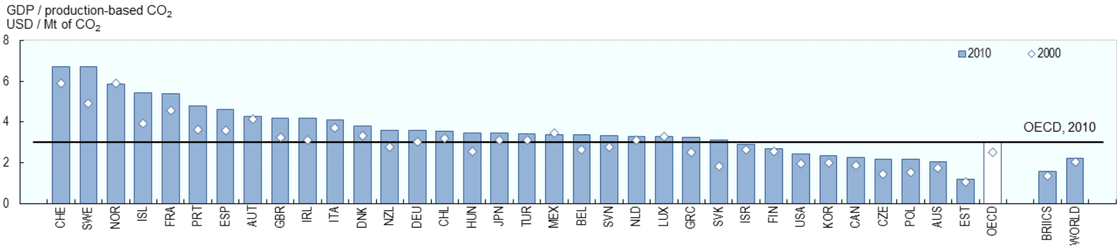
Box 2.5. Trends in CO_2 productivity

CO_2 emissions from energy use are still growing worldwide, mainly due to increases in the transport and the energy transformation sectors. In 2013, global energy-related CO_2 emissions reached a record high of 32.2 billion tonnes.

At the same time, the overall carbon productivity of OECD economies has grown and CO_2 emissions increased at a lower rate than GDP (relative decoupling). In more than one-third of OECD countries emissions have decreased in absolute terms (absolute decoupling). In recent years, emissions have been decreasing in almost 80% of OECD countries, mainly due to decreases in economic activity following the economic crisis.

Figure 2.4. Production-based CO_2 productivity

OECD and BRIICS countries, 2000 and 2013



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using *IEA CO_2 emissions from fuel combustion statistics (database);* http://dx.doi.org/10.1787/888932925160

DATA SOURCES AND AVAILABILITY

In EaP countries national GHG inventories constitute the key source of data for these indicators. National statistical and/or environmental agencies collect data on GHG emissions from stationary sources using a standardised reporting form. Emissions from mobile sources are calculated on the basis of consumed fuel and composition of the vehicle fleet. Parties to the United Nations Framework Convention on Climate Change (UNFCCC) submit national GHG inventories to UNFCCC. Annex I Parties[10] are required to submit a national communication to the UNFCCC on a regular basis (every four to five years) and a GHG inventory on a yearly basis.

Continued efforts are being made to further improve national GHG inventories, particularly to better evaluate sinks and indirect effects and to calculate comparable net GHG emissions, including for non-Annex I countries. More needs to be done to monitor the effects of domestic demand and the use of international transactions and the flexible mechanisms of the Kyoto Protocol on emissions outside the national territory.

Data on CO_2 emissions from fossil fuel combustion for all EaP countries can be found in the International Energy Agency (IEA) energy databases[11].

[10] Annex 1 parties include the EaP countries Belarus and Ukraine

[11] See, for example, https://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2015.pdf

2.2.2 Energy productivity

POLICY CONTEXT

Energy is a major component of the economy, both as a sector in itself and as a factor input to all other economic activities. The structure of a country's energy supply and the intensity of its energy use, along with changes over time, are key determinants of the environmental performance and the sustainability of economic development, and hence of green growth. Another concern regarding energy choices is that access to affordable energy is essential to reduce poverty.

The environmental effects of energy production and use differ by energy source. The main concerns relate to contributions to GHG emissions and local and regional air pollution. Other effects involve the impact on water quality, land use, and risks related to the nuclear fuel cycle and to the extraction, transport and use of fossil fuels. The use of renewable energy sources and of low-carbon and clean fuel technologies plays an important role in addressing climate change, as well as improving energy security.

Progress towards green growth can be assessed against the energy productivity of the economy and against domestic objectives for energy intensity, energy efficiency targets, or the share of renewable energy in energy or electricity supply. Progress can further be assessed against international environmental and climate change commitments that have implications for domestic energy policies and strategies.

DEFINITION AND CALCULATION OF INDICATORS

- The **energy productivity (2.1)** [12] of the economy, expressed as GDP in constant prices per unit of total primary energy supply (TPES), measures how much national revenue is generated for each unit of primary energy supplied.

This indicator is based on information on a country's total TPES, which is calculated as the production plus imports minus exports of energy minus international marine and aviation bunkers plus or minus stock changes.

- The **energy intensity by sector (2.2)** is calculated as the amount of energy consumed per activity or output for sub-sectors (manufacturing, transport, households, services) and end uses.

The ***Energy intensity by sector (2.2)*** is the inverse of energy productivity. The choice of the denominator often depends on data availability, but the energy intensity in the residential sector, service sector, industrial sector, and the transport sector are usually calculated. The output or activity may be defined differently for different sectors: for the passenger transport sector, for example, they could be defined as the total passenger transport energy consumption per passenger-kilometre (pkm); for the industry sectors it could be total industry energy consumption per unit of value-added.

The following should be noted for the different sectors: Services include residential and commercial and public services; Industry includes manufacturing, mining and quarrying, and construction, but does not include energy used for transport; Transport covers all transport activity (in mobile engines) regardless of the economic sector to which it is contributing.

- The **share of renewables in TPES and in electricity generation (2.3)** is calculated as the proportion of renewable sources of energy in a country's total primary energy supply. Depending on data availability, the share of renewables in electricity generation may be presented as an alternative or complement. The main renewable forms include:

[12] It should be noted that energy productivity is not the same as carbon productivity, though the two are closely related. As fossil fuel use declines and more "clean energy" technologies are deployed, CO_2 productivity becomes decoupled from energy productivity.

– *Hydro power* represents the potential and kinetic energy of water converted into electricity in hydroelectric plants.

– *Geothermal* is the energy available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It can be used directly as heat for district heating, agriculture, *etc.*, or to produce electricity. Unless the actual efficiency of the geothermal process is known, the quantity of geothermal energy entering electricity generation is inferred from the electricity production at geothermal plants assuming an average thermal efficiency of 10%.

– *Wind* represents the kinetic energy of wind exploited for electricity generation in wind turbines. The quantities entering electricity generation are equal to the electrical energy generated.

– *Solar* includes solar thermal and solar photovoltaic (PV). The quantities of solar PV entering electricity generation are equal to the electrical energy generated. Direct use of solar thermal heat is also included.

– *Combustible renewables and waste* comprises solid biomass, liquid biomass, biogas, industrial waste and municipal waste. Biomass is defined as any plant matter used directly as fuel or converted into fuels (*e.g.* charcoal) or electricity and/or heat. Included here are wood, vegetal waste (including wood waste and crops used for energy production), ethanol, animal materials and/or waste, and sulphite lye (black liquor). Municipal waste is waste produced by the residential and commercial and public service sectors (which is collected by local authorities for disposal in a central location for the production of heat and/or power).

– *Tide, wave and ocean* represents the mechanical energy deriving from tidal movement, wave motion or ocean current and exploited for electricity generation. The quantities entering electricity generation are equal to the electrical energy generated.

Box 2.6. Calculating energy-related GGIs based on SEIS dataflows

The dataflows underpinning SEIS contain dataflows, which are also necessary to calculate the GGIs on *Energy intensity by sector, Energy productivity, and Share of renewable energy sources in Total primary energy supply (TPES)*. In the following paragraphs, each of these areas will be discussed separately. Both the dataflows required by the EIs on energy and by the subindicators under the GGI *Energy productivity (2)* are based on energy balances provided by the International Energy Agency (IEA) and are therefore generally compatible. However, based on this data, slightly differing statistical operations are to be performed.

Energy productivity (2.1)

The SEIS dataflow on TPES (EI G2) can be used to produce GGI *2.1*, which is calculated as GDP per TPES. As both UNECE and OECD dataflows are based on IEA energy balances, TPES is consistently calculated as production plus imports minus exports minus international marine and aviation bunkers plus or minus stock changes. For the production of GGI 2.1 these data on TPES are to be related to a country's GDP. The relevant SEIS dataflow is expressed as thousand tonnes of oil equivalent (ktoe). From this, the unit of measurement of the GGI 2.1 (unit of GDP per ton of oil equivalent (toe)) can be easily calculated.

Energy intensity by sector (2.2)

The SEIS dataflow *Final energy consumption (EI G1)* contains data on final energy consumption by category, with accordance to the International Standard Industrial Classification of All Economic Activities (ISIC) classification: industry, transport, households, commercial and public services, agriculture, forestry and fishery, non-specified and non-energy use. This complies with the dataflow on the consumption of energy by sectors, Likewise following ISIC, which is required for GGI *Energy intensity by sector (2.2)*. For the production of GGI 2.2 this data has to be related with the output for sub-sectors and end uses (*see above*). The energy consumption by sector is to be provided as 1,000 tonnes of oil equivalent (ktoe) for the SEIS dataflow, from which the dataflow for the GGI, expressed as toe per unit of GDP, toe per passenger-kilometre etc. can be calculated.

The share of renewables in TPES and in electricity generation (2.3)

The SEIS dataflows on *Renewable energy supply (EI G4)* can be used for the production of GGI *Share of renewable energy sources in TPES (2.3)*. Both indicators require the production of dataflows on the share of different renewable sources of energy in TPES. Units of measurement for those indicators are fully compatible, both being expressed as percentage of the respective renewables in TPES. Moreover, beyond the share of renewables in TPES, the under GGI 2.3 share of renewables in electricity generation may be presented. This dataflow goes beyond the data included in the SEIS dataflow, as the total energy supply is not broken down into electricity generation and the generation of other fuels.

At the macro level, energy intensity can also be expressed as total final energy consumption per GDP, TPES per capita, or TPES per GDP (also in EI G3). However, as in the context of green growth "energy productivity" is preferred over "energy intensity" as an indicator on energy efficiency on the macro level, these possibilities are not further discussed here.

Box 2.6. Calculating energy-related GGIs based on SEIS dataflows - continued

Table 2.3. Mapping of UNECE and OECD dataflows on energy

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Total primary energy supply (G2)	TPES (production + imports - exports - international marine and aviation bunkers +/- stock changes)	Kilotonnes of oil equivalent (ktoe)
GGI	Energy productivity (2.1)	GDP per TPES	Unit of GDP / tonnes of oil equivalent (toe)
SEIS dataflows	Final energy consumption (G1)	Final energy consumption by category (according to ISIC: industry, transport, households, commercial and public services, agriculture, forestry and fishery, non-specified, non-energy use)	Ktoe
GGI	Energy intensity by sector (2.2)	Energy intensity (final consumption or by sectors according to ISIC: manufacturing, transport, households, services)	Toe /unit of GDP Other sectoral units, e.g. for transport sector: toe / pkm
SEIS dataflows	Renewable energy supply (G4)	Energy from hydropower, geothermal energy, wind power, biomass and waste and solar power in TPES	Ktoe Percentage of the respective renewables in TPES
GGI	Share of renewable energy sources in TPES (2.3)	The share of renewables in TPES and in electricity generation (hydro, geothermal, wind, biomass, waste and solar energy)	Percentage of the respective renewables in TPES

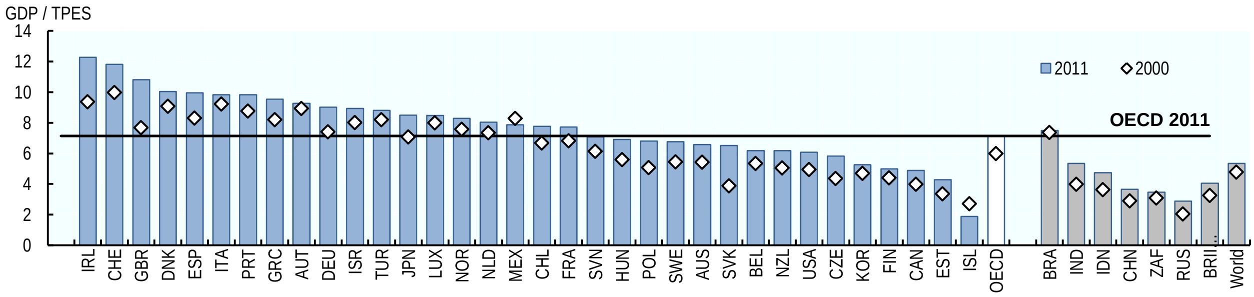
Source: Extract from OECD et al. (2015).

Box 2.7. Trends in energy productivity in OECD countries

Over the past two decades, energy productivity increased for OECD countries overall, and some decoupling of environmental effects from growth in energy use was achieved. This is a consequence of structural changes in the economy and energy conservation measures, as well as, in some countries, decreases in economic activity and the transfer of energy-intensive industries to other countries. Differences between OECD countries in energy productivity remain high, though there are feeble signs of convergence in productivity trends since 1990.

Figure 2.5. Energy productivity

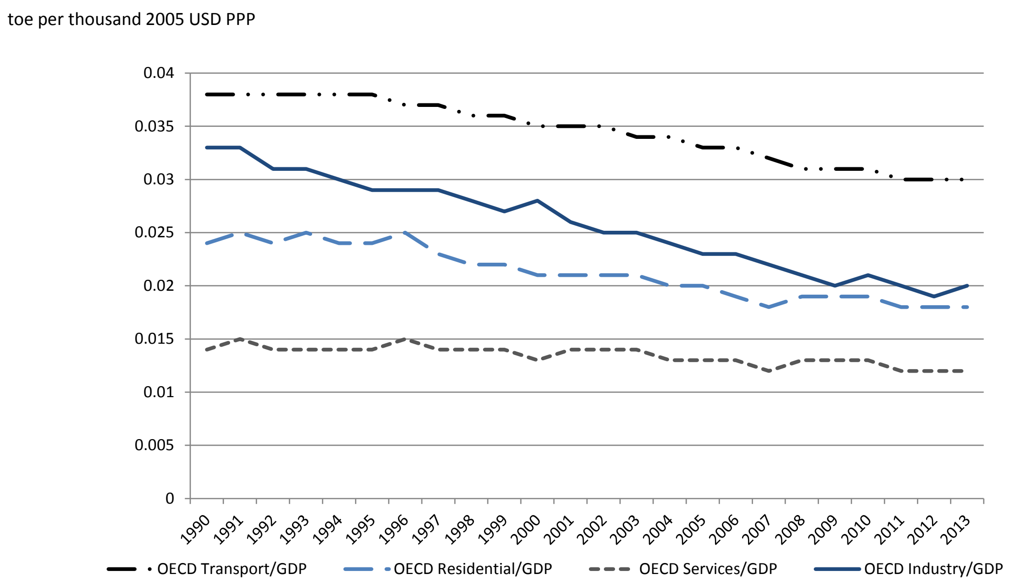
OECD and BRIICS countries, 2000 and 2011



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using IEA World Energy Statistics and Balances (database). DOI:http://dx.doi.org/10.1787/888932925236

Box 2.7. Trends in energy productivity in OECD countries - continued

Figure 2.6. Total final energy consumption by sector



Source: IEA (2016) World Energy Statistics and Balances (database); http://dx.doi.org/10.1787/888932925236 (database)

DATA SOURCES AND AVAILABILITY

Data on energy supply and consumption are available from the IEA for all EaP countries. The agency's Energy Balances contain the data on TPES, consumption by sectors, and on the share of renewables in TPES, which are required for the production of the indicators (up to 2014)[13].

In addition, the World Bank gathers information on energy supply and use. It also has information on electric power transmission and distribution losses in EaP countries.

2.2.3 Resource productivity – materials

POLICY CONTEXT

Material resources[14] form the physical foundation of the economy; essential raw materials and other commodities support economic activity and are an important source of income and jobs. Material resources differ in their physical and chemical characteristics, their abundance and their value to countries. The use of materials from natural resources and the attendant production and consumption-processes have many environmental, economic and social consequences that often extend beyond the borders of countries or regions:

- From an ***environmental perspective***, the manner in which materials are used and managed affects the quantity and quality of natural resource stocks and the quality of ecosystems and environmental media. The intensity and nature of the consequences depend on the kind and amounts of natural resources and materials used, the stage of the resource cycle at which uses

[13] http://www.iea.org/statistics/statisticssearch/

[14] Materials are aggregated using mass-based weights and are classified as biotic materials (biomass for food and feed, wood), construction minerals, other abiotic materials (industrial minerals and metals) and energy carriers.

occur, the way the material resources are used and managed and the type and location of the natural environment where they originate.

- From an ***economic perspective***, the manner in which materials are used and managed affects *(i)* short-term costs and long-term economic sustainability, *(ii)* the supply of strategically important materials and *(iii)* the productivity of economic activities and industrial sectors.

Progress towards green growth can in part be assessed against changes in the amounts of materials needed to support economic activities and in the associated material productivity. It can also be assessed against international objectives and national targets concerning material productivity and resource efficiency. Examples of international initiatives include the 3R (Reduce, Reuse and Recycle) Action Plan, the 2004 and 2008 OECD Council Recommendations and the UNEP International Resource Panel.

DEFINITION AND CALCULATION OF INDICATORS

- ***Domestic material productivity*** is expressed as the amount of economic output generated in terms of GDP per unit of materials consumed in terms of raw material consumption (RMC) or domestic material consumption (DMC).

Materials are aggregated using mass-based weights and are classified as biotic materials (biomass for food and feed, wood), construction minerals, other abiotic materials (industrial minerals and metals) *and energy carriers*. Since energy is already covered under the indicators "carbon productivity" and "energy productivity", it is suggested to focus the material productivity indicator on non-energy materials.

Domestic material consumption (DMC) measures the total amount of materials used in an economy (apparent consumption) and is calculated as Domestic extraction used (DEU) minus export plus imports. DEU measures the flows of materials that originate from the environment (i.e. that are extracted from natural resource stocks) and that physically enter the economic system for further processing or direct consumption (they are "used" by the economy). They are converted into or incorporated in products in one way or another, and are usually of economic value.

- ***Demand-based material productivity*** is a comprehensive measure to calculate the raw material equivalents embodied in the trade of goods and services, and to monitor flows of secondary raw materials.

The measure should then be related to real disposable income. However, there may be gaps in data availability for the demand-based indicator, and more needs to be done to calculate it in an internationally harmonised way. Therefore, the EaP countries may wish to start working on the production-based material productivity (domestic material productivity).

Box 2.8. Trends in domestic material productivity in OECD countries

Worldwide use of most significant materials has been rising for many years, causing recurrent concerns about shortages of natural resource stocks, the security of supply of energy and other materials, and the environmental effectiveness of their use.

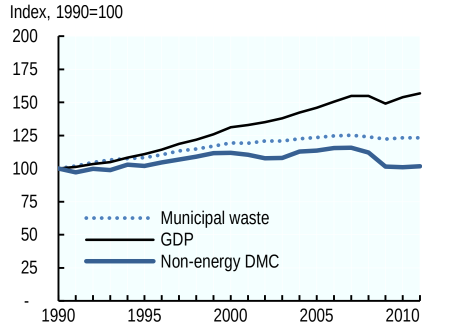
Global extraction of materials is up more than 60% since 1990, but growing more slowly in OECD countries than worldwide. Construction materials, fossil fuels, and biomass for food and feed, together represent more than 80% of total global extraction.

Material consumption in OECD countries grew by 12% during the 1990s, reached about 23 Gt per year in the mid-2000s, and then decreased to 21 Gt in the late 2000s due to the economic downturn. Per capita material consumption in OECD countries remains high at about 17 tonnes per year, and is about 60% higher than the world average.

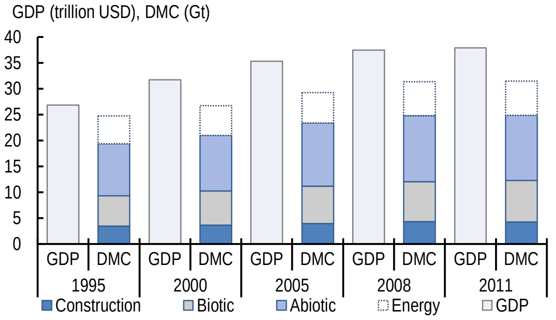
Material productivity is improving. OECD economies today generate 50% more economic value with a tonne of materials other than energy than in the 1990s. From 1990 to 2010, the non-energy material productivity of OECD economies increased from USD 1.6/kg to USD 2.5/kg in real terms.

Figure 2.7. Domestic material consumption (DMC)

DMC, GDP and municipal waste, OECD, 1990-2011



DMC and GDP, OECD, 1995-2011



Source: OECD (2014a), Green Growth Indicators 2014, OECD Publishing, Paris, using OECD Environment Statistics (database); http://dx.doi.org/10.1787/888932925312.

DATA SOURCES AND AVAILABILITY

The OECD maintains a “database on material flows” based on ongoing international work on material flow accounting and analysis (MFA). Estimations of material resources are aggregated using mass-based weights and are classified as biotic materials (biomass for food and feed, wood), construction minerals, other abiotic materials (industrial minerals and metals) and energy carriers.

Data for EaP countries can be found in a database on material flows set up by the Sustainable Europe Research Institute (SERI) and the Vienna University of Economics and Business[15].

Although considerable progress has been made to set up material flow accounts, missing information, including on physical flows of international trade, and a lack of consensus on conversion factors limit the calculation of some material flow indicators at international level. Work is ongoing to calculate internationally harmonised demand-based indicators that measure the raw material equivalents embodied in the trade of goods and services, and to monitor flows of secondary raw materials.

15 http://www.materialflows.net/

2.2.4 Resource productivity - waste

POLICY CONTEXT

Waste is generated at all stages of human activities. Its composition and amounts depend largely on consumption and production patterns. Inappropriate treatment and disposal of the generated waste may cause pollution and expose humans to harmful substances and infectious organisms. A reduction in the volume of waste generated per unit of GDP can be an indication of the economy's move towards less material intensive production patterns.

DEFINITION AND CALCULATION OF INDICATORS

- The ***Waste generation intensity*** can be calculated by dividing total waste generation by unit of GDP or value added. Waste recovery ratios help to understand which proportion of the amount of waste generated (or collected) is collected for recovery operations.

The categorisation of waste by sector should follow the International Standard Industrial Classification of All Economic Activities (ISIC). When data on the total amounts of waste are not available, municipal waste can be used instead. It should however be noted that municipal waste commonly only represents about 10% of the total waste generated.

Municipal waste encompasses household and similar waste collected by or on behalf of municipalities. It includes waste originating from households, small commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that dispose of waste at the same facilities used for municipally collected household waste. Household waste is waste generated by the domestic activity of households. It includes mixed household waste, bulky waste and separately collected waste.

- ***Waste recovery rates*** for municipal waste can be defined as the amount of waste (or material) collected for recovery operations as a percent of the amount of waste generated (or collected, or treated - depending on data availability). Recovery operations include recycling, composting and incineration with energy recovery.

Box 2.9. Calculating GGI “Waste generation intensity and recovery ratios” based on SEIS dataflows

Dataflows under SEIS on *Waste generation (EI I1)* and *Waste reuse and recycling (EI I3)* can be used for the production of GGI *Waste generation intensity and recovery ratios (3.3)*.

Both EI I1 and GGI 3.3 contain a dataflow on municipal waste generation and on waste generation by source following ISIC.

While the EI in particular refers to the methodology of data collection applied in the UNSD/UNEP Questionnaires on Environment Statistics, the OECD collects data via the OECD questionnaire on the state of the environment, a joint questionnaire with Eurostat for common member countries. The questionnaires are harmonized between OECD, UNSD, and other organizations and the same data are required.

For EI I1, thousand tonnes are used as a unit of measurement for the total amounts of waste and kilogram per unit of GDP and kilogram per capita for the respective subindicator. Those are easy to recalculate into the units of measurement used for GGI 3.3: thousand tonnes, tonnes per unit of GDP and tonnes per capita, respectively.

Dataflows on the percentage of reused and recycled waste in total managed waste (and/or in total municipal waste managed) contained in EI *Waste reuse and recycling (I3)* are compatible with the approach of GGI 3.3 for calculating waste recovery rates. The EI I3 includes a dataflow on the share of total waste recycled in total waste managed (expressed as a percentage). The GGI measures waste recovery rates, which are defined as “the amount of waste (or material) collected for recovery operations as a percent of the amount of waste generated (or collected)”. In practice, the definition used varies across countries and depends on data availability and on surveying methods used.

Data on the “amount of recycled materials (secondary raw materials) used in production as a percent of the total apparent consumption of the same materials”, suggested as a dataflow for GGI 3.3, are not part of the EIs.

Table 2.4. Mapping of UNECE and OECD dataflows of waste

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Waste generation (I1)	Total waste generation (may be expressed as generation of municipal waste) Waste generation by sector (following ISIC)	1000 t Kg / unit of GDP Kg / capita
GGI	Waste generation intensity and recovery ratios (3.3)	Total waste generation (may be expressed as generation of municipal waste) Waste generation by sector (following ISIC)	1000 t t / unit of GDP t / capita
SEIS dataflows	Waste reuse and recycling (I3)	Total waste recycled in total waste managed	1000 t Percentage of total waste managed
GGI	Waste generation intensity and recovery ratios (3.3)	Waste recovery ratios of waste generated (or collected) Amount of recycled materials (secondary raw materials) used in production	Waste (or material) collected for recovery operations as a percentage of the amount of waste generated Percentage of recycled materials used in the total consumption of selected materials

Source: Extract from OECD et al. (2015).

DATA SOURCES AND AVAILABILITY

In EaP countries, data on the generation of waste from economic sectors are usually collected by environmental authorities or by statistical agencies. In many countries, data on waste generation are published in national state-of-the-environment reports and statistical yearbooks. National data on waste generation are collected by the United Nations Statistics Division (UNSD) and UNEP in their Questionnaire on Environment Statistics and published under the UNSD Environmental Indicators[16].

[16] http://unstats.un.org/unsd/environment/wastetreatment.htm

A 2013 UNEP report (Hak et al, 2013) looked at 12 EECCA countries, including all EaP countries, to provide a better understanding of resource efficiency issues in the region. For this purpose, a material flows database was established using mainly FAO and IEA statistics.

2.2.5 Resource productivity - nutrients

POLICY CONTEXT

The sustainability of agro-food systems is at the centre of green growth considerations. The main concerns relate to food security, flows of potentially polluting nutrients (nitrogen, phosphorus) from commercial fertiliser use and intensive livestock farming, and pesticide residues that may leach into surface water and groundwater and may enter the food chain. Agriculture’s environmental effects can be negative or positive. They depend on the scale, type and intensity of farming as well as on agro-ecological and physical factors, climate and weather, and policy, economic and market developments. Farming can lead to deterioration in soil, water and air quality and to loss of natural habitats and biodiversity. These environmental changes can in turn have implications for the level of agricultural production and food supply, and limit the sustainable development of agriculture. But farming can also provide sinks for GHGs, contribute to conservation of biodiversity and landscapes, and help prevent floods and landslides.

Progress towards green growth can partly be assessed against changes in agricultural nutrient balances and intensities. Nutrient balances are an indication of the level of potential environmental pressures from nutrients, in particular on soil, water and air in the absence of effective pollution abatement.

DEFINITION AND CALCULATION OF INDICATORS

- Nitrogen and phosphorus surplus intensities, expressed as the gross *N* and *P* balance per hectare of agricultural land

- Agricultural nutrient intensity related to changes in agricultural output, expressed as changes in the gross *N* and *P* balance per hectare of agricultural land versus changes in agricultural production.

The indicator ***Nutrient flows and balances (N, P) (3.3)*** describes potential environmental pressures, and may hide important spatial variations. They reflect nutrient balances from primary agriculture, and do not consider nutrient flows from other food production systems, such as fisheries or total nitrogen cycles in the economy. Cross-country comparisons of change in nutrient surplus intensities over time should take into account the absolute intensity levels during the reference period.

The indicators relate to the gross nutrient balances, which is the difference between the quantity of nutrients inputs entering an agricultural system and the quantity of nutrient outputs leaving the agricultural system. It is calculated by subtracting the uptake of nutrients (e.g. by crops and forage) from the total nutrient supply (e.g. fertilisers, livestock manure, animal feed). This calculation can be used as a proxy to reveal the status of environmental pressures, such as declining soil fertility in the case of a nutrient deficit, or for a nutrient surplus the risk of polluting soil, water and air.

The nutrient balance indicator is expressed in terms of kilograms of nutrient surplus (or deficit) per hectare of agricultural land per year to facilitate the comparison of the relative intensity of nutrients in agricultural systems between countries. The nutrient balances are also expressed in terms of changes in the physical quantities of nutrient surpluses (deficits) to indicate the trend and level of potential physical pressure of nutrient surpluses into the environment. Spatial variations in nutrient balances depend on regional differences in farming systems, differing climates and types of soil, farming types and crop types, and varying topography across agricultural regions.

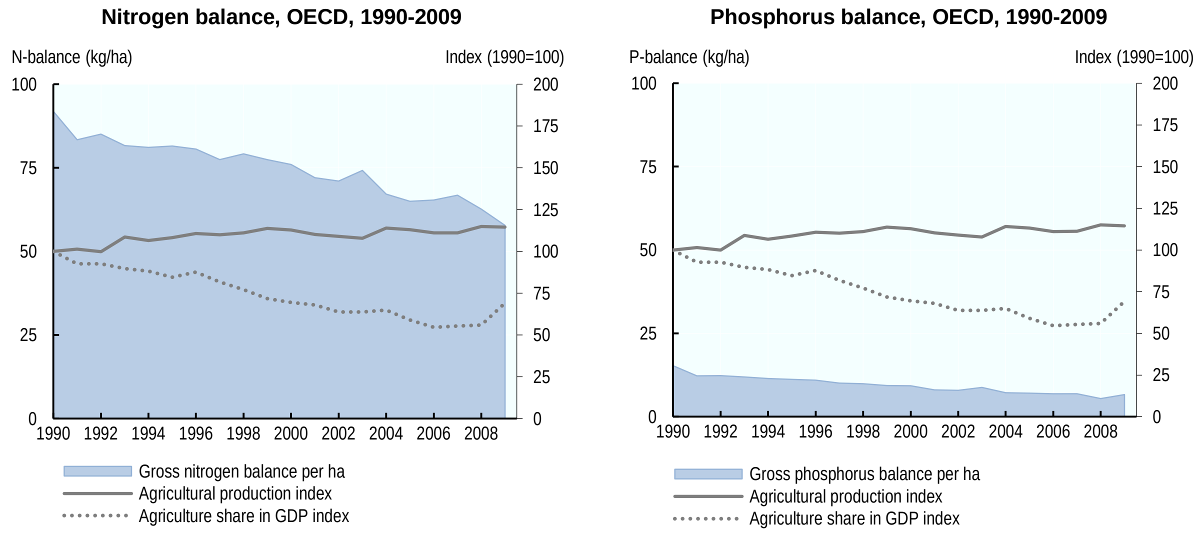
Handbooks on the calculation methods for agricultural nutrient balances are available from OECD/Eurostat[17].

Box 2.10. Trends in agricultural nutrient balances and agricultural production in OECD countries

For many OECD countries, nutrient surpluses relative to changes in agricultural output declined in terms of both absolute tonnes of nutrients and nutrient surpluses per hectare of agricultural land. The rate of reduction in OECD nutrient surpluses was more rapid in the 2000s than the 1990s. Over the past decade, the volume of OECD agricultural production increased by more than 1% per year, whereas the nitrogen balance (tonnes) declined by over 1% per year and the phosphorus balance by over 5% per year.

There are, however, sizeable variations within and between countries in terms of the intensity of and trends in nutrient surpluses. Territorial variations within countries are explained by the spatial distribution of intensive livestock farming and cropping systems that require high nutrient inputs, such as those for maize and rice. In some countries the absolute pressure on the environment (measured as the intensity of nitrogen and phosphorus surpluses) remains high.

Figure 2.8. Decoupling trends: agricultural nutrient balances and agricultural production



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using *"OECD agri-environmental indicators", OECD Agriculture Statistics (database);* *http://dx.doi.org/10.1787/888932925407.*

DATA SOURCES AND AVAILABILITY

In the EaP countries data on the use of mineral and organic fertilisers as well as on agricultural outputs are collected by the ministries of agriculture or the environment, and by statistical agencies. Rather complete and current data (until 2011/2013) on the consumption of nitrogen and phosphate fertilisers are published in the databases of FAOSTAT (Agri-Environmental Indicators)[18] and the World Bank[19].

[17] http://www.oecd.org/greengrowth/sustainable-agriculture/40820243.pdf and http://www.oecd.org/greengrowth/sustainable-agriculture/40820243.pdf

[18] http://faostat3.fao.org//faostat-gateway/go/to/compare/Q/QC/E
[19] http://data.worldbank.org/indicator/AG.CON.FERT.ZS

2.2.6 Resource productivity – water productivity

POLICY CONTEXT

The availability of water for meeting basic human needs is a prerequisite for life, health and economic development. Progress towards green growth can be assessed against changes towards more efficient use of limited water resources by the different economic sectors. Increasing values in time series indicate decoupling of the economic growth from water use. It does not necessarily indicate decline in total water use or decline of the (regional) impact of water use.

DEFINITION AND CALCULATION OF INDICATORS

Water productivity (4) is calculated as economic outputs (value added) per unit of water consumed by economic sectors (classified according to ISIC).

Water consumed can be calculated as the water supplied to a given industry or sector, including the water abstracted for self-supply. The choice of economic sectors depends on data availability. The outputs may be defined differently for different sectors: for the energy sector, for example, they could be defined as the amount of energy generated per unit of water used; for agriculture it could be the crop output per unit of water used.

Box 2.11. Calculating GGI "Water productivity" based on SEIS dataflows

SEIS Dataflows on *Total freshwater use (EI C3)* can be used for the production of the GGI *Water productivity (4)*. Both indicators are calculated on the basis of data on total freshwater use by ISIC sectors (households, agriculture, forestry and fishing, manufacturing, electric power industry, other economic activities). At the same time, the GGI includes the value added per unit of water consumed by sector. While the general required data on water use is fully compatible, the data on the value added by economic sectors are not part of the dataflows under SEIS.

Water use by sectors is to be provided as million cubic metres (m^3) for EI C3, from which the dataflow for the GGI, expressed as unit of GDP per cubic metre, unit of energy per cubic metre, etc. can be calculated.

Table 2.5 Mapping of UNECE and OECD dataflows on water productivity

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Total water use (C3)	Total freshwater use (classified according to ISIC)	Million m^3
GGI	Water productivity (4)	Value added per unit of water consumed or supplied, by sector (classified according to ISIC) – value added expressed as economic output or as physical output of the economic sectors, e.g. energy generated per unit of water used	Unit of GDP / m^3 Other sectoral units, e.g. for energy sector: toe generated per m^3

Source: *Extract from OECD et al. (2015).*

DATA SOURCES AND AVAILABILITY

In EaP countries data on water use are usually collected by national environmental authorities from the water supply industry and other enterprises and users. Measurement methods employed may vary considerably among the countries. Data on total freshwater use by sector was collected in the Questionnaire on Environment Statistics (2013) of UNSD and UNEP.

2.3 The natural asset base

Natural resources are a major foundation of economic activity and human welfare. Their stocks are part of the natural capital and they provide raw materials, energy carriers, water, air, land and soil. They support the provision of environmental and social services that are necessary to develop human and social capital. The extraction and consumption of resources affects the quality of life and well-being of current and future generations.

Natural resources differ in their physical characteristics, abundance and value to countries or regions. Their efficient management and sustainable use are key to economic growth and environmental quality. The aim is to optimise the net benefits from resource use within the context of economic development by *(1)* ensuring adequate supplies of renewable and non-renewable resources to support economic activities and economic growth; *(2)* managing environmental impacts associated with extracting and processing natural resources to minimise adverse effects on environmental quality and human health; *(3)* preventing natural resource degradation and depletion; and *(4)* maintaining non-commercial environmental services.

Progress can be monitored by looking at stocks of natural resources and of other environmental assets along with flows of environmental services, and by using indicators that reflect the extent to which the asset base is being maintained, in terms of quantity, quality or value.

The main issues of importance to green growth include:

- availability and quality **of renewable natural resource stocks**, including freshwater, forests and fish
- availability and accessibility of **non-renewable natural resource stocks**, particularly mineral resources such as metals, industrial minerals and fossil energy carriers
- **biological diversity and ecosystems**, including species and habitat diversity and the productivity of land and soil resources.

Moreover, the availability of natural resources can be measured through a comprehensive **index of natural resources**, which is not further discussed here, as it is still being tested. For more information on the currently performed tests please refer to Schreyer and Obst (2015).

Table 2.6. The natural asset base - proposed indicators

Theme	Proposed indicators	Type	M
Natural resource stocks	Index of natural resources Comprehensive measure expressed in monetary terms	M	M
Renewable stocks	Freshwater resources Available renewable natural resources (groundwater, surface water) and related abstraction rates (national, territorial)	M	S/M
	Forest resources Area and volume of forests; stock changes over time	M	S/M
	Fish resources Proportion of fish stocks within safe biological limits (global)	M	S
Non-renewable stocks	Mineral resources Available (global) stocks or reserves of selected minerals: metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates	M	M/L
Biodiversity and ecosystems	Land resources Land cover types, conversions and cover changes from natural state to artificial state	M	M/L
	Land use: state and changes	P	S/M
	Soil resources Degree of topsoil losses on agricultural land, on other land	M	M/L
	Agricultural land area affected by water erosion, by class of erosion	P	S/M
	Wildlife resources (*to be further refined*) Trends in farmland or forest bird populations or in breeding bird populations	P	S/M
	Species threat status: mammals, birds, fish, vascular plants in % species assessed or known	P	S
	Trends in species abundance	P	S/M

Type: M = Main indicators
P = Proxy indicators when the main indicators are not available

Measurability (M): S = short term, M = medium term, L = long term

See Annex for a complete list of indicators.

Source: *Extract from OECD (2014a).*

2.3.1 Renewable stocks - freshwater resources

POLICY CONTEXT

Freshwater resources are of major environmental and economic importance. Their distribution varies widely among and within countries. Pressures on water resources are exerted by overexploitation as well as by degradation of environmental quality. Water quality is affected by water abstraction, by pollution loads from human activities (agriculture, industry, households) and by climate and weather.

The main concerns relate to inefficient use of water and the environmental and socio-economic consequences: low river flows, water shortages, salinisation of freshwater bodies in coastal areas, human health problems, loss of wetlands, desertification and reduced food production.

Progress towards green growth can be assessed against domestic objectives and international commitments. The Agenda 21 from the United Nations Conference on Environment and Development (UNCED, Rio de Janeiro, 1992) explicitly considered the protection and preservation of freshwater resources. This was reaffirmed at the World Summit on Sustainable Development (WSSD, Johannesburg, 2002). Relating resource abstraction to renewal of stocks is a central question concerning sustainable water resource management.

DEFINITION AND CALCULATION OF INDICATORS

- Available **renewable freshwater resources** expressed as the long term annual average availability in cubic metres per capita;

Total renewable freshwater resources refer to internal flow plus actual external inflow. The internal flow is equal to precipitation less actual evapotranspiration. It represents the total volume of river run-off and groundwater generated, in natural conditions, exclusively by precipitation into a territory. The external inflow is the total volume of the flow of rivers and groundwater coming from neighbouring territories. The amount of water required to sustain ecological processes should be taken into account.

- The **intensity of freshwater resource use** (or water stress), expressed as gross abstraction from groundwater or surface water bodies in percentage of total available renewable freshwater resources (including transboundary inflows) and in percentage of internal freshwater resources (precipitation minus evapotranspiration).

Water stress can be categorised as:

- low (less than 10%): generally no major stress on the available resources
- moderate (10-20%): water availability is becoming a constraint on development and significant investment is needed to provide adequate supplies
- medium-high (20-40%): implies management of both supply and demand, and a need for conflicts among competing uses to be resolved.
- high (more than 40%): indicates serious scarcity and usually shows unsustainable water use, which can become a limiting factor in social and economic development.

National water stress levels may hide important variations at subnational (*e.g.* river basin) level, particularly in countries with extensive arid and semi-arid regions.

These indicators can usefully be complemented with further information on water abstraction, e.g. the abstraction broken down by major use or industry according to the International Standard Industrial Classification (ISIC) (abstraction by water supply industry, households, agriculture, forestry and fishing, manufacturing, electric power industry, and other economic activities); intensity of water abstractions per capita, or water supply prices in selected cities. In the presentation and analysis of data a comprised categorisation may be used, depending on the quality of data, as well as on the policy question.

Box 2.12. Calculating GGI "Freshwater resources" based on SEIS dataflows

SEIS dataflows on *Renewable freshwater resources (EI C1)* and *Freshwater abstraction (EI C2)* correspond to the GGI *Freshwater resources (7)*. Both EI C1 and GGI 7 require data on available renewable freshwater resources. The EI in particular refers to the methodology of data collection applied in the UNSD/UNEP Questionnaires on Environment Statistics while the OECD collects data via the OECD questionnaire on the state of the environment, a joint questionnaire with Eurostat for common member countries. The questionnaires are harmonized between OECD, UNSD, and other organizations (UN Water 2012) and the same data are required.

The available freshwater resources are to be provided in million cubic metres for the EI, from which the unit of measurement used for the GGI, cubic metres per capita, can easily be calculated.

Moreover, the "Water Exploitation Index (WEI)" included in the EI C2 is equal to the "Water stress index" contained in GGI 7. It is calculated as the share of freshwater abstracted in the available renewable freshwater resources and expressed as a percentage.

Table 2.7. Mapping of UNECE and OECD dataflows on water

	Topic	*Indicator and dataflows*	*Unit of measurement*
SEIS dataflows	Renewable freshwater resources (C1)	• Renewable freshwater resources (Internal flow + Inflow of surface and groundwaters)	• Million m^3
GGI	Freshwater resources (7)	• Available renewable natural resources (Internal flow + Inflow of surface and groundwaters)	• m^3/capita
SEIS dataflows	Freshwater abstraction (C2)	• Water Exploitation Index (WEI): freshwater abstracted over available renewable freshwater resources	• Percentage (Freshwater abstracted / Renewable freshwater resources)
GGI	Freshwater resources (7)	• Water stress (intensity of freshwater resource use): abstraction rates (national, territorial) of available renewable natural resources	• Percentage (Freshwater abstracted / renewable freshwater resources)

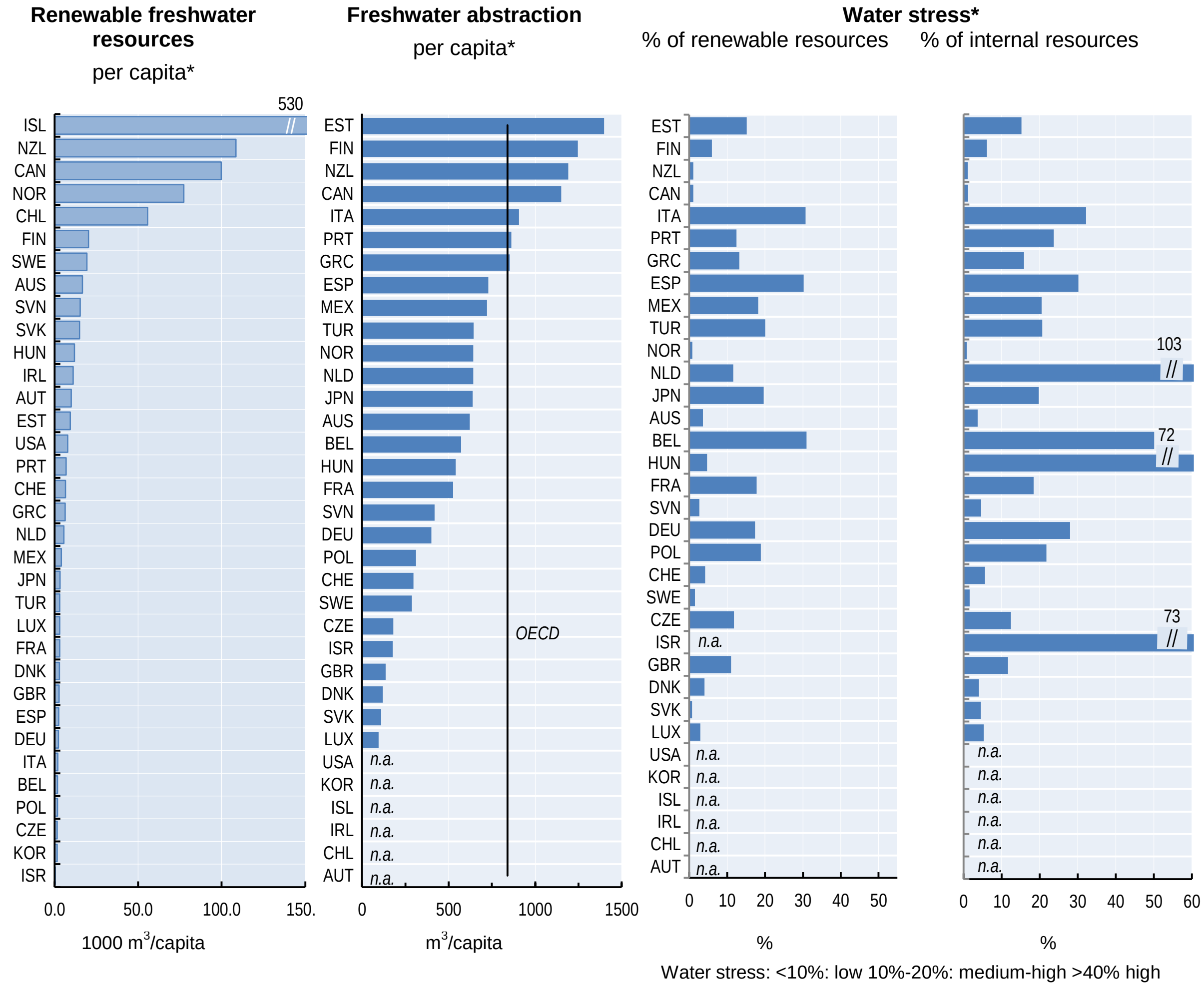
Source: Extract from OECD et al. (2015).

Box 2.13. Trends in freshwater stocks and abstraction intensities in OECD countries

Most OECD countries increased their water abstractions over the 1970s in response to demand by the agricultural and energy sectors. In the 1980s, some countries stabilised their abstractions through more efficient irrigation techniques, the decline of water-intensive industries (e.g. mining, steel), increased use of more efficient technologies and reduced losses in pipe networks. Since the 1990s trends in water abstractions have been generally stable. In some countries this is due to increased use of alternative water sources, including water reuse and desalination. Trends since 2000 indicate a relative decoupling between water use and GDP growth in many OECD countries.

Water stress levels – the intensity of use of available resources – show a wide variation among and within countries. Most OECD countries face at least seasonal or local water quantity problems and several have extensive arid or semi-arid regions where water scarcity is a constraint to economic development. In about one-third of OECD countries, freshwater resources are under medium to high stress.

Figure 2.9. Freshwater stocks and abstraction intensities in OECD countries



* Latest available year. Data prior to 2006 were not considered. OECD totals are estimated and exclude Chile and Ireland.

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using OECD Environment Statistics (database); http://dx.doi.org/10.1787/888932925445.

DATA SOURCES AND AVAILABILITY

For EaP countries data on renewable freshwater resources data are collected at selected hydrological stations and calculated on the basis of long-term measurements of levels, flow rates and inflows/outflows carried out on rivers and lakes as well as groundwater horizons and countrywide precipitation. In the UNSD Environmental Statistics database (Inland Water Resources)[20] data on Precipitation, Internal flow, Inflow of surface and ground waters and on total renewable freshwater are published for all EaP countries. Aquastat also collects data on renewable freshwater resources[21] but data may not be based on national submissions but on estimations by international experts.

Definitions and estimation methods may vary considerably by country and over time. More work is needed to improve the completeness and historical consistency of data on water abstraction, and the methods for estimating renewable water resources.

The World Bank gathers information on freshwater resources including renewable internal freshwater resources per capita and annual withdrawals by different sectors and covers EaP countries.

2.3.2 Renewable stocks – forest resources

POLICY CONTEXT

Forests are among the most diverse and widespread ecosystems on earth, and have many functions: they provide timber and other products; have cultural values; deliver recreation benefits and ecosystem services including regulation of soil, air and water; are reservoirs for biodiversity; and commonly act as carbon sinks.

The main concerns relate to the impact of human activities on forest diversity and health and on natural forest growth and regeneration, and to the consequences for the provision of economic, environmental and social forest services. Many forest resources are threatened by overexploitation, fragmentation, degradation of environmental quality and conversion to other types of land use. The main pressures from human activities include agriculture expansion, transport infrastructure development, unsustainable forestry, air pollution and intentional burning of forests.

Progress towards green growth can be assessed against national objectives and international principles on sustainable forest management adopted at UNCED in 1992 and reaffirmed at the WSSD in 2002. Other relevant international initiatives include the Ministerial Conferences for the Protection of Forests in Europe, which led to the Pan-European Criteria and Indicators for Sustainable Forest Management; the Montreal Process on Sustainable Development of Temperate and Boreal Forests; and the UN Forum on Forests.

DEFINITION AND CALCULATION OF INDICATORS

- **The area of forest land** represents the share of total land area or square kilometres per capita.

For the calculation of the indicator ***area of forest land***, relevant definitions established by FAO/UNECE for its Global FRA should be used. Forests are defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 %, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use. Out of these areas classified as forest, areas which are which are natural or planted forest, areas designated for production, as well as areas designated for the protection of soil and water, ecosystem services and biodiversity can be distinguished.

[20] http://unstats.un.org/unsd/environment/waterresources.htm
[21] http://www.fao.org/nr/water/aquastat/water_res/index.stm

- ***Forest resource stocks*** are measured as volume over bark of living trees more than *X* cm in diameter at breast height (or above buttress if these are higher). It is expressed in cubic metres, or related changes.

Includes stem from ground level or stump height up to a top diameter of *Y* cm, and may also include branches to a minimum diameter of *W* cm. The diameters used may vary by country; generally the data refer to diameters of more than 10 cm at breast height. The area of other wooded land may be provided as a complement.

Box 2.14. Calculating GGI "Forest resources" based on SEIS dataflows

The SEIS dataflows on *Forests and other wooded land (EI D3)* and the GGI *Forest resources (8)* contain dataflows on forest area and the area of wooded land to understand whether forests and wooded land are used in a sustainable way. Both indicators refer to the FAO/UNECE Global Forest Resource Assessments (FRA) for data collection. Therefore these dataflows are fully compatible.

In terms of the unit of measurement of forest areas both under the SEIS dataflows and the GGIs use square kilometres and measure the percentage of forest areas in the total land area. Also, the forest area per capita, which is part of the GGI and expressed as square kilometres per capita, can easily be calculated based on the units of the EI.

The GGI also contains data on volume of forest resource stocks and stock changes over time, which are not part of the EI, but are contained in the FRA.

Table 2.8. Mapping of UNECE and OECD dataflows on forest resources

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Forests and other wooded land (D3)	Total forest area Total area of other wooded land	1000 km^2 Percentage of total land area
GGI	Forest resources (8)	Area of forests land (and other wooded land) Volume of forests and stock changes	km^2 per capita percentage of total land area

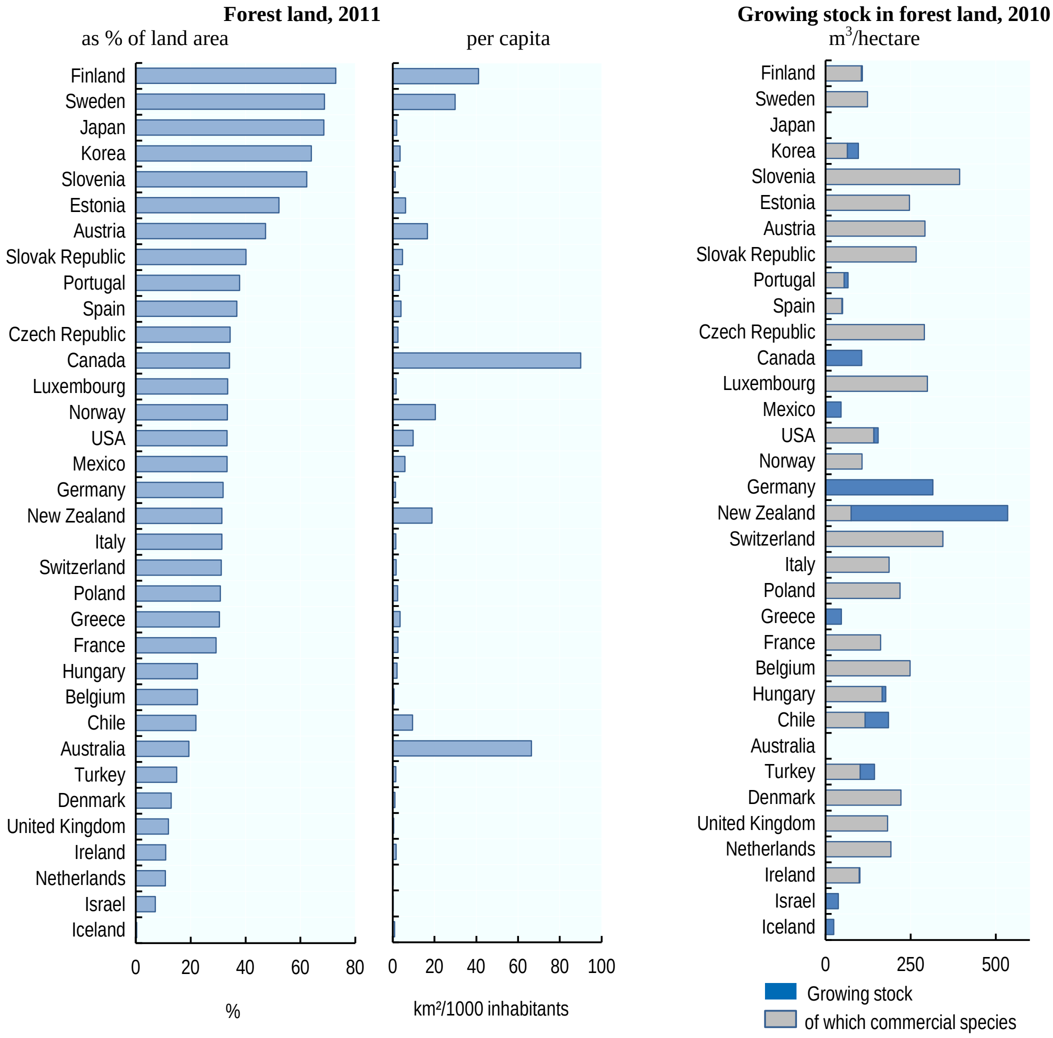
Source: *Extract from OECD et al. (2015).*

Box 2.15. Trends in forest land and volume of forest resource stocks in OECD countries

The global forest area is about 4 billion ha, which amounts to 30% of the total land area or an average of 0.6 ha per capita. OECD countries account for about one-fourth of the world's forest area.

Over the past 50 years, the area of forests and wooded land has remained stable or slightly increased in most OECD countries, but fragmentation, degradation of environmental quality and conversion to other types of land use raise concerns. At world level, the area of forests has been decreasing, due in part to continued deforestation in tropical countries, often to provide land for agriculture, grazing and logging.

Figure 2.10. Forest land and growing stock



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using *FAOSTAT (database); OECD Environment Statistics (database); http://dx.doi.org/10.1787/888932925483*

DATA SOURCES AND AVAILABILITY

Data on the area of forests and wooded land are available all EaP countries with varying degrees of completeness. Data on forest resources and the intensity of their use can be derived from forest accounts and from the FAO/UNECE Global Forest Resource Assessments (FRA)[22].

The World Bank gathers information on forest area, as a share of land area or square km for EaP countries[23].

2.3.3 Renewable stocks – fish resources

POLICY CONTEXT

Fish resources play key roles for human food supply and aquatic ecosystems. In many countries fisheries make an important contribution to sustainable incomes and employment opportunities.

The main concerns relate to the impact of human activities on fish stocks and habitats in marine waters and freshwater, and to the consequences for biodiversity and for the fish supply for human consumption and other uses. Pressures on fish resources include fishing, coastal development and pollution loads from land-based sources, maritime transport, and maritime dumping. Many valuable fish stocks are fully exploited or overexploited. Natural variability and climate change have significant implications for the productivity and management of capture fisheries and aquaculture development.

Progress towards green growth can be assessed against domestic objectives and bilateral and multilateral agreements such as those on conservation and use of fish resources (Atlantic Ocean, Pacific Ocean, Baltic Sea, *etc.*), the Rome Consensus on world fisheries, the Code of Conduct for Responsible Fishing (FAO, November 1995) and the UN Convention on the Law of the Sea and its implementation agreement on straddling and highly migratory fish stocks. Within the framework of the FAO Code of Conduct for Responsible Fishing, efforts are being made to address the issue of illegal, unreported and unregulated (IUU) fishing.

DEFINITION AND CALCULATION OF INDICATORS

Fish resources within safe biological limits can be defined as the proportion of fish stocks exploited within their level of maximum biological productivity. It is expressed as the percentage of fish stocks exploited within their level of maximum biological productivity, i.e. underexploited, moderately exploited or fully exploited. Safe biological limits are the precautionary thresholds advocated by ICES. The stocks assessed are classified on the basis of various phases of fishery development: underexploited, moderately exploited, fully exploited, overexploited, depleted and recovering.

This indicator is designed for global and regional assessments, and is not well suited for country assessments. For monitoring fisheries management in countries, more specific indicators are needed. Therefore, for a country level assessment, this indicator may have to be adjusted or replaced, e.g. by indicators on fish production (from aquaculture and capture fisheries) and on fish supply for food.

[22] http://www.fao.org/forestry/fra/en/

[23] http://data.worldbank.org/indicator/AG.LND.FRST.ZS

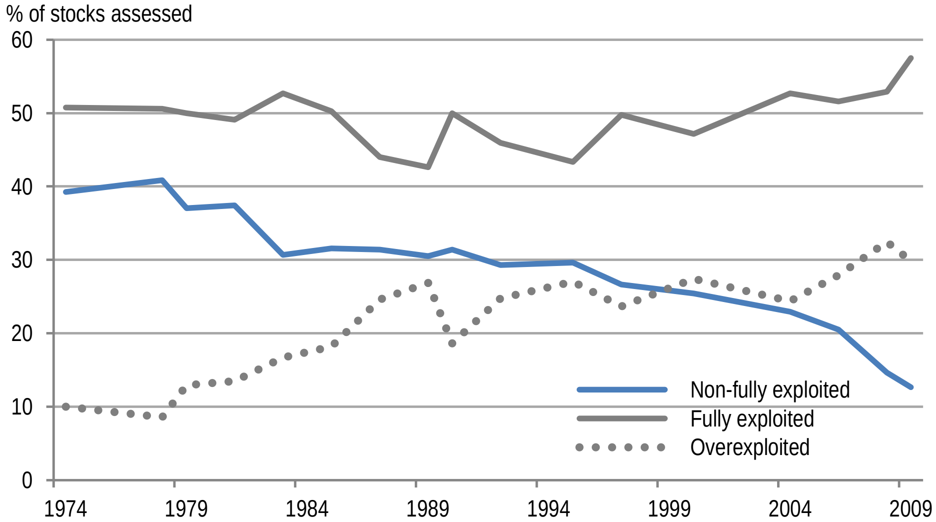
Box 2.16. Trends in the state of world marine stocks

The trend towards increased global fish production since 1980 has been achieved partly through exploitation of new or less valuable species and partly through aquaculture. Illegal, unreported and unregulated (IUU) fishing remains widespread and hinders the achievement of sustainable fishery management objectives.

Global production of marine capture fisheries peaked in 1996 at about 74 Mt and has since declined slightly, reaching about 68 Mt in 2011. The stabilisation of production from marine capture fisheries in recent years arises from a combination of greater exploitation of some stocks and declines in stock size and productivity in others.

In the European Union, 63% of fish stocks (for which the information is available) are being fished beyond maximum sustainable yields; these fish populations could generate higher economic output if they were subject to reduced fishing pressure. In addition 30% of these stocks are outside safe biological limits, meaning they have a high risk of depletion.

Figure 2.11. Global trends in the state of world marine stocks



Source: OECD (2014a), Green Growth Indicators 2014, OECD Publishing, Paris, using FAO (2012), The State of World Fisheries and Aquaculture.

DATA SOURCES AND AVAILABILITY

Data on the size of major fish populations exist but are scattered across national and international sources. At a global level, some information on the state of fish stocks is available from *The State of World Fisheries and Aquaculture*, published every two years by the FAO. For a large number of stocks, it is still not possible to determine the status. Assessments of internationally managed stocks are available from regional fisheries management organisations and from the International Council for the Exploration of the Sea (ICES). This indicator is also included in the Millennium Development Goal (MDG) monitoring framework (for more information on MDGs/SDGs please refer to Box 2.26).

2.3.4 Biodiversity and ecosystems – land resources

POLICY CONTEXT

Land and soil resources are essential components of the natural environment and of the natural asset base of the economy. They are both a private property and a global common; and are critical for the production of food and other biomass, the preservation of biological diversity and the productivity of ecosystems.

The way land is used and managed influences land cover and soil quality in terms of nutrient content and carbon storage, affects water and air quality, determines erosion risk, plays a role in flood protection and affects GHG emissions. Land's economic value derives from food and other biomass production, mineral extraction and activities linked to built environment. From a social point of view, land acquires value through ownership and through cultural and traditional heritage. As land is a factor input into many economic activities, competing demands and conflicting uses may become constraints to both economic development and environmental protection. Competing demands and the main drivers behind land use conversions, include: agriculture and food production; forestry and biomass; urbanisation and infrastructure development; production of biofuels and non-food crops; other renewable energy production (hydroelectricity; windmills); mining and quarrying; water and flood management; and the protection of biodiversity and cultural landscapes. Land use is also increasingly influenced by global economic and environmental change (*e.g.* as a result of climate change mitigation and adaptation).

Progress towards green growth can be assessed against changes in land use and cover, conversions of land from its natural state to an artificial state and changes in the share of built-up areas. This delivers important messages about competing uses of land and pressures on biodiversity that may alter habitats.

DEFINITION AND CALCULATION OF INDICATORS

The proposed indicators on **land resources (11)** inform about land cover types, conversions and cover changes. Particular attention is given to:

- changes from a "natural state" to an "artificial" or man-made state (or **land take**) and **drivers of land take**, i.e. the sectors responsible for **cover changes** from natural state to artificial state.

For the calculation of the indicator on ***drivers of land take***, data on land take in ha/year should be provided for major sectors, including housing, services and recreation, industrial and commercial activities, transport and infrastructures, mines, quarries and dumpsites, as well as construction.

Indicators on land use and land-use changes complete the picture:

- the **state of land use**, by category of uses (arable and permanent crop land, pastures, forest land, and other land);

Land use is characterised by the arrangements, activities and inputs that people undertake in a specific land cover type to produce, change or maintain it. Land use defined in this way establishes a link between land cover and the actions of people in their environment. A given land use may take place on one, or more than one, piece of land and several land uses may occur on the same piece of land. For the calculation of the indicator on the state of land use, the total area of a country can be distinguished by the following categories:

- *Arable and permanent crop land: (i)* all land generally under rotation, whether for temporary crops or meadows, or left fallow (less than five years), and *(ii)* land under permanent crops, *i.e.* crops that occupy land for a long period and do not have to be planted for several years after each harvest.

- *Pastures:* permanent grassland, *i.e.* land used for five years or more for herbaceous forage, either cultivated or growing wild.

– *Forest land:* land of more than 0.5 ha with a canopy cover of more than 10 %, or trees able to reach these thresholds in situ. This excludes woodland or forest predominantly in agricultural or urban use and used only for recreation purposes.

– *Other land:* built-up and related land, wet open land and dry open land, with or without vegetation cover. Areas under inland water bodies (rivers and lakes) are excluded.

- **land-use changes** relate to the change over time of the distribution of land uses within a country. The unit of observation is the proportion of each category of land use changed to another land use over a given period.

Box 2.17. Calculating GGI "Land resources" based on SEIS dataflows

SEIS dataflows on *Land uptake (EI E1)* can be used to produce the dataflows on *drivers of land take* that are part of the GGI on *land resources (11)*

In terms of EI E1, dataflows on total land uptake broken down by sectors, as well as dataflows on total land uptake broken down by country area, are collected. For the dataflow the following drivers are distinguished: mining and quarrying areas, constructions, manufacturing areas, technical infrastructure, transport and storage infrastructure, commercial, financial and public services, residential areas including recreational facilities and other uses (landfills, waste dumps, tailing pits and refuse heaps). For the GGI different sectors are suggested (*housing, services and recreation*, *industrial and commercial activities*, *transport and infrastructures*, *mines, quarries and dumpsites*, as well as *construction),* but the sectors are overlapping and the selection may depend on data availability.

Data on EI E1 are given in thousands of square kilometres. Additionally, the share of total land uptake in the country area is calculated as percentage. For GGI 11 changes in land use are calculated in hectares and square kilometres. Furthermore natural areas lost for urban development are provided as percentage. Therefore EI E1 is compatible with GGI 11 pertaining to units of measurement.

Data on the state of land use by category of uses and on land-use changes are not part of the SEIS dataflows.

Table 2.9. Mapping of UNECE and OECD dataflows on land resources

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Land uptake (E1)	Total land uptake (broken down by sectors) Total land uptake (broken down by country area)	1000 km^2
GGI	Land resources: land cover conversions and cover changes from natural state to artificial state (11)	Land take and related drivers Land use, by category of uses Land use changes	Hectare; km^2

Source: Extract from OECD et al. (2015).

Box 2.18. Trends in land use in OECD countries

Biodiversity-rich natural and semi-natural areas have continuously declined in OECD countries.

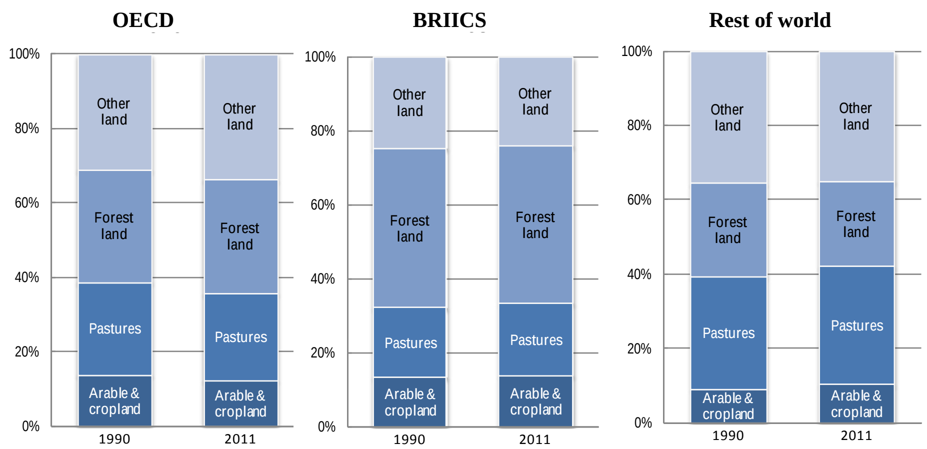
- The area of forests and wooded land has remained stable or slightly increased in most OECD countries, but fragmentation, degradation of environmental quality and conversion to other types of land use raise concerns.

- There has been a net loss of wetlands to agricultural use, although the rate of loss has been declining. Wetlands are highly valued habitats for biodiversity and their loss is of international significance.

Permanent pasture, which represents a major share of agricultural semi-natural habitats, has declined most OECD countries; it has mainly been converted to forest or, in some countries, arable and permanent cropland. The area of other types of semi-natural agricultural habitats (farm woodland and fallow land) has increased or remained stable.

Figure 2.12. Land-use changes

OECD and BRIICS countries, rest of the world, 1990-2011



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using FAO, FAOSTAT (database); http://dx.doi.org/10.1787/888932925559.

DATA SOURCES AND AVAILABILITY

Data on land take are calculated by the EEA based on satellite images[24]. However, this does not cover EaP countries yet.

Time series data on land use (including the total area of agricultural land and arable land as well as data on forest areas) are published for EaP countries by FAOSTAT[25], the World Bank[26] and as part of the UNSD Environmental Indicators[27]. The World Bank gathers information on agricultural land, arable land, forest area as a share of land area for all EaP countries up to 2013.

[24] http://www.eea.europa.eu/data-and-maps/indicators/land-take-2
[25] http://faostat3.fao.org/faostat-gateway/go/to/download/E/EL/E
[26] http://data.worldbank.org/indicator
[27] http://unstats.un.org/unsd/environment/Time series.htm#

However, many countries have their own classifications on land types and their own methodologies in building a land cadastre, which are not compliant with international standards. In most countries the data are collected from land agencies. Further work is needed to harmonise classifications and definitions and more needs to be done to exploit satellite images to monitor changes in land cover.

2.3.5 Biodiversity and ecosystems – wildlife resources

POLICY CONTEXT

Biological resources provide the raw materials of production and growth in many sectors of the economy. They are essential elements of ecosystems and of natural capital and their diversity plays an essential role in maintaining life-support systems and quality of life.

Conservation of biodiversity is a key concern nationally and globally. Pressures on biodiversity from human activities can be physical (*e.g.* habitat alteration and fragmentation through changes in land use and land cover), chemical (toxic contamination, acidification, oil spill, other pollution from human activities) or biological (*e.g.* alteration of population dynamics and species structure through the release of exotic species or commercial use of wildlife resources). The primary drivers are land use changes for conversion from natural state to agriculture and infrastructure, unsustainable use of natural resources, invasive alien species, climate change and pollution.

Progress towards green growth can be assessed against domestic objectives and international agreements such as the Convention on Biological Diversity (CBD, 1992), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Washington, 1973) and the Convention on Wetlands of International Importance (Ramsar, 1971).

DEFINITION AND CALCULATION OF INDICATORS

- The number of **threatened species** compared to the number of known or assessed species.

For the calculation of the indicator on ***Threatened species***, critically endangered, endangered, and vulnerable species, i.e. those plants and animals that are in danger of extinction or soon likely to be, should be taken into account (IUCN 2001). For the presentation and analysis of data certain categories of species may be selected. In OECD (2014a), data cover mammals, birds, and vascular plants, while other major groups (e.g. fish, reptiles, amphibians, invertebrates, fungi) are not covered.

- Trends in **species abundance** shows the trends in the abundance of selected species over time.

OECD (2014a) uses bird populations (farmland or forest bird populations or breeding bird populations). Depending on data availability and national importance other species may be used.

Box 2.19. Calculating GGI "Wildlife resources" based on SEIS dataflows

SEIS dataflows on *Threatened and protected species (EI D4)* and *Trends in the number and distribution of selected species (EI D5)* contain information that can be used to produce the GGI *Wildlife resources (13)*.

Both EI D4 and GGI 13 require dataflows on threatened species. The dataflows necessary for the production of both indicators are based on the IUCN lists of threatened species. Therefore, those dataflows are fully compatible. However, for the presentation and analysis of data certain categories of species may be selected. As units of measurement the percentage of species threatened of species assessed or known is used for both indicators.

Complementary to the dataflows on threatened species, data on the abundance of selected species are contained in both EI *Trends in the number and distribution of selected species (D5)* and GGI *Wildlife resources (13)*. For the EI two species each from the categories "Keystone species", "Flagship species", "Endemic species" and "Other characteristic species" should be selected as proxies and data on the number of individuals should be provided. OECD uses a similar approach by selecting certain species under its indicator 13. OECD (2014a) uses bird populations (farmland or forest bird populations or breeding bird populations) as a proxy to measure the state of wildlife in a country. As those may be selected as characteristic species for a country for the EI, both indicators are compatible. The number of individuals of the respective species is used as units of measurement for the SEIS dataflows and the GGIs.

Table 2.10. Mapping of UNECE and OECD dataflows on wildlife resources

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Threatened and protected species (D4)	Number and percentage of species threatened (mammals, birds, fishes, reptiles, amphibians, invertebrates, vascular plants, mosses, lichens, fungi, algae)	Number of species threatened Percentage of species threatened
GGI	Wildlife resources (13)	Species threat status: mammals, birds, fish, vascular plants in percentage of species assessed or known	Percentage of species threatened
SEIS dataflows	Trends in the number and distribution of selected species (D5)	Number of selected species — Keystone species, Flagship species Endemic species, Other species — characteristic species for country	Thousands of individuals
GGI	Wildlife resources (13)	Trends in species abundance (e.g. farmland or forest bird populations or in breeding bird populations)	Number of individuals

Source: *Extract from OECD et al. (2015).*

Box 2.20. Threatened species in OECD countries

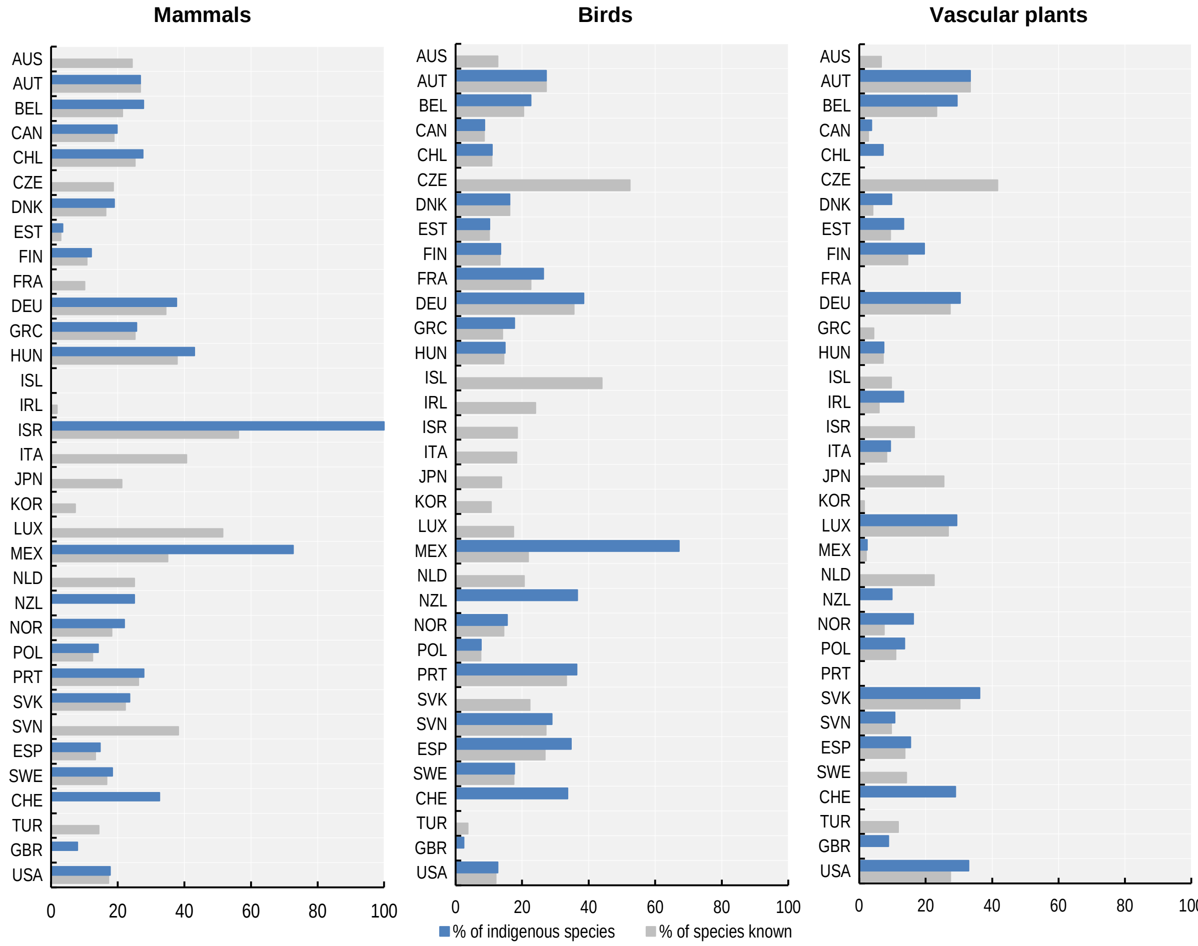
While protected areas have grown in most OECD countries, pressures on biodiversity and threats to global ecosystems and their species are also increasing. The targets agreed in 2002 by parties to the CBD to "significantly reduce the rate of biodiversity loss" by 2010 were not met, at least not at global level. Parties to the CBD have defined a new set of 20 targets for 2020 that can be measured with related indicators[28].Diversity of genes, species and ecosystems continues to decline as pressures on biodiversity remain constant or increase in intensity, mainly as a result of human actions. Scientific consensus projects a continuing loss of habitats and high rates of extinction throughout the century if current trends persist.

In most OECD countries, the number of animal and plant species identified as endangered is increasing. Many species are threatened by habitat alteration or loss, both within and outside protected areas (e.g. on farms and in forests). Threat levels are particularly high in countries with high population density and a high concentration of human activities.

[28] https://www.cbd.int/sp/targets/default.shtml

Figure 2.13. Threatened species

OECD countries, latest available year, in % of species known or assessed



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using OECD Environment Statistics (database) http://dx.doi.org/10.1787/888932925597

DATA SOURCES AND AVAILABILITY

For many years, the International Union for the Conservation of Nature (IUCN) has been monitoring the extent and pace of biodiversity degradation by assigning species to categories of threat through detailed assessments of information against a set of quantitative criteria. The IUCN Red List of Threatened Species[29] is regularly updated and contains country level data on threatened species (totals by taxonomic group[30], and by Red List Category[31]) for all EaP countries. In the majority of countries information on threatened species is collected in "red books", which include data on the abundance and state of rare and/or protected species of wild fauna and flora and conservation measures.

The World Bank provides information on threatened bird, mammals and plants species for year 2015 for EaP countries. Threatened species are the number of species classified by the IUCN as endangered, vulnerable, rare, indeterminate, out of danger, or insufficiently known.

[29] http://www.iucnredlist.org/about/summary-statistics#Tables_5_6
[30] http://cmsdocs.s3.amazonaws.com/summarystats/2014_2_Summary_StatsPage_Documents/2014_2_RL_Stats_Table5.pdf
[31] http://cmsdocs.s3.amazonaws.com/summarystats/2014_2_Summary_StatsPage_Documents/2014_2_RL_Stats_Table6a.pdf

Furthermore, all EaP countries are Parties to the Convention on Biological Diversity (CBD) and are regularly submitting national reports to the CBD that contain data on endangered species[32]. However, the definitions that should follow IUCN standards are applied with varying degrees of rigour in countries. Historical data are generally not comparable or are not available.

2.4 The environmental quality of life

Environmental outcomes are important determinants of human health and well-being. They demonstrate that production and income growth may not always be accompanied by a rise in well-being. Degraded environmental quality can result from and cause unsustainable development patterns. It can have substantial economic and social consequences, from health costs and lower labour productivity to reduced agricultural output, impaired ecosystem functions and a generally lower quality of life.

Environmental conditions affect the quality of people's life in various ways. They affect human health through air and water pollution and exposure to hazardous substances and noise, as well as through indirect effects from climate change, transformations in water cycles, biodiversity loss and natural disasters that affect the health of ecosystems and damage people's property and life. People also benefit from environmental services, such as access to clean water and nature, and their choices are influenced by environmental amenities.

The main aspects of importance to green growth include:

- **Human exposure to pollution and environmental risks**, the associated effects on human health and on quality of life, and the related health costs and impacts on human capital.

- **Public access to environmental services and amenities**, or the level and type of access various groups have to environmental services such as clean water, sanitation, green spaces and public transport.

Indicators on **exposure to natural or industrial risks and related economic losses** are not yet fully measurable and require further specification. They are not further discussed here.

[32] http://www.cbd.int/reports/map

Table 2.11. The environmental quality of life - proposed indicators

Proposed indicators

Theme	Proposed indicators	Type	Measurability
Environmental health and risks	Environmentally induced health problems & related costs (*e.g.* years of healthy life lost from degraded environmental conditions)	M	L
	Population exposure to air pollution	P	S/M
	Exposure to natural or industrial risks and related economic losses	M	L
Environmental services and amenities	Access to sewage treatment and drinking water	M	
	Population connected to sewage treatment (at least secondary, in relation to optimal connection rate)		S/M
	Population with sustainable access to safe drinking water	–	S/M

Type: M = Main indicators
P = Proxy indicators when the main indicators are not available

Measurability (M): S = short term, M = medium term, L = long term

See Annex for a complete list of indicators.

Source: Extract from OECD (2014a).

2.4.1 Environmental health and risks – air quality

POLICY CONTEXT

Atmospheric pollutants from energy transformation, energy consumption and industrial processes are the main contributors to regional and local air pollution. Degraded air quality can have substantial economic and social consequences, from health costs, reduced labour productivity and building restoration needs to reduced agricultural output, forest damage and a generally lower quality of life.

Major concerns relate to effects on human health and ecosystems. Human exposure is particularly high in urban areas, where economic activities are concentrated. Some population groups, notably the very young and very old, are especially vulnerable. Causes of growing concern are concentrations of fine particulates, NO_2, toxic air pollutants and acute ground-level ozone episodes in both urban and rural areas.

Progress towards green growth can be assessed against domestic objectives and international commitments regarding air emissions and quality, and against changes in the number of people exposed to certain levels of air pollution, with particular attention to vulnerable groups (children, the elderly). Progress can also be assessed against health costs induced by degraded air quality and the impact on labour productivity and human capital.

DEFINITION AND CALCULATION OF INDICATORS

The proposed indicators on **environmentally induced health problems and related costs** (14) were selected to measure the influence of environmental degradation as well as pollution on human health, well-being and human capital. One important dimension of this is the **population exposure to air pollution.** The indicator informs about:

- exposure to **fine particulates ($PM_{2.5}$)**: Estimates of the share of the population exposed to various $PM_{2.5}$ levels, derived from satellite-based measurements.

- exposure to **small particulates (PM_{10})**: Urban-population weighted PM_{10} levels in residential areas of cities with more than 100 000 residents. It represents the average annual exposure level of an average urban resident to outdoor particulates;

The major components of ***particulate matter ($PM_{2.5}$ and PM_{10})*** are sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. Small particulates are suspended particulates of less than 10 µm in diameter (PM_{10}), fine particulates are particulates smaller than 2.5 microns in diameter ($PM_{2.5}$).

Air quality measurements are typically reported in terms of daily or annual mean concentrations of particles per cubic meter of air volume (m^3), and routinely expressed in terms of micrograms per cubic meter ($\mu g/m^3$).

Information on the indicator on fine particulates may be derived from satellite-based measurement of $PM_{2.5}$. The 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. Current World Health Organisation (WHO) air quality guidelines are annual mean concentrations of 10 micrograms per cubic meter for particulate matter less than 2.5. microns in diameter.

The indicator on small particulates should show urban-population weighted PM_{10} levels in residential areas of cities with more than 100,000 residents. Estimates should represent the average annual exposure level of the average urban resident to outdoor particulate matter. Current WHO air quality guidelines are annual mean concentrations of 20 micrograms per cubic meter for particulate matter less than 10 microns in diameter.

If data from satellite-based measurement is not available, the indicator could be calculated based on ground-based measurements according to the methodology proposed by UNECE[33].

- Exposure to **ground-level ozone (O_3)**: Estimates of O_3 levels in selected cities.

Ozone at ground level (O_3) – not to be confused with the ozone layer in the upper atmosphere – is one of the major constituents of photochemical smog. It is formed by the reaction with sunlight (photochemical reaction) of pollutants such as nitrogen oxides (NO_x) from vehicle and industry emissions and volatile organic compounds (VOCs) emitted by vehicles, solvents and industry.

The indicator on ground-level ozone (O_3) shows the population weighted concentration of ozone to which the urban population in Europe is potentially exposed. It refers to the annual sum of daily maximum 8-hour mean concentrations above a threshold (70 microgram ozone per m^3 or 35 parts per billion) at urban background stations in agglomerations and calculated for all days in a year. Current WHO air quality guidelines for ozone are 8-hour mean concentrations of 100 micrograms per cubic meter. For data collection ground-based measurement is applied.

[33] http://www.unece.org/fileadmin/DAM/env/europe/monitoring/Indicators/A-2-en-final.pdf

Box 2.21. Calculating GGI "Population exposure to air pollution" based on SEIS dataflows

SEIS dataflows on *Ambient air quality in urban areas (EI A2)* can contribute to producing GGI *Environmentally induced health problems & related costs (14)*. Both indicators require data on particulate matter (PM $_{2.5}$ and PM_{10}) and ground-level ozone (O_3) expressed as annual average concentrations. EI A2 measures concentrations for the capital city and other major cities and the number of days with exceeded daily limit value. GGI 14 measures the average annual exposure level of an average urban resident to outdoor particulates ($PM_{2.5}$ and PM_{10} levels in residential areas of cities with more than 100,000 residents). It further measures a weighted annual sum of maximum daily 8-hour mean ozone concentrations above the threshold (µg/m^3 per day) and is calculated for all days in a year. For data collection on O_3 ground-based measurement is applied, whereas - depending on the unit chosen - ground-based monitoring or satellite-based-measurements for $PM_{2.5}$ PM_{10} are used. As there are differences between both GGI and EI in terms of data collection, raw data are not fully compatible for $PM_{2.5}$ and PM_{10}. At the same time, data evaluation may lead to similar conclusions.

While the GGI 14 is designed to reflect to the average human exposure level to the pollutants, the EI A2 focusses on annual average concentrations and daily values of PM_{10} and O_3. Furthermore EI A2 strongly focuses on concentrations of PM_{10} and O_3 in agglomerations and exceeding daily limit values to get an overview of the general exposure of the country's urban population, whereas the GGI 14 focuses on aspects with regard to population weighted concentrations.

Table 2. 12. Mapping of UNECE and OECD dataflows on air pollution and ozone depletion

	Topic	Indicator and dataflows	Unit of measurement
SEIS dataflows	Ambient Air quality in urban areas (A2)	Annual average concentration of particulate matter (PM_{10}) PM_{10} - Number of days with exceeded daily limit value Annual average concentration of ground-level ozone (O_3) O_3 - Number of days with exceeded daily limit value	µg/m^3 Number of days
GGI	Environmentally induced health problems & related costs (14)	Urban-population weighted $PM_{2.5}$ and PM_{10} levels in residential areas of cities (>100 000) Population weighted concentration of ozone to which the urban population is potentially exposed	Percentage of population; µg/m^3 µg/m^3 per day

Source: Extract from OECD et al. (2015).

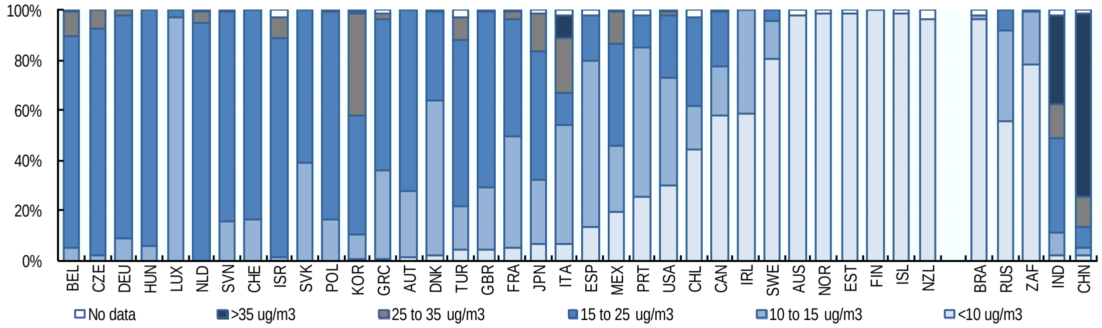
Box 2.22. Trends in air quality in OECD countries

Over the past two decades, urban air quality in OECD countries has continued to improve slowly with respect to sulphur dioxide (SO_2) concentrations, and the estimated average annual exposure level of an average urban resident to PM_{10} has been decreasing. This progress is due to, among other factors, switching from coal to natural gas for electricity generation and improvement in the performance of pollution abatement equipment at industrial facilities, which has reduced PM_{10} emissions.

But acute ground-level ozone pollution episodes in both urban and rural areas, NO_2 concentrations, $PM_{2.5}$ and toxic air pollutants have often exceeded recommended limits and are of growing concern. These exceedances are largely due to the concentration of pollution sources in urban areas and to increasing use of private vehicles for urban trips. Exposure to ambient ozone concentrations increased in the EU between 2000 and 2011 by 1.7% per year on average, with considerable temporal and spatial variation across cities.

Figure 2.14. Population exposed to air pollution by fine particulates (PM2.5) by WHO thresholds

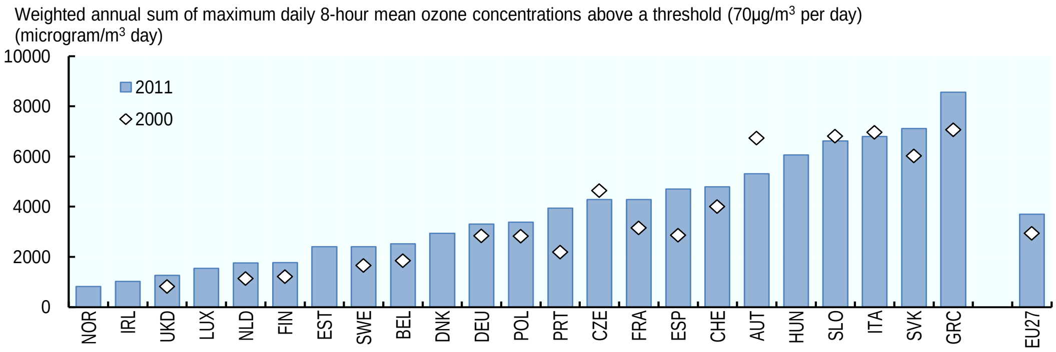
OECD and BRIICS countries, 2001-06 average, share of population



Source: OECD (2014a), Green Growth Indicators 2014, OECD Publishing, Paris, using OECD (2011), Regions at a Glance 2011; [http://dx.doi.org/10.1787/888932925635.](http://dx.doi.org/10.1787/888932925635)

Figure 2.15. Population exposed to air pollution by ozone

selected European countries, 2000 and 2011



Notes: Population exposure to pollution by ozone: weighted yearly sum of maximum daily 8-hour mean ozone concentrations above a threshold (70 micrograms per m^3) at urban background stations in agglomerations. Based on EEA calculations.

Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using European Environment Agency; Eurostat, Sustainable Development Indicators (database); [http://dx.doi.org/10.1787/888932925673.](http://dx.doi.org/10.1787/888932925673)

DATA SOURCES AND AVAILABILITY

Data on population exposure to air pollution are scattered. Internationally comparable measures can be derived from satellite-based measurements. These can be less precise than ground-based measurements, but have the advantage of being available for the large areas of the globe that still lack air monitoring stations. They measure $PM_{2.5}$ originating from both natural and human sources. Country aggregates of urban-population-weighted PM_{10} concentrations are available from the World Bank[34] for all EaP countries. They are annual means that may deviate from actual daily and seasonal data. The data come either from primary sources or from municipal monitoring stations. Monitoring techniques, sampling frequencies and the location of monitoring stations vary by country and over time.

[34] http://data.worldbank.org/indicator/

At the same time, data from national ground-based measurements of $PM_{2.5}$, PM_{10} and O_3 are available for all EaP countries, following the standards of the UNECE environmental indicators[35]. For the ground-based measurement, dataflows are collected from an air quality-monitoring network incorporating fixed manual or automated monitoring stations, which may be complemented by mobile stations.

Moreover, the Global Burden of Disease (GBD) study thoroughly covers a number of issues related to environmentally induced health problems. Country profiles for all EaP countries are available at the website of the Institute for Health Metrics and Evaluation (IHME)[36].

The World Bank gathers information on air pollution in EaP countries up to 2013, including on PM2.5 (as mean annual exposure or as share of the population exposed to levels exceeding WHO guideline value).

2.4.2 Environmental services and amenities - access to sewage treatment and drinking water

POLICY CONTEXT

Water quality, which is closely linked to water quantity, is of economic, environmental and social importance. It has many aspects (physical, chemical, microbial, biological), and can be defined in terms of a water body's suitability for various uses, such as drinking water supply, swimming and protection of aquatic life. If pressure from human activities becomes so intense that water quality is impaired to the point that drinking water requires ever more advanced and costly treatment, or that aquatic plant and animal species in rivers and lakes are greatly reduced, then the sustainability of water resource use is in question. Poor quality water affects people's health and well-being, and can be a cost factor for economic activities.

Progress towards green growth can be assessed against domestic objectives and international commitments. It can also be assessed against changes in the share of the population that has access to safe drinking water and appropriate sanitation and sewage treatment services, and changes in the health status of the population.

[35] http://www.unece.org/index.php?id=38894
[36] http://www.healthdata.org/results/country-profiles

Box 2.23. The Sustainable Development Goals

The Sustainable Development Goals (SDGs) were agreed on 25 September 2015 at a summit of world leaders in New York. The 17 goals, encompassing 169 targets, provide an agenda for: ending extreme poverty, ensuring environmental sustainability and achieving well-being for all. They are universal, and will apply equally to OECD members and to other countries. The SDGs replace the Millennium Development Goals (MDGs), which in September 2000 rallied the world around a common 15-year agenda to tackle the indignity of poverty.

Countries will be responsible for setting national targets that are consistent with the overall ambitions of the goals, and for monitoring progress through indicators. The international community, including the OECD, will need to adapt its work to support countries in implementing the SDGs.

An Inter-agency Expert Group on SDG Indicators (IAEG-SDGs) was established with the task to develop an indicator framework for the goals and targets of the post-2015 development agenda at the global level, and to support its implementation. It is expected that an agreement on an indicator framework will be reached in the course of 2016.

Monitoring progress in terms of the SDGs requires reliable, timely and comparable data from both traditional and new sources, regular updates, and continuity in measurement. Countries will need to improve their statistical capacity and monitoring systems, at a time when many also have to cope with economic challenges and tight budgets. The SDGs provide a good opportunity for strengthening their efforts to advance the measurement agenda for green growth and for environmental indicators.

Several of the proposed indicators currently under discussion are the same as or similar to those produced and used by the OECD. These include indicators on development aid and education, as well as a few environmental and green growth indicators, and agri-environmental indicators.

It is recommended that the respective indicators listed in this document that have so far been measured in accordance with the MDGs, if selected for the national set of GGIs, are defined and measured according the SDG indicator framework developed by the IAEG-SDGs. Once the list of global SDG indicators has been adopted at UN level, a detailed mapping and comparison of indicators will be carried out by OECD.

DEFINITION AND CALCULATION OF INDICATORS

- **Public access to sewage treatment services (16.1)** shows the percentage of the national resident population that is connected to a wastewater treatment plant and to sewerage.

The indicator reflects the level of service provided to the inhabitants. Individual private treatment facilities such as septic tanks are not covered. Ideally data should be related to an estimated optimal connection rate taking into account economic and environmental aspects.

The extent of secondary (biological) and/or tertiary (chemical) treatment provides an indication of efforts to reduce pollution loads. Primary treatment refers to a physical and/or chemical process involving settlement of suspended solids, or other process in which the BOD_5 (the amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter) of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids are reduced by at least 50%. Secondary treatment refers to a process generally involving biological treatment with a secondary settlement or other process, resulting in reductions in biochemical oxygen demand of at least 70% and chemical oxygen demand of at least 75%. Tertiary treatment refers to treatment of nitrogen and/or phosphorus and/or any other pollutant affecting the quality or a specific use of water: microbiological pollution, colour, *etc.*

- **Population with sustainable access to safe drinking water (16.2),** as measured by the Millennium Development Goals (MDG) and the Sustainable Development Goals (SDG) indicators (Box 2.23);

The GGI on ***Population with sustainable access to safe drinking water*** is defined according to the MDGs. In the MDGs "access to safe drinking water" is defined as the proportion of people using improved drinking water sources: household connection; public standpipe; borehole; protected dug well; protected spring; rainwater. The MDG on water was reaffirmed in the SDG goal 6 "Ensure access to water and sanitation for all".

- **Public access to basic sanitation**, expressed as the percentage of the national resident population that has access to improved sanitation facilities, as measured by the MDGs.

The indicator ***Public access to basic sanitation*** relates to population with access to facilities that hygienically separate human excreta from human waste. Improved facilities include flush/pour-flush toilets or latrines connected to a sewer, septic tank or septic pit, ventilated improved pit latrines, pit latrines with a slab or platform of any material which covers the pit entirely, except for the drop hole, and composting toilets/latrines.

Box 2.24. Calculating GGI "Access to sewage treatment and drinking water" based on SEIS dataflows

Population connected to sewage treatment services

Both SEIS dataflows on the *Population connected to wastewater treatment (EI C14)* and the GGI *Population connected to sewage treatment (16.1)* show the degree of a country's population connected to facilities for the physical and/or chemical reduction of biochemical oxygen demand (BOD) and suspended solids in wastewaters. Both dataflows are to be categorised in primary, secondary, and tertiary treatment. The data on the share of the population not connected to a sewerage network, which are required by the GGI, can be easily calculated based on UNECE dataflows by abstracting the population connected to a wastewater collecting system from the total population of a given country.

The same units of measurement are used for the EI and GGI: total numbers of the population connected are to be provided in millions, and the shares of the population connected in the total population are expressed as a percentage.

Population with sustainable access to safe drinking water

SEIS dataflows on *Drinking water quality (EI C9)* is partially suitable to produce the GGI *Population with sustainable access to safe drinking water (16.2)*. For the EI C9, the population connected to the water supply industry, and the population using untreated surface water and groundwater is measured. The respective data should be estimated based on numbers from the water supply industry and from national public authorities. At the same time, the OECD defines its GGI 16.2 according to the Millennium Development Goals (MDGs). To this end, the categorisation of drinking water sources is more detailed in the GGI 16.2 than in the EI C9. For both indicators, the same units of measurement are to be used: the population connected to different sources of drinking water is expressed in millions of people or as a percentage of the total population.

Table 2.13. Mapping of UNECE and OECD dataflows on sewage treatment and drinking water

	Topic	*Indicator and dataflows*	*Unit of measurement*
SEIS dataflows	Population connected to wastewater treatment (C14)	Population connected to wastewater treatment facilities (by categories: primary, secondary, tertiary treatment) Population connected to a wastewater collecting system	Million Percentage of total population
GGI	Population connected to sewage treatment (16.1)	Population connected to sewage treatment plants (by level of treatment: primary, secondary, tertiary treatment)	Percentage of total population
SEIS dataflows	Drinking water quality (C9)	Population connected to water supply industry Population using untreated surface water Population using untreated groundwater	Million Percentage of total population
GGI	Population with sustainable access to safe drinking water (16.2)	Population with sustainable access to safe drinking water - proportion of people using household connection; public standpipe; borehole; protected dug well; protected spring; rainwater.	Percentage of total population

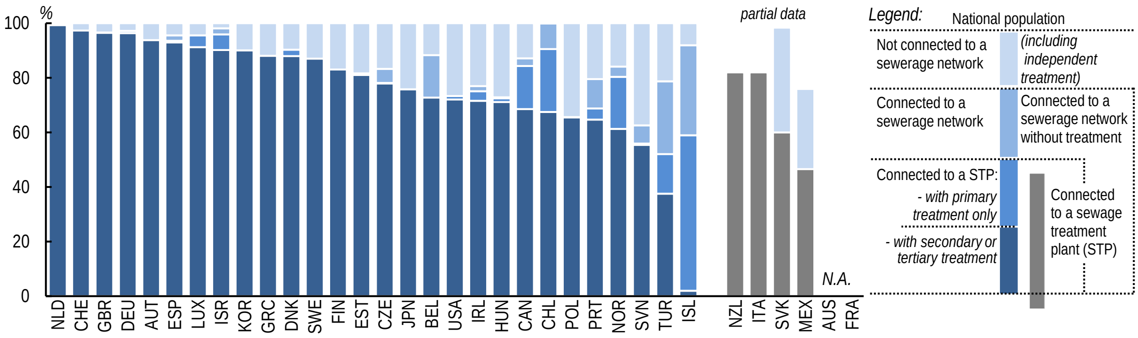
Source: Extract from OECD et al. (2015).

Box 2.25. Trends in access to sewage treatment in OECD countries

OECD countries have progressed with basic domestic water pollution abatement: the share of the population connected to a municipal waste water treatment plant rose from about 60% in the early 1990s to over 75% today. Due to varying settlement patterns, economic and environmental conditions, starting dates, and the rate at which the work was done, the share of population connected to waste water treatment plants and the level of treatment vary significantly among OECD countries. Some countries have reached the economic limit in terms of sewerage connection and must find other ways of serving small, isolated settlements.

Figure 2.16. Population of OECD countries connected to a wastewater treatment plant

2011 or latest year available



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using *UN Water, Key Water Indicators (database);* OECD (2014a), http://dx.doi.org/10.1787/888932925692

DATA SOURCES AND AVAILABILITY

Data on the share of the population connected to sewage treatment plants are available for all EaP countries in the UNSD database[37], though the data are not always up to date and information on the level of treatment remains partial.

At the same time, the EaP countries monitor drinking water quality regularly. However, the number of samples of drinking water taken varies considerably between the countries. The WHO/United Nations Children's Fund (UNICEF) Joint Monitoring Programme (JMP) for Water Supply and Sanitation[38] publishes current estimates on the share of population using different sources of drinking water and on the percentage of the national population with access to improved sanitation facilities all EaP countries.

2.5 Economic opportunities and policy responses

Governments play a key role in fostering green growth by creating conditions that stimulate greener production and consumption through economic and other policy instruments, by encouraging co-operation and sharing of good practices among enterprises, by developing and promoting use of new technology and innovation, and by increasing policy coherence. The main challenge is to harness environmental protection as a source of growth, international competitiveness, trade and jobs.

Businesses have an important role in adopting greener management approaches and new business models, developing and using new technologies, carrying out research and development (R&D) and

[37] http://unstats.un.org/unsd/ENVIRONMENT/wastewater.htm
[38] http://www.wssinfo.org/documents/?tx_displaycontroller[type]=country_files

spurring innovation. Business, government and civil society also contribute by giving consumers with the information needed to make purchasing choices that reduce the environmental impact of consumption.

The main issues of importance to green growth dealt within this section are:

- **Technology and innovation**, which are important drivers of growth and productivity in general, and of green growth in particular. They are important for managing natural resources and raw materials and minimising the pollution burden. Innovation can spur new markets, contribute to job creation, support shifts towards new management methods and facilitate the adoption of co-operative approaches and the diffusion of knowledge.

- **Production of environmental goods and services**, which are an important aspect of the economic opportunities that arise in a greener economy.

- **International financial flows** to facilitate uptake and dissemination of technology and knowledge, foster cross-country exchange of knowledge and contribute to meeting development and environmental objectives.

- **Prices, taxes and transfers**, which provide important signals to producers and consumers. They serve as tools to internalise externalities and influence market participants to adopt more environment-friendly behaviour patterns.

Ideally, these indicators should be complemented by indicators on **regulation and training and skill development**. However, data availability and comparability of regulatory measures across countries hamper the construction of such indicators. Those indicators will yet have to be developed in the future. Moreover, the set contains indicators on **International financial flows**, which would have to be reformulated to be relevant to national contexts in EaP countries.

Table 2.14. Economic opportunities and policy responses - proposed indicators

Proposed indicators

Theme	Proposed indicators	Type	Measurability
Technology and innovation	Research and development (R&D) expenditure of importance to green growth	M	M
	- Renewable energy sources (% of energy-related R&D)		S
	- Environmental technology (% of total R&D, by type)		S
	- All-purpose business R&D (% of total R&D)		S
	Patents of importance to green growth (% of country applications under the Patent Cooperation Treaty)	M	S/M
	- Environment-related and all-purpose patents		S/M
	- Structure of environment-related patents		S/M
	Environment-related innovation in all sectors	M	M
Environmental goods and services	Production of environmental goods and services (EGS)	M	M
	Gross value added in the EGS sector (% of GDP)		M
	Employment in the EGS sector (% of total employment)		M
International financial flows	International financial flows of importance to green growth % of total flows and % of GNI	M	L
	Official development assistance		S
	Carbon market financing		S
	Foreign direct investment		L
Prices and transfers	Environmentally related taxation	M	S/M
	- Level of environmentally related tax revenue (% of total tax revenues and in relation to labour-related taxes)		
	- Structure of environmentally related taxes (by type of tax base)		S/M
	Energy pricing (share of taxes in end-use prices)	M	S
	Water pricing and cost recovery (tbd)	M	S/M
	To be complemented with indicators on:		
	Environmentally related subsidies		M/L
	Environmentally related expenditure: level and structure		L
Regulations and management approaches	Indicators to be developed		..
Training and skill development	Indicators to be developed		..

Type: M = Main indicators
P = Proxy indicators when the main indicators are not available

Measurability (M): S = short term, M = medium term, L = long term

See Annex for a complete list of indicators.

Source: Extract from OECD (2014a).

2.5.1 Technology and innovation

POLICY CONTEXT

Technology development and innovation are key drivers of economic growth and productivity. They are important for managing energy and materials successfully and have a bearing on policies intended to preserve natural resources and materials and to minimise the pollution burden.

- Innovation in technology supports the move towards more integrated approaches to material production and management. Much technology associated with energy use, such as “clean” technology and information and communications technology (ICT), results in reduced emissions.

- Innovation in education and governance is important to support shifts towards new management methods and greater transparency in decision making. It also facilitates the adoption of co-operative approaches and partnerships, and the diffusion of knowledge.

While technology and innovation have a huge potential, new technology can also generate additional environmental pressures or strain material availability. It often involves new or substitute materials whose consequences may not yet be known. The same applies to the development and marketing of new products that affect air pollution, chemical safety, recyclability and waste disposal.

Progress towards green growth can be assessed against governments’ actions to spur innovation and technology change in terms of R&D and intellectual property support, and against technology development and system innovation in the business sector.

CALCULATION OF THE INDICATORS

- **Research and development (R&D) expenditure of importance to green growth (17)**. The data refer to government appropriations or outlays for R&D (GBAORD) and to business expenditure on R&D, expressed as percentages of all R&D expenditure.

These are defined on the basis of the primary purpose of the funder and include control and care for the environment as well as energy. The selection can be based on the socio-economic objectives “energy” and “environment” in the NABS 2007 classification (Nomenclature for the Analysis and Comparison of Scientific Budgets and Programmes). Additional information on the methodology for internationally harmonised collection and use of R&D statistics can be found in the Frascati Manual (OECD 2002).

R&D budgets for control and care for the environment include research on the control of pollution and on developing monitoring facilities to measure, eliminate and prevent pollution. Energy R&D budgets include research on the production, storage, transport, distribution and rational use of all forms of energy, but exclude research on prospecting and on vehicle and engine propulsion. The notion of which technologies are considered “environmental” evolves over time, as it tries to reflect the public consensus on the comparative usefulness of different technologies in reducing environmental impact.

- Patents of importance to green growth (18)

The indicator ***Patents of importance to green growth (18)*** refers to patent applications filed under the Patent Cooperation Treaty (PCT) related to certain technologies listed below, using inventor's residence and application date. Patents in environmental technologies are identified using refined search strategies based on the International Patent Classification (IPC) and the detailed European Classification System (ECLA). The following technology fields should be considered:

- energy generation and efficiency, including renewables-based energy generation, energy generation from fuels of non-fossil origin, insulation, heating and lightning

- transport, including internal combustion engines, electric motors, hybrid propulsion and fuel efficiency

- environmental management, including air pollution abatement, water pollution abatement, waste management, soil remediation and environmental monitoring

- technology with potential for emission mitigation, including for improved output efficiency and for improved input efficiency (both relating to combustion technology with mitigation potential), as well as technology specific to climate change mitigation and with potential or indirect contribution to emission mitigation.

Data on patent applications under the PCT are based on inventors' addresses, but the inventor may live in one country while the patent is owned by an enterprise headquartered in another country.

For more information on measuring environmental innovation using patent data please refer to Haščič and Migotto (2015).

- **Environment-related innovation in all sectors (19)** can be captured by the share of firms with procedures in place to identify and reduce environmental impacts, expressed in terms of all innovating firms across all sectors.

Environment-related innovation in all sectors (19) is difficult to capture with measured indicators. For OECD (2014a), the latest information from the EU Community Innovation Survey is used to give a snapshot of possible indicators of environmentally related innovation.

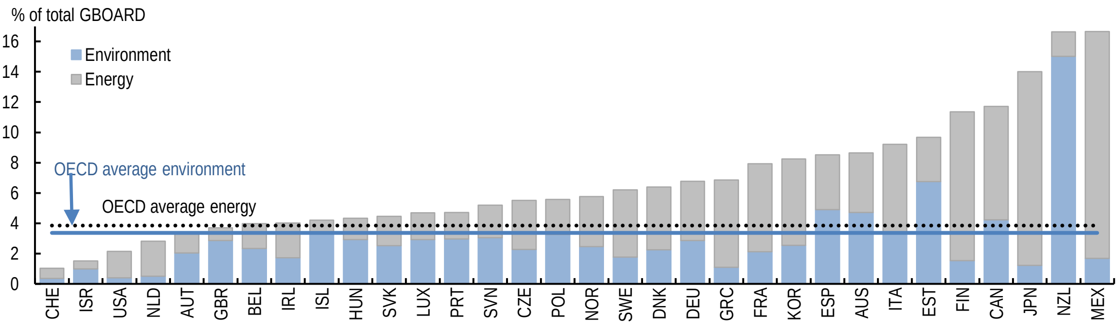
Box 2.26. Trends in research and development (R&D) expenditure in OECD countries

Public R&D spending in OECD countries has slightly decreased since 1990, but the amount dedicated to environment and energy efficiency has increased.

Data on government budget appropriations or outlays for R&D (GBAORD) show the public resources that economies invest in research on energy and the environment. There are large differences among countries as regards government R&D spending on energy and on environment. In absolute terms, Japan, the United States and Germany are the largest funders, while Mexico, New Zealand, Canada and Japan are top investors in relative terms. With few exceptions, energy related R&D accounts for the vast majority of the spending. Compared to the 2002 most economies have increased the percentage of GBAORD going to energy and environment-related programmes.

Figure 2.17. Government R&D budget related to energy and environment

OECD countries, 2008-2012 average



Source: OECD (2014) Green growth indicators. http://dx.doi.org/10.1787/888932925711

DATA SOURCES AND AVAILABILITY

Data on government R&D expenditure are available for all EaP countries in the databases of the United Nations Educational, Scientific and Cultural Organization (UNESCO)[39], though the coverage of national surveys and the sampling and estimation methods used may vary and data are not always up to date. This information has been complied in the World Bank database[40]. The IEA collects and publishes related data on government support for energy demonstration projects, typically referred to as RD&D[41].

Data on patent applications are available in the statistics database of the World Intellectual Property Organization (WIPO)[42].

The data availability in terms of environment-related innovation may be fragmentary in some countries. Little information is available on non-technological innovation, such as changes in business models, work patterns, city planning or transport arrangements that are also instrumental in driving green growth.

2.5.2 Environmental goods and services

POLICY CONTEXT

Producing environmental goods and services (EGS) generates growth and employment while contributing to greener growth. Examples for EGS are catalytic converters, air filters or consultancy services on wastewater management. The move from end-of-pipe pollution abatement to pollution prevention at source and to integrated pollution and resource management throughout the supply chain, along with new business models, has created new markets for EGS[43]. It has also influenced the structure of the EGS sector by increasing the importance of R&D, innovation, market and product design, environmental consulting and other services.

Progress towards green growth can be assessed by examining the share of the EGS sector in the economy in terms of employment and value added, along with conditions for doing business and accessing financing. It can also be assessed against transformation in economic sectors and shifts from traditional business activities to greener activities.

DEFINITION AND CALCULATION OF INDICATORS

- Gross value added in the environmental good and services (EGS) sector (20) is expressed as a percentage of the GDP;

The scope of the indicator ***Gross value added in the EGS sector*** should be defined according to the classification of environmental protection activities (CEPA) and the classification of resource management activities (CREMA).

Despite existing definitions, setting the boundaries of the EGS sector remains difficult as does measurement and interpretation. Eurostat (2009) defines the sector as comprising activities to measure, control, restore, prevent, treat, minimise, research and sensitise regarding environmental damage to air, water and soil, resource depletion and problems related to waste, noise, biodiversity and landscapes. The definition includes cleaner technologies, goods and services that prevent or minimise pollution and

[39] http://data.uis.unesco.org/?queryid=74
[40] http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS

[41] Statistics on public energy-related RD&D spending in OECD member countries are not available for all years or all technologies. Most of the available statistics focus on public RD&D; by definition, this fails to capture private sector efforts.
[42] http://ipstats.wipo.int/ipstatv2/
[43] http://www.oecd.org/tad/envtrade/tradethatbenefitstheenvironmentanddevelopmentopeningmarketsforenvironmentalgoodsandservices.htm

resource-efficient technologies, goods and services that minimise natural resource use. At the same time, some studies have tried to capture the broader aspect of green activities. From a green growth point of view, there is good reason to measure activities with environmental benefits outside the EGS sector as internationally defined. Examples include water supply, ecotourism, energy and resource savings from information technology, and activities related to natural hazards and risk management intended to prevent or reduce the impact of disasters on human health (included in an earlier OECD/Eurostat definition) (OECD 2012a, Nordic Co-operation 2012).

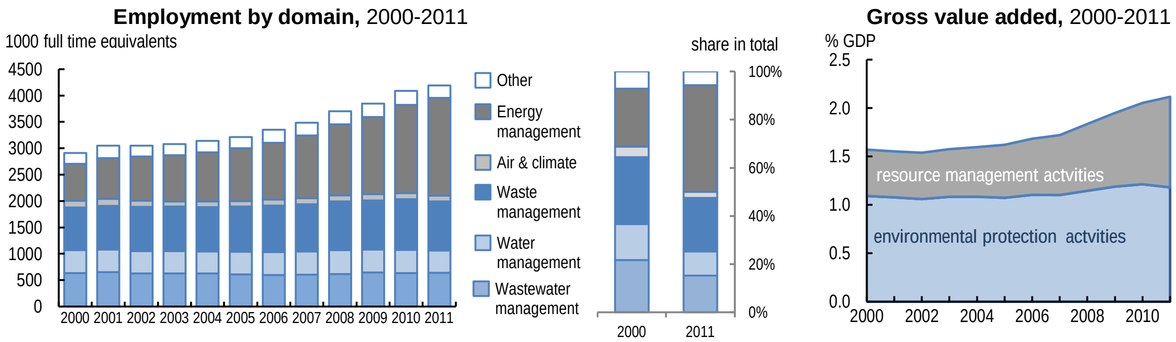
- **Employment in the EGS sector** and in selected environmental protection activities **(20)** is expressed as a percentage of all employment in various sectors such as recycling (ISIC 37); water collection, purification and distribution (ISIC 41); and sewage and refuse disposal, sanitation and similar activities (ISIC 90).

The indicator ***Employment in the EGS sector*** consists of two dimensions. Firstly, the employment in the environmental products sector, for selected countries and selected sectors, is expressed as a percentage of the total employment. Secondly, the employment in environmental protection and resource management activities is measured by the full-time equivalent employment engaged in the production of the environmental output. The full-time equivalent is the number of full-time equivalent jobs, defined as total hours worked divided by average annual hours worked in full-time jobs.

Box 2.27. Trends in the environmental goods and services sector in the European Union

In the European Union, the contribution of the EGS sector to GDP in terms of gross value added is estimated to have grown from 1.6% in 2000 to about 2.0% in 2011; this is a conservative estimate since not all resource management activities are covered. Employment in environmental protection activities and in water and energy management is estimated to represent more than 4 million full time equivalents, an increase of about 44% since 2000. The driver for this increase is the growing importance of energy related activities, in particular the production of energy from renewable sources and equipment and installations for heat and energy savings.

Figure 2.18. The environmental goods and services sector in the European Union



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using STAN: OECD *Structural Analysis Statistics* (database); Eurostat; http://dx.doi.org/10.1787/888932925787

DATA SOURCES AND AVAILABILITY

When interpreting these indicators, it should be kept in mind that the scope of EGS as defined in the context of trade negotiations is not the same as the scope defined to analyse the domestic EGS sector. Interpretation thus depends on how “green industries” are defined (for more information see OECD 2014, p 121, OECD 2012a, Nordic Co-operation (2012)).

Environmental goods and services include specific services, connected products and adapted goods, but their definition and measurement scope varies across and within countries. Further efforts are needed to generate internationally comparable data on EGS (turn-over, value added, exports, employment, etc.) in accordance with the recommendations of the SEEA Framework.

Most indicators used to describe entrepreneurial performance are not available at the level of detail required to capture activities characterised as ‘green’. For OECD (2014a), data on the environmental goods and services sector in the EU result from a data collection carried out by Eurostat in 2009, 2011 and 2013, and include estimates.

2.5.3 Prices and transfers

POLICY CONTEXT

Prices and financial transfers (taxes, subsidies) provide important market signals that influence the behaviour of producers and consumers. Along with regulations, they can be used to address the environmental externalities of economic activity and to leverage more environment-friendly production and consumption patterns.

Environmentally related taxes are an important instrument for governments to shape relative prices. In the case of energy, changes in relative price affect substitution between various types of energy input and between energy and other production inputs. The level of taxation of energy relative to that of labour can influence the relative price of inputs, affect labour demand and stimulate the use of energy from cleaner sources. Energy end-use prices influence overall energy demand and their composition influences the fuel mix, which in turn determines environmental pressures caused by energy activities.

Environmentally related subsidies, if properly targeted and phased out when necessary, can be used to counteract distributional effects of policies or to leverage consumer behaviour and corporate investment towards cleaner options. Budgetary support to environmentally harmful consumption or production, by contrast, does not meet the criteria of effective subsidisation. Reforming or eliminating support to environmentally harmful products or activities can contribute to tackling pressing environmental problems while improving economic and fiscal outcomes.

Progress towards green growth can be assessed against the evolution of tax structures, price signals and producer and consumer support mechanisms.

DEFINITION AND CALCULATION OF INDICATORS

- **Environmentally related taxation (22)** can be expressed in percentage of the GDP and percentage of the total tax revenue, and can be compared to labour tax revenue in percentage of GDP and percentage of total tax revenue.

Environmentally related taxes include taxes on energy products (for transport and stationary purposes, including electricity, petrol, diesel and fossil fuels), motor vehicles and transport (one-off import or sales taxes, recurrent taxes on registration or road use, other transport taxes), waste management (final disposal, packaging, other waste-related product taxes), ozone-depleting substances and other environmentally related taxes. The structure of the tax base may be provided as a complement.

- **Energy pricing (23),** expressed as the share of taxes in end-use prices of energy for both industry and households.

- **Government support in the agriculture sector** by type of support as defined in the OECD framework for producer and consumer support estimates, and expressed as percentages of total support estimates and in USD;

The indicator ***Government support in the agriculture sector*** can be provided as the theoretically more environmentally harmful and the more environmentally favourable agricultural support. The more environmentally harmful support refers to the share of payments based on output and input use in terms of total producer support estimates (% PSE). Payments based on output refer to transfers from taxpayers to agricultural producers from policy measures based on current output of a specific agricultural commodity.[44] Payments based on input refer to transfers from taxpayers to agricultural producers arising from policy measures based on on-farm use of inputs; to transfers reducing the on-farm cost of a specific variable input or a mix of variable inputs; to transfers reducing the on-farm investment cost of farm buildings, equipment, plantations, irrigation, drainage and soil improvement; and to transfers reducing the cost of technical, accounting, commercial, sanitary and phyto-sanitary assistance, and training provided to individual farmers.

The indicator of theoretically more environmentally favourable agricultural support refers to the share of payments based on non-commodity criteria (% PSE), which refer to transfers for the long-term retirement of factors of production from commodity production; to transfers for the use of farm resources to produce specific non-commodity outputs of goods and services, which are not required by regulations; and to other non-commodity criteria.

- Road fuel taxes and prices.

Road fuel taxes and prices for diesel and unleaded petrol should be reported in USD at current prices and exchange rates.

These indicators could be complemented with indicators reflecting **Water pricing and cost recovery (24),** environmentally related subsidies and the level and the structure of environmentally related expenditure. Those indicators yet have to be further developed.

[44] Further reading on the PSE methodology is available at the OECD Producer Support Estimate web page: www.oecd.org/agriculture/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

Box 2.28. Trends in environmentally related tax revenue in OECD countries

The use of environmentally related taxes is growing but remains limited in many countries. The revenue they raise represents about 2% of GDP in OECD countries. The share has decreased slightly over the past decade, in part due to rising international fuel prices that triggered substitution away from motor vehicle fuels, some of the most heavily taxed products in the economy. It has to be kept in mind, however, that a tax can have an impact on the environment without raising much revenue; from an environmental perspective, one would like to see the tax bases in question being significantly reduced.

In the OECD area, the structure of environmentally related tax revenue is dominated by taxes on motor vehicles and transport (28%) and on energy products, including motor vehicle fuels (69%). Other environmentally related taxes, such as those on waste and water management and on hazardous chemicals – for which the price elasticities in many cases are larger than for energy and vehicles – represent a relatively low share in current tax revenue (3%).

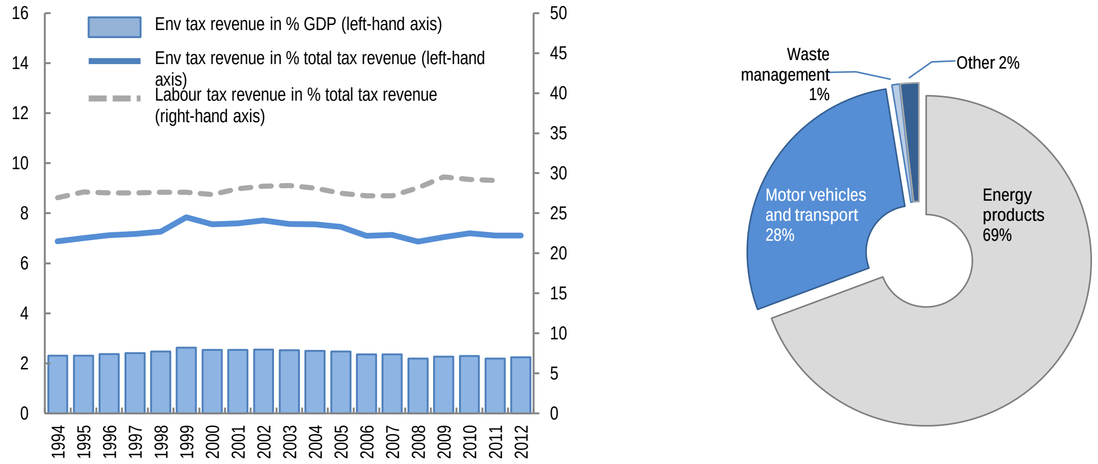
Figure 2.19. Environmentally related tax revenue

As a share of GDP and of total tax revenue

OECD, 1994-2012

By tax base

OECD, 2012



Source: OECD (2014a), *Green Growth Indicators 2014*, OECD Publishing, Paris, using OECD Tax Statistics (database); OECD-EEA, Database on Instruments Used for Environmental Policy. http://dx.doi.org/10.1787/888932925825

DATA SOURCES AND AVAILABILITY

Information on environmentally related taxes is available for OECD countries and some other countries from the OECD database on instruments used for environmental policy and natural resource management[45]. The data are more complete for taxes; further efforts are needed to cover other instruments, such as fees and charges, tradable permits, deposit refund systems and environmentally motivated subsidies.

Information on energy prices and taxes is available only for OECD countries from the IEA. Data availability for EaP countries may be fragmentary. Deregulation of energy markets has led to an exponential increase in the number of market players and to more and more difficulties in collecting price data on an equivalent basis.

[45] http://www2.oecd.org/ecoinst/queries/Query_2.aspx?QryCtx=3

CHAPTER 3: GREEN GROWTH INDICATORS IN PRACTICE

Since 2011, governments increasingly have used the OECD green growth measurement framework to develop their own indicators and to assess progress towards a green transformation of their economy. This goes beyond the OECD member countries: of the 23 national initiatives described in a recent report (OECD 2014a), 15 involve emerging or developing economies. This chapter presents lessons learned in different countries.

3.1 Application by the OECD

Internationally, the OECD has issued two reports (OECD 2011a and 2014a) so far that reflect progress on green growth in its member countries and several other economies. Such reports will be published regularly. As a complementary tool, a database[46] containing selected GGIs has been established, covering 46 countries (OECD and G20 countries).

GGIs are regularly being integrated into relevant country-specific OECD work on the environment and the economy. For example, green growth considerations are being built into national policy surveillance, such as Economic Surveys, Environmental Performance Reviews (EPR), Investment Policy Reviews, Innovation Reviews and the Green Cities programme. Two areas where GGIs are figuring prominently are in the OECD's work on environment and on the economy.

For over a decade, OECD Economic Surveys have included analysis of policies with environmental dimensions and recommendations to enhance policy integration. In a first phase, there was the practice of developing chapters dedicated to sustainable development or specific environmental challenges. Since 2010, the development of chapters related to green growth has become more systematic over time and across member countries. The Economic Surveys of several countries, e.g. Denmark, Norway, Poland, Sweden, and the United States have addressed environmental issues more regularly than others. Some countries never had any environment or sustainable development related chapter in their Economic Surveys (e.g. Greece, Portugal, Estonia, and Slovenia) but integrated these topics within the main recommendations. Issuing the OECD GGIs-based report regularly can help keeping the buy-in for such integration and for GGI work at the country level.

As the indicators are further developed and their linkages with economic and environmental outcomes are better explored, they can serve for mainstreaming green growth considerations into the OECD Going for Growth[47] project. Going for Growth uses the OECD's expertise on structural policy reforms and economic performance to provide recommendations on reform areas that have been identified as priorities for achieving sustained growth. It examines among others the potential side effects of growth-enhancing measures on such aspects of well-being as income distribution and the environmental quality of life.

The OECD's EPRs have been restructured to place a greater emphasis on green growth and the use of related indicators. These indicators complement and reinforce the OECD core set of EIs. In all third-cycle EPRs, a first chapter uses the green growth measurement framework to present a snap-shot of the reviewed countries' progress in *(i)* transition to a low-carbon, resource-efficient economy, *(ii)* managing the natural asset base, and *(iii)* improving the environmental quality of life. The UNECEs EPRs also strengthen the position of the green growth development. Therefore a part of the reports analyses how the policies in the various economic sectors could be directed towards greening the economy. The most important sectors in this context are agriculture, including fishery and forestry, energy, industry and transport. Consumption

[46] http://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH
[47] http://www.oecd.org/eco/growth/goingforgrowth.htm

patterns are another component to be assessed. Issues such as economic instruments, environmental expenditures, costs of action and of inaction and eco- innovation have to be looked at as well.[48]

3.2 Application in the OECD countries

The practical application of the OECD-suggested set of GGIs started in the member states even prior to the official launch of this set: in April 2011, the Netherlands issued its first report of this kind. Very soon, the Czech Republic followed this initiative. Today, the Netherlands, the Czech Republic, Germany, Denmark, Slovenia, the Slovak Republic and the Republic of Korea have produced GGIs-based reports.

Table 3.1. Comparative analysis of GGIs application

The Netherlands, the Czech Republic, Germany, Denmark, Slovenia and the Slovak Republic

Country	Number of indicators	Grouping	Additional indicators	Comparison with targets	International comparison	Dashboard use
Netherlands	20 (2011) 33 (2012) 36 (2015)	Adjusted[49]	Yes	Some	Yes	Yes
The Czech Republic	27 (2011) 27 (2013)	Identical	Yes	Yes	Yes	Yes
Germany	27 (2012)	Identical	Yes	Some	Some	No
Denmark	5 (2012)	Adjusted[50]	No	Yes	Yes	No
Slovenia	14 (2014)	Identical	Yes	Yes	Yes	Yes
Slovak Republic	32 (2014)	Identical	No	Yes	Yes	Yes

Source: Compiled by the OECD based on English versions of the country reports

3.2.1 The Netherlands

The first edition of Netherland's indicator-based report contained data and analysis of 20 indicators derived from the preliminary OECD set. They were identified by an inter-ministerial working group under the direction of the Ministry of Infrastructure and Environment, with the participation of the Ministries of Finance and Economic Affairs, Agriculture and Innovation, the Netherlands Environmental Assessment Agency and Statistics Netherlands. In the report's first edition, the indicators were grouped around four main dimensions, following the OECD set of GGIs. The second edition of the report, published in November 2013, contains 33 indicators that are broken down in six themes resulting from the sub-division of two OECD-suggested groups: *(i)* environmental efficiency; *(ii)* resource efficiency; *(iii)* natural asset base; *(iv)* environmental quality of life; *(v)* green policy instruments; and *(vi)* economic opportunities. The latest edition of the report (Statistics Netherlands, 2015) uses the same OECD-suggested groups.

Not all indicators from the OECD list were considered relevant for the Netherlands. For instance, the OECD indicator "access to sewage treatment and sanitation" was judged irrelevant, as (almost) all households have access to these amenities (Statistics Netherlands 2013). Therefore this indicator was

[48] https://www.unece.org/fileadmin/DAM/env/documents/2010/ece/cep/ECE.CEP.2010.8.e.pdf.
[49] Indicator groups: *(i)* environmental efficiency, *(ii)* natural asset base, *(iii)* quality of life, *(iv)* policy responses and economic opportunities.
[50] Indicators groups: *(i)* Denmark's green production, *(ii)* enterprises with green production, *(iii)* Research, development and innovation in enterprises with green production, *(iv)* Danish green goods exports, *(v)* international benchmarking.

omitted in favour of water quality indicators, which do not feature in the OECD set but are highly relevant for the situation in the Netherlands.

Data for the Dutch GGIs originate from several different sources (Statistics Netherlands 2013). Many indicators are derived from the Dutch environmental accounts, which are fully consistent with macro-economic indicators from the national accounts. Other indicators come from a variety of statistics, including environmental statistics, energy statistics, and innovation and technology statistics. A few indicators are obtained from sources outside Statistics Netherlands.

A key aspect of the Dutch reports was the interpretations of trends, which were labelled as positive, neutral, and negative. For example, when the share of renewable energy rises or the waste recycling percentage increases this is scored as “positive”. If the trend is stable, such as a stable exposure to air pollution, the indicator is assessed as “neutral”. If the trend deteriorated since 2000, such as a decline in biodiversity or decrease in energy reserves, the indicator is assessed as “negative”. The scores for environmental and resource efficiency indicators are based on the notion of decoupling. Absolute decoupling has been assigned a positive score; relative decoupling – a neutral score, and a lack of decoupling – a negative score. Also international comparisons were used to come up with low, average or high international ranking. The results of data interpretation are presented in a dashboard using a colour code.

The report takes a ***sectoral perspective*** (Box 3.1.), analysing the evolution of GGIs in the so-called “top sectors” of the Dutch economy. These sectors, including Energy, High Tech Systems and Materials, Agriculture and Food, or Logistics, play a central role for the goal of promoting innovation, job creation and strengthening the Dutch economic competitiveness. The sectoral analysis uses fourteen indicators of green growth, categorised according to green growth themes formulated by the OECD. Data resulting from analysis of top sectors performance is compared with data on non-top sectors and the average of the Dutch economy.

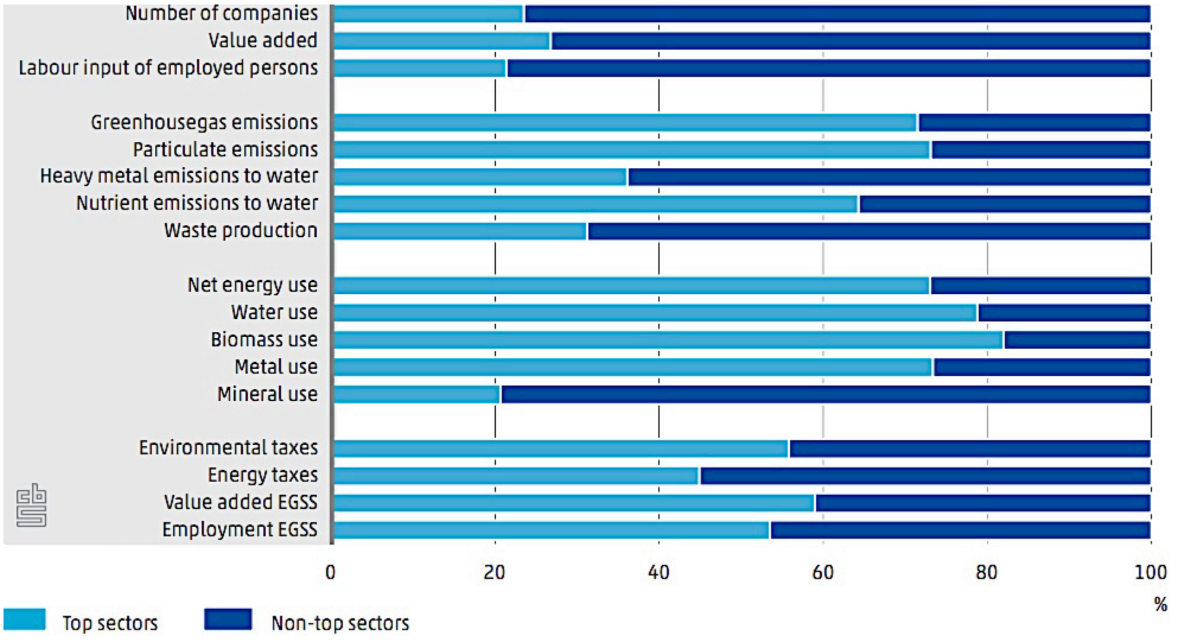
Box 3.1. The sectoral perspective

While all top sectors combined comprise 27% of the value added and 21% of the employment in the Dutch economy, they are also responsible for 70% of all GHG and PM emissions. The second green growth theme (resource efficiency) shows a similar picture: the top sectors use three-quarters of all energy and materials used within the Dutch economy as a whole. The fact that the top sectors share a large proportion of the total environmental pressure can be explained by their composition. The top sectors consist mainly of businesses that are active in the manufacturing, energy, agricultural and transportation sectors. These are all sectors in which the production processes are characterised by relatively high environmental and material intensities.

A striking finding with regard to the third theme (green policy-instruments and economic opportunities) is that the top sectors are taxed relatively less in terms of environmental taxes compared to the Dutch average or other (non-top) sectors. The top sectors therefore experience less financial burden, despite the relatively high level of environmental pollution associated with them. Consequently, the financial cost of this level of pollution is less incorporated within the price. A further finding concerning the third theme is that the production of EGSs is relatively high among the top sectors with respect to the Dutch economy. The contribution of the top sectors to the transition to a green economy, in terms of economic opportunities, is therefore above average.

Figure 3.1. Top sectors and green growth indicators in the Netherlands

Share of top sectors in total economy for macro-economic and green growth indicators, Netherlands, 2010



Source: Statistics Netherlands (2013), Statistics Netherlands (2015).

The 2013 and 2015 editions of the Dutch reports are also a useful example of how analysis of GGIs can be placed in an ***international perspective*** (Box 3.2). The basis for international benchmarking has been the comparison of the position of the Netherlands with the other OECD and EU member states.

Box 3.2. The international perspective

The Netherlands might be dealing less efficiently with resources or pollution control than other countries, incurring higher compensation costs for society and companies and making the Netherlands less competitive. In order to compare performance, the Netherlands have been scored by comparing the value of the indicator for the most recent year with other countries. This was different from scoring trends from a national perspective that was based on assessing change of greening growth over a time period. The position of the Netherlands in the OECD or European ranking is divided by the number of countries for which data are available. For example, if the Netherlands is in 10th place and data are available for 27 countries, the indicator value for the Netherlands is 10/27 = 0.37. The value was then colour-coded with the following boundaries:

(i) Green $0 \leq$ value $\leq 1/3$;

(ii) Yellow $1/3 <$ value $< 2/3$; and

(iii) Red $2/3 \leq$ value ≤ 1.

Countries with the same values for a certain indicator are assigned the same position.

The scores for this international benchmark, however, should be interpreted with care. First of all, the Netherlands might be positioned close to a boundary for some indicator values. A relatively small change in the figures may also result in a different indicator colour and score though (see colour code above). Secondly, there is no internationally comparable data available for certain indicators. Therefore, it is not entirely possible to assess the position of the Netherlands against other countries. Thirdly, the international comparison is based on data from the most recent available year. This is not always the same year for each indicator though this might not result in substantial changes, since the indicators are quite robust and year-on year changes are generally relatively small for the indicators. Finally, indicators that are best harmonised and comparable internationally are not always exactly the most appropriate ones to measure green growth in the Netherlands. However, it is the best one that approximates it.

An important addition to the second edition of the report is an (interactive) infographic site that was developed in 2012 to inform policymakers and the general public on the status of green growth in the Netherlands. This exercise was reiterated in 2015 (table 3.2)[51].

[51] http://www.cbs.nl/NR/rdonlyres/2C613080-F668-439C-B12C-98BF361B5ADF/0/2013p44pub.pdf and http://download.cbs.nl/pdf/green-growth-in-the-netherlands-2015.pdf

Table 3.2. Position of the Netherlands in the OECD and internationally in terms of green growth indicators

				CBS/OECD GG comparison	
Indicator	Time series	Trend in the Netherlands	Position in the OECD or Europe	Score	International score
Environmental efficiency					
Production-based GHG emissions	2000-2014	absolute decoupling	2012: 12 (23); 2008:11(23)		
Consumption-based GHG emissions	2000-2011	no significant change	2009: 20(28)		
Emissions heavy metals to water	2000-2012	absolute decoupling	-		
Nutrient surplus agriculture	2000-2014	absolute decoupling	2012: 20(20); 2004: 23(23)		
Total waste	2000-2012	absolute decoupling	2012: 12(23); 2004: 9(23)		
Resource efficiency					
Groundwater abstraction	2000-2012	absolute decoupling	2012:5(14); 2001: 3 (15)		
Domestic use of biomass	2000-2014	no decoupling	2013: 6(22); 2000:12(21)		
Domestic use of metals	2000-2014	absolute decoupling	2013: 4(22); 2000: 9 (20)		
Domestic use of minerals	2000-2014	absolute decoupling	2013: 1(22); 2000:3(20)		
Net domestic energy use	2000-2013	relative decoupling	2013: 16(34); 2000:14(34)		
Renewable energy	2000-2014	improvement	2013:21(22); 2004: 19(22)		
Raw materials footprint	2000-2012	deterioration	-		
Waste recycling	2000-2012	no significant change	2012: 1(24); 2010: 1(24)		
Natural asset base					
Energy reserves	2000-2014	deterioration	2014: 8(13); 2000: 4(11)		
Stocks of standing timber	2000-2015	improvement	2010: 8(32); 2005: 13(32)		
Stocks of fish	2000-2015	improvement	-		
Land conversion into built-up land	2000-2010	deterioration	2000-2006:18(22)		
Red list indicator	2000-2014	no significant change	2000: 8(18)		
Farmland bids	2000-2014	deterioration	2005: 12(21)		
Biodiversity footprint	2000-2010	improvement	-		
Environmental quality of life					
Urban exposure to particulate matter	2000-2013	improvement	2012: 12(24); 2000: 9(14)		
Chemical quality of surface water	2000-2013	-	2009: 6(21)		
Biological quality of surface water	2000-2013	-	2009: 21(21); 2007: 17(17)		
Concentration of nitrate in groundwater	2000-2012	improvement	-		
Level of concern	2000-2012	improvement	-		
Willingness to pay	2000-2012	deterioration	-		
Green policy instrument					
Share of environmental taxes	2000-2014	deterioration	2013: 3(20); 2000: 2(19)		
Implicit tax rate for energy	2000-2013	improvement	2013: 5(21); 2000: 9(20)		
Share of environmental subsidies	2000-2013	no significant change	-		
Mitigation expenditure by central government	2000-2013	improvement	-		
Environmental costs	2000-2013	no significant change	2011: 4(19); 2000:17(19)		
Economic opportunities					

Employment environmental goods and services sector	2000-2013	improvement	-		
Employment sustainable energy sector	2000-2014	improvement	-		
Value added environmental goods and services sector	2000-2013	improvement	-		
Green patents	2000-2009	improvement	2011: 23(34); 2000:23(34)		
Environmental investments	2000-2013	improvement	2011:7(20); 2000: 9(19)		

1) Some top sectors overlap with respect to certain activities. This could not be taken into account in this graph as no data for this overlap with regard to GGI is available.

To give a better picture of green growth Netherlands in an international context and the notion of comparison, the theme resource efficiency is described in more detail below.

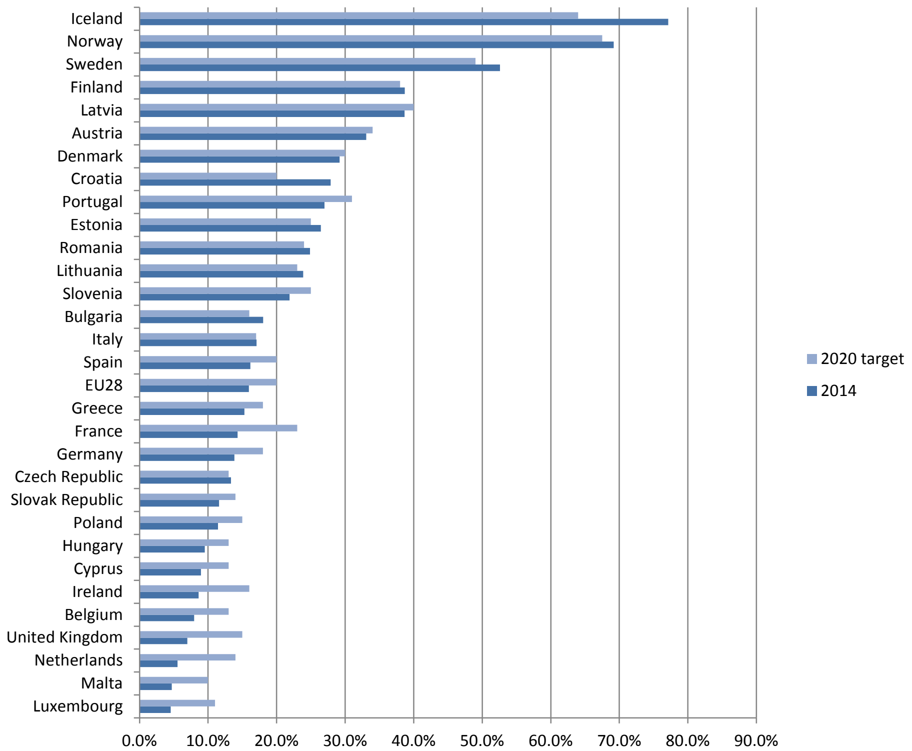
Resource efficiency

All indicators for resource efficiency could be measured internationally. The international position of the Netherlands is rather mixed. The Netherlands scores green for groundwater abstraction (ranking 5 of 14 in 2012) and the use of domestic biomass, metals and minerals per capita is low compared to other OECD countries. Landfilled waste per inhabitant is the lowest in Europe.

The share of renewable energy consumption (table 18) shows a score below average. Although the share of energy from renewable energy sources has increased over the years, up to 5.6% of final energy consumption in 2014, the level still remains well below the European average of 15 %. Norway, Sweden and Finland produce a lot of renewable energy by hydropower and the use of biomass. Denmark also scores relatively high with 23%, due to its extensive application of wind power. The low ranking of the Netherlands can be explained by the lack of fast-moving rivers for generating hydropower, by the low level of government support for renewable energy and by the fact that households are already linked to gas networks for heating (rather than biomass) (Statistics Netherlands, 2015).

Figure 3.2. Share of renewable energy in gross final energy consumption

Selected countries, 2013



Note: 2013 data used in Statistics Netherlands (2015)

Source: Eurostat (2016) SHARES 2014. Accessed on 10 August 2016, http://ec.europa.eu/eurostat/web/energy/data/shares.

3.2.2 The Czech Republic

In order to pursue the development of a Czech economy based on green growth, a first report on "Green Growth in the Czech Republic and Selected Indicators" was published in 2011, in which the OECD framework on GGIs was adopted (Czech Statistical Office 2011). Similarly to the Netherlands, the Czech Republic developed a set of 27 GGIs which builds the basis for future analysis on the field of measuring green growth. The chosen indicators cover the four main dimensions of the OECD green growth framework (*(i)* Environmental and resource productivity/intensity; *(ii)* Natural asset base; *(iii)* The environmental quality of life; *(iv)* Policies and economic opportunities), as well as the socio-economic context with emphasis on sustainability and equity issues. This report was complemented by a second edition, launched in 2013 (Czech Statistical Office 2013). This update takes into account the framework of the GGKP (2013) - a global network of researchers and development experts addressing green growth theory and practice that help countries to make advances on measurement, design and implementation of green growth policies. The Czech Statistical Office in cooperation with the Charles University Environment Centre has prepared both documents.

The updated report of 2013 contains 27 indicators, out of a set of fifty proposed and identified by the GGKP. The indicators were selected by a team of authors according to their relevance to Czech conditions and data availability. Part of data was "mined from existing administrative sources" (Czech Statistical Office 2013) given that not all domains of this green growth are covered by statistical surveys. The set was amended to include data on "Adjusted Net Savings" (as part of contextual information) and "Ecological Debt" (as part of the "natural asset base" group).

The results of data analysis are summarised in a dashboard that evaluates trends for the entire period of data availability, highlights the last year-to-year change and makes compares the country's data mainly with data from the EU and OECD member countries. Time series are provided, commonly, from 1995 or, in some cases, for the earliest year available. There are indicators for which even longer periods are analysed (e.g. on old age index – since 1945). Within the report each indicators explanation is complemented by a graph, illustrating the development over the available period of time. The portrayal of the indicator "Energy productivity" (Box 3.3.) can serve as an example for the approach of the Czech report.

It is aimed to further assess and develop the set of GGIs in the Czech Republic in cooperation with international organisations and partners, to cement ties and to strengthen the national green growth and green economy strategy.

Box 3.3. Energy productivity in the Czech Republic

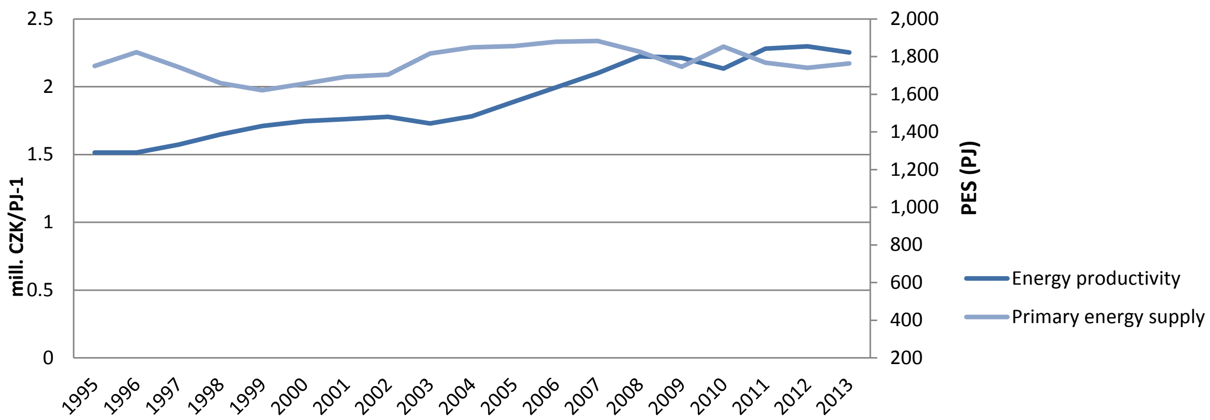
The energy productivity indicator is the ratio between gross domestic product in constant prices and total primary energy supply.

Growing energy productivity allows the production of more economic output from the same amount of energy. This in principle does not necessarily reduce consumption of raw materials and fuels, but it does increase GDP produced by the same amount of energy. Energy productivity is influenced by technological development and economic structure.

Energy productivity in the Czech Republic steadily increased until 2008, since when it more or less stagnated for a number of reasons, e.g. the global economic crisis. The country has no legal binding target for energy productivity, but has one for energy intensity (the inverse value of productivity) which should aim to stabilise the annual rate of fall of the energy intensity of GDP creation by 3.0 – 3.5% (indicative target) according to the Czech Republic's energy policy.

In 2011, the Czech Republic was about 18% below the OECD average in energy productivity.

Figure 3.3. Energy productivity and primary energy supply in the Czech Republic



Source: *Czech Statistical Office (2016) Energy Balance 2013. Access on 10 August 2016, https://www.czso.cz/csu/czso/energy-balance-2013*

3.2.3 Germany

Germany has tested the OECD set of GGIs building on the German experience with sustainable development indicators and with environmental accounting. The German Federal Statistical Office published a report called "Test of the OECD set of green growth indicators in Germany" in 2012 (Destatis 2012). Its 27 indicators cover the four main dimensions of the OECD green growth framework (*(i)* Environmental and resource productivity/intensity; *(ii)* Natural asset base; *(iii)* The environmental quality of life; *(iv)* Policies and economic opportunities). As it was impossible to be consistent with the definitions proposed by OECD for the chosen GGIs, definitions had to be changed depending on the data situation or other conditions in order to be able to use/test an indicator. As a result of that, for some indicators the definition was adjusted. In such cases, the relevant definitions were compiled into an annex in order to provide the necessary transparency for comparison purposes and follow-up work. Sixteen indicators could be implemented completely or to a large extent in line with the OECD framework, for five indicators the definition used deviates from the proposals, and three further applied definitions differ significantly from the proposed version (Destatis 2012). Another three indicators (multifactor productivity, mineral resources and soil resources) could not be provided as there was no data available in Germany or the quality did not appear sufficient.

Presented data are provided for a time range of around 20 years, starting 1991 or 1993. For scattered indicators time series starts only in 2005. The deadline for presented data was the middle of 2012, which consequently builds the end of time series within the report.

The work was carried out by the German Federal Statistical Office (Destatis). While pilot testing the GGI set, Germany blended official statistics with data from other sources. The main aim was to test feasibility; it was a secondary consideration whether the data were up-to-date (Destatis 2012).

For the pilot study the conscious decision not to present economic framework conditions (growth, general productivities, jobs market, trade data, etc.) was made, as these data are available in national statistics and therefore do not need to be "tested". Furthermore the indicators trends have not been calculated and political targets were not compared, as those are not part of the provided set of OECD GGIs, in contrast to the sustainability indicators of the national sustainability strategy. As a result of this, it was not possible to show assessments related to the achievements of these targets (Destatis 2012).

In the report the status and development of each of the indicators are presented with a brief description and visuals such as diagrams or charts. In Box 3.4. the indicator "CO_2 and greenhouse gas emissions and productivity" illustrates the applied structure, which is similar to the publication of Statistics Netherlands (2011) as well as to indicator-based report under the German Sustainability Strategy (Destatis 2013).

Box 3.4. CO_2 and GHG emissions and productivity in Germany

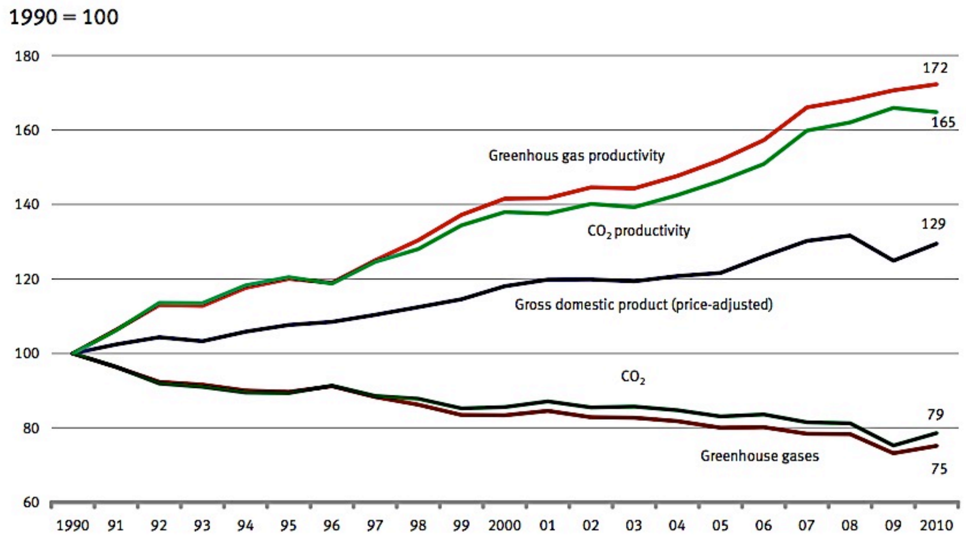
According to the Kyoto Protocol, the following six substances are included as GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous monoxide (previously: nitrous oxide) = laughing gas (N_2O), partly halogenated hydrofluorocarbons (HFCs), perfluoro- carbons (PFC) and sulphur hexafluoride (SF_6).

In 2012, 939 million tonnes of GHGs (in CO_2 equivalents) were emitted in Germany. With 87.5 % carbon dioxide accounted for by far the largest share in GHG emissions. Methane accounted for 5.2 %, laughing gas for 5.9 % and fluoro-carbons for 1.4 %.

From 1990 until 2012 GHG emissions in Germany fell substantially by 25 % (309 million tonnes CO_2 equivalents). In the case of the most important component, namely CO_2, the decrease was 220 million tonnes (−21 %). A large proportion was above all saved by companies closing down during the first five years after German reunification. After this, environmental and climate policies had an effect. Between 1990 and 2010 the GDP rose by 29 %.

Overall, GHG productivity rose by 72 % between 1990 and 2012, CO_2 productivity alone, however, only by 65 %. This means that resources were used more efficiently with increasing economic growth. The trend in economic growth and GHG emissions was decoupled so that the environmental burden from a German perspective also declined when considered in absolute terms (without taking account of imports). At the end of the time series the trend reflects the economic crisis of 2008/2009 as well as the subsequent recovery.

Figure 3.4. Greenhouse gas productivity in Germany (domestic concept)



Source: *Destatis (2013).*

3.2.4 Denmark

In November 2012 the report "Green production in Denmark – and its significance for the Danish economy" was jointly published by the following national institutions: Danish Energy Agency; Ministry of Climate, Energy and Building; Danish Business Authority; Ministry of Business and Growth; Danish Environmental Protection Agency (EPA) and the Ministry of Environment.

Denmark used the OECD measurement framework to develop a set of five GGIs in the fields of *(i)* resource productivity of the economy as well as *(ii)* the socio-economic context and characteristics of green growth. Also the report identifies and describes Danish enterprises' production of green technologies, goods and services (Danish Energy Agency et al. 2012). In addition the report informs about research, development and innovation in enterprises with green production as well as Danish green goods exports and international benchmarking.

The purpose of the report was to monitor the future development of green business in Denmark based on solid statistics. Green production was broken down into nine green business areas (Box 3.5.), adapted from Eurostat's guidelines EGS sector (Eurostat 2009), which allowed a detailed definition of products sold by Danish enterprises (Danish Energy Agency et al. 2012).

In view of achieving the best coverage rate as possible, four sources were used to generate data on green business statistics. The first and most essential source is the product code, which gives information on what a company produces and sells[52]. The results of a questionnaire survey addressing 10 % of all Danish enterprises builds the second source, complemented by the third source, which is a review of the on-line appearance of 2,000 Danish enterprises. The fourth source, used for data on organic farms in the country, is the National AgriFish Agency.

Box 3.5. Green business areas defined for Denmark

- Air pollution control
- Surface and wastewater management
- Better utilisation of energy
- Protection of soil, groundwater and the aquatic environment
- Protection of biodiversity and landscape
- Waste management
- Utilisation of renewable energy sources
- Measurement and analysis related to climate protection
- Noise and vibration abatement

Source: Danish Energy Agency et al. (2012).

Through the green business statistics it was possible to identify the share of green production for each Danish enterprise. Furthermore, indicators on green productivity were calculated, building the basis for comparisons between economic sectors and their green production of goods and services.

The first chapter of the report gives information on key economic indicators for Denmark's green production, such as turnover, exports, export intensity, added value (per full-time employee (productivity)).

[52] The identification of Danish green enterprises across industries was based on the official German list of green product codes published by Federal Statistical Office of Germany (Destatis) in April 2012.

To further clarify the Danish approach, Box 3.6 shows the depiction of indicator “Added value from green production”, as it is presented within the report.

Box 3.6. Added value from green production in Denmark

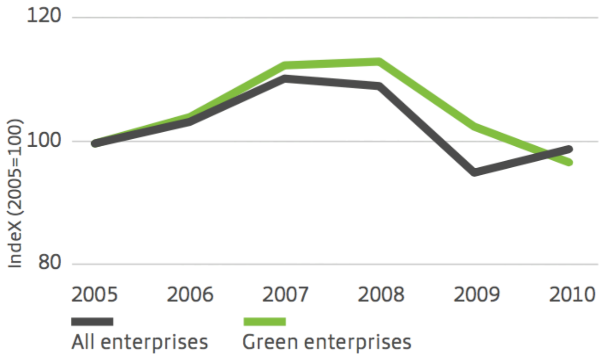
Added value is a measure for how much the individual enterprise contributes to enhancing the value of goods and services through using labour and capital stock, e.g. machinery. Added value is calculated by deducting the expenditure on raw materials, auxiliaries and services purchased from other enterprises or abroad from the sales prices of the goods or services which the individual enterprise has sold. Added value from green production went up by around 13% from 2005 to 2008, measured in constant prices. After peaking in 2008, added value fell by around 14% from 2008 to 2010, and today the 2005 level. The trend is similar for the rest of the business community, which however experienced a smaller decrease than did green production (Figure 3.5.).

The contribution to added value by enterprises with green production increased steadily from 9% in 2005 to around 10% in 2009, after which it fell to just under 9% in 2010. Looking at added value relative to the number of full-time employees, reveals a measurement of productivity. In 2005, the productivity in green production was more or less at a par with the average for all enterprises in manufacturing, trade and service, respectively.

From 2006 to 2009 the productivity in green production by service enterprises increased relative to other service enterprises, while green production in trade and manufacturing continued to be more or less at the same level as other production in trade and manufacturing. In 2010, the productivity in green production was the average level for all enterprises in manufacturing, trade and service (Figure 3.6.). The statistics do not therefore reveal any systematic differences between green and non-green production productivity. In 2009, in particular, green service enterprises had very high productivity compared to non-green service enterprises. The high relative productivity of green service enterprises in 2009 can therefore be attributed to the fact that their productivity rose by around 4%, but also that the other service enterprises had a drop in productivity of 5%. The large drop in the relative productivity of the green service enterprises in 2010 can be explained by the fact that their productivity fell by around 6%, but also that the service enterprises in the general population had an increase in productivity of 15%. Furthermore, it should be noted that there are large differences in productivity across industries and across enterprise size, and these calculations have not taken this into account.

Figure 3.5. Added value from green production

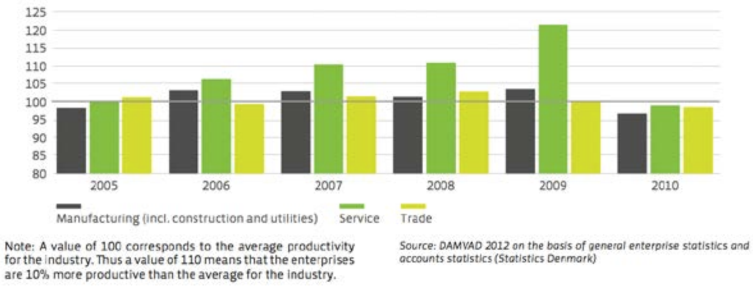
Denmark, in 2010 prices



Source: DAMVAD 2012 on the basis of general enterprise statistics and accounts statistics (Statistics Denmark)

Source: Danish Energy Agency et al. (2012).

Figure 3.6. Added value per full-time employee from green production, Denmark



Source: Danish Energy Agency et al. (2012).

3.2.5 Slovenia

The Statistical Office of the Republic of Slovenia has developed a national set of GGIs building on the OECD framework and published a corresponding report “Green growth indicators for Slovenia” in 2014 (Statistical Office of the Republic of Slovenia 2014). From the proposed set of OECD GGIs, 14 were selected for the Slovenian report. The indicators were selected with regard to data availability from the Slovenian Statistical Office and Eurostat. In accordance with the OECD framework, the Slovenian report on GGIs covers the following thematic areas: *(i)* Environmental and resource productivity; *(ii)* the natural asset base; *(iii)* environmental quality of life; and *(iv)* economic opportunities and policy responses.

Furthermore, Slovenian authorities added five additional indicators into the national framework that are not part of the GGI set proposed by OECD: exploitation of national resources, separate waste collection, drinking water pollution, agricultural area and utilised agricultural area with ecologic production. These indicators were considered to be of national importance and suitable to give a good picture of the extent the green growth strategy is being enforced in Slovenia.

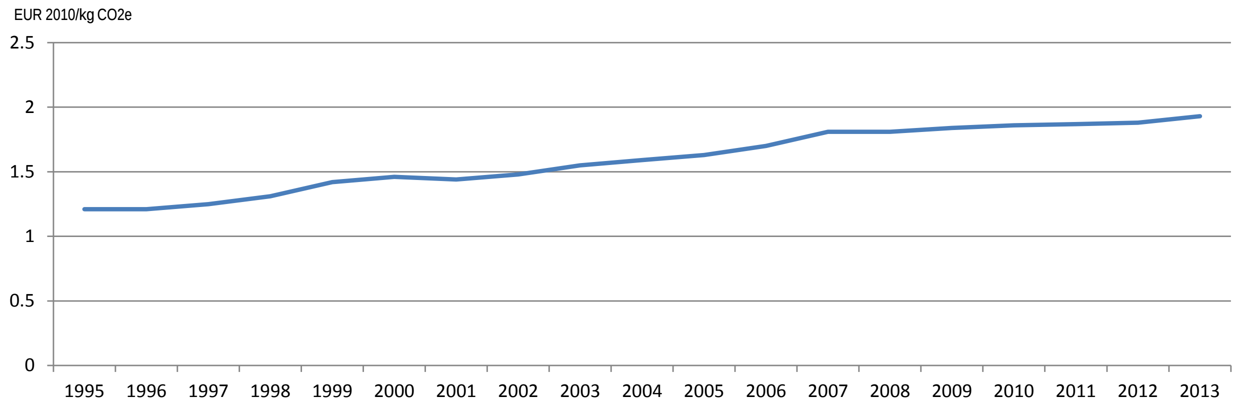
Through a schema the report gives an overview of all 19 examined indicators, showing the available time series of data and the trend (increase, stagnation, decrease) of the GGIs. For the presented indicators, time series embraces 12 years on average, beginning around the year 2000 in most cases. The monitoring process for a couple of indicators already started between 1990 and 1993.

The presentation of all considered indicators in the Slovenian report follows the same structure, which includes the indicators definition, a chart showing the development over the available time series and further explanations on the presented data as well as trends. The explanation of the indicator “Emissions productivity” is shown exemplary for the concept applied in the Slovenian report (Box 3.7.).

Box 3.7. Emission productivity in Slovenia

Explanation: Climate change ranks among the important factors that impact the well-being of people and the environment as a whole. In line with the First Commitment period of the Kyoto protocol, in the 2008-2012 period the EU should have decreased by 8% over the base year. The statistical data reveal that the quantity of greenhouse gas emissions in Slovenia increased until 2008, and then started to gradually diminish. In order to fulfil its commitment under EU Burden Sharing Agreement, Slovenia shall put forward the sinks which are the direct result of man's activity in forestry and in handling the land, namely in the amount of 1,320 kilotons of carbon dioxide equivalent (i.e. a 6.5% decrease in view of the quantity of the emissions in the base year). In 2008 the gross domestic product started to decrease and in the 2008-2012 period it decreased by 8.5%. The value of the indicator emission productivity slowly but firmly increased from 1995 on and in 2013 it reached the value of EUR 1.93 per kilogram of carbon dioxide equivalent. It increased by 60% between 1995 and 2013.

Figure 3.7. Emission productivity, Slovenia



Note: This indicator is expressed in EUR, in fixed 2010 prices per kilogram of CO2 equivalent.

Source: *Statistical Office of the Republic of Slovenia (2016) Indicators of environmental and resource productivity database. Accessed 11 August, http://pxweb.stat.si/pxweb/Database/Environment/27_environment/01_27752_green_growth_ind/01_27752_green_growth_ind.asp*

3.2.6 Slovak Republic

The Slovak Republic has published a report on selected GGIs in 2014. The work was led by the Slovak Environmental Agency in cooperation with the ministry of environment and the statistical office. At the same time, a process of intergovernmental data collection and processing scheme was initiated to ensure a regular updating of the indicators.

The present set of GGIs in the Slovak Republic comprises 32 indicators, covering the fields of *(i)* environmental and resource productivity, *(ii)* the natural asset base, *(iii)* environmental quality of life and *(iv)* economic opportunities and policy responses. The selection of indicators and the methodology of assessment were based on OECD's proposed set of GGIs.

Data presented within the Slovak report originate from official or international databases. In addition, the assessed trends were discussed with national state specialists (departments of the ministries of environment, economy, labour and social affairs and family, finance, agriculture and rural development). Although for a few indicators the assessment period begins 1996 or 1998, the majority of available data covers a time series between 2000 and 2012. In some cases, however, data are not available for the complete span due to differing approaches in data collection or changes in methodology and assessment.

In the report, a dashboard shows information on trends of all 32 indicators. For two thirds of the indicators the overview finds a positive trend and future perspective.

Similar to the Slovenian national report, each indicator's definition is published with visuals (graphs, charts, maps), giving an impression of the development during the monitored time series (see example in Box 3.8.). It is also to mention, that differently to other reports, the Slovakian publication provides text in the national language and English within one document.

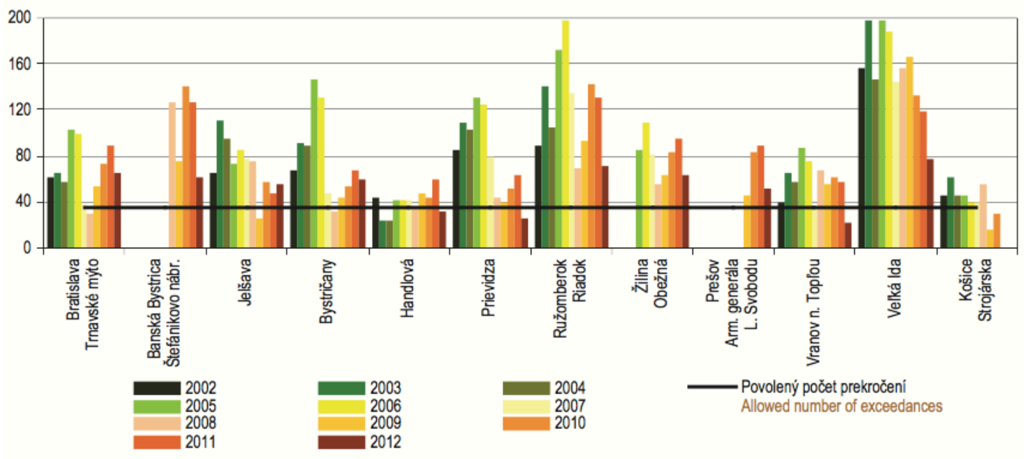
Box 3.8. Exposition of the public to air pollution by particulate matter (PM10) in the Slovak Republic

The major current issue in the quality of air in the Slovak Republic and the whole of Europe is air pollution through suspended particulate matter (PM_{10}). It is likely that in the upcoming years, the trend of exceeding the daily limit values will continue despite the fact that annual PM_{10} concentrations in the Slovak Republic have recorded long-term below-limits values.

Trends in average annual PM_{10} concentrations in the Slovak Republic show fluctuating characteristics since 2000, with a slight increase in recent years. PM_{10} is currently monitored at 32 stations of the national air quality monitoring network. In 2012, two stations reported exceeded annual limit values (Jelšava, Ružomberok). Far more significant, however, is exceeding the permitted number of 35 exceeding limit values per day. This limit value was exceeded at most monitoring stations in 2012 with most exceeding occurrences reported from the station of Veľká Ida (77).

Figure 3.8. Number of exceedances of daily limit value for PM10

2002-2014 at selected monitoring stations in the Slovak Republic



Source: *Slovak Environment Agency (2014).*

3.2.7 Republic of Korea

The Republic of Korea adopted a National Strategy for Green Growth in 2009, accompanied by a Low Carbon-Green Growth Law in 2010. In this context, Statistics Korea (KOSTAT) has been developing green growth related statistics in order to monitor green growth progress. The work is carried out by Statistics Korea in cooperation with the Seoul National University and the Presidential Committee on green growth. Statistics Korea has been compiling information on green growth indicators, green lifestyle surveys, SEEA, and Green Industry Statistics.

Korea became the third country to publish a report using the OECD Green Growth Indicators framework (Statistics Korea 2012) in which it analysed 23 of the OECD GG indicators. They are organised around four themes: (i) environmental and resource productivity, (ii) natural asset base, (iii) environmental quality of life and (iv) economic opportunities and policy responses. Most indicators show that the decoupling of environmental pressure from economic growth is under way but more has to be done (Statistics Korea, 2012). An update of this report was done in 2013 (Statistics Korea, 2013). The indicators are organised according to 3 main strategies and 10 policy agendas such as “efficient reduction of GHG emissions”.

3.2.8 Mexico

Mexico is applying the OECD GGIs, building on experience with environmental accounting. Additional country specific indicators relate to: the productivity of wastewater treatment services, subsidies to electric power services, and companies with green certifications. The work is led by the National Statistical and Geographical Institute (INEGI).

3.3 Application in Latin America and the Caribbean

In Latin America and the Caribbean, work is underway in Colombia, Costa Rica, Ecuador, Guatemala, Paraguay and Peru. The initiative is supported by the United Nations Industrial Development Organization (UNIDO) in co-operation with the OECD, the Latin American Development Bank (CAF), the Latin American and Caribbean Economic System (SELA), and UNEP.

The aim is to establish a framework to monitor green growth in the LAC region based on the OECD green growth measurement framework and drawing upon UNEP work on environmental indicators in Latin America. A considerable wealth of information has thus been compiled, and is being disseminated and published (Box 3.9). Particular attention is given to the living standards of people and opportunities from green growth. Examples of additional country specific indicators include: malnutrition, acute respiratory infections and reforestation.

The feedback received so far indicates that the use of GGIs in developing countries requires some special considerations. Developing countries may face many different challenges that are less prevalent or acute in developed countries, such as a substantial dependence on natural assets, persistent and high levels of poverty, a large informal economy, and, often, weak institutions. Beyond ensuring a balanced coverage of the two dimensions of green growth – “green” and “growth” – achieving green growth in developing countries is also about increasing the economic and environmental resilience of the society and ensuring that growth is inclusive. These aspects will also need to be reflected in an indicator set aiming to monitor progress.

Box 3.9. Applying the OECD green growth measurement framework in LAC countries

Through the project "Monitoring green growth in the LAC region", the United Nations Industrial Development Organization (UNIDO) in co-operation with the OECD, the Latin American Development Bank (CAF), the Latin American and Caribbean Economic System (SELA), and UNEP – initiated a pilot study to test the applicability of the OECD green growth measurement framework and indicators in the LAC region. The selection of the indicators took into account the countries' institutional and statistical capacity, their experience with indicators, and national industrial strategies.

The study reveals a number of implementation challenges that are common to many countries, and describes ways to address them:

Challenges	Ways to address the challenges
Indicator selection ♦ Reflecting adequately national circumstances and policy issues. ♦ Reflecting adequately the linkages between economic growth and environmental issues. ♦ Assessing each indicator with respect to its relevance, soundness, and measurability.	♦ Adapt the indicators to the national context by developing new indicators on aspects of particular importance to the country. ♦ Ensure that the indicator set encompasses both indicators that are internationally comparable and indicators that are country specific.
Data compilation and measurement ♦ Identifying data sources across different institutions and government levels, and remaining gaps. ♦ Compiling the data and organising data flows. ♦ Harmonising the data across national sources and addressing data quality issues, including discontinuity over time.	♦ Document the data using harmonised formats. ♦ Ensure compliance with statistical standards. ♦ Organise data flows in a way that enables regular updates. ♦ Combine graphics and tables with diagrams and explanatory text to compensate for missing data.
Interpretation and communication ♦ Placing the indicators in the country's socio-economic context. ♦ Interpreting the results in view of underlying economic, social and political factors.	♦ Provide background information on specific national circumstances. ♦ Be clear about the limitations of the indicators and their interpretation. ♦ Release the indicators through user-friendly reports and public websites. ♦ Adapt the ways of reporting to the various audiences. ♦ Use standardised reporting templates for all indicators.
Institutional co-ordination and capacity building ♦ Coping with limited (human, financial) resources; ♦ Coordinating between national institutions at different levels. ♦ Providing appropriate training and capacity building.	♦ Establish a network of data providers and indicator users. ♦ Maximise the use of existing data. ♦ Exchange knowledge and learn from peers on: - indicator selection and calculation methods. - data management and quality assurance. - interpretation of indicators and ways to use and communicate them

Several lessons emerge from this experience.

First, clear communication is important and can be achieved in many different ways. Countries have opted for different solutions: producing user-friendly and visually appealing reports (e.g. Paraguay), adopting more concise, standardised reporting (e.g. Colombia, Mexico, Paraguay), complementing the indicator-based report with a summary for policy makers (e.g. Costa Rica), and highlighting concrete policy steps and their inter-linkages to facilitate application of the indicators in national policy agendas (e.g. Ecuador).

Second, the indicators need to be adapted to the national context. For example, some countries (e.g. Mexico, Colombia and Paraguay) have added more indicators on a particular natural resource because of its national importance.

Third, the application of the OECD framework that cuts across different themes and policy issues, contributes to a better cooperation among government institutions and helps improve the countries' environmental information systems and their connection with economic information systems.

Finally, exchange of experience and good practices between the participants helps them address data challenges and measurability issues.

Source: CAF-OECD-UNIDO (2012).

3.4 Application in East Asia

In East Asia, eight emerging and developing ASEAN (Association of Southeast Asian Nations) countries, Malaysia, Thailand, Indonesia, the Philippines, Vietnam, Lao People's Democratic Republic, Cambodia and Myanmar participate in a project on the promotion of green growth in the region supported by the Republic of Korea and led by the OECD. A database with GGIs for participating countries is currently being established. Particular attention is given to business opportunities for small and medium-sized enterprises (SMEs) and to productivity issues.

In co-operation with officials and researchers from across the ASEAN-region, the OECD published *Towards Green Growth in Southeast Asia* in November 2014 (OECD 2014b). The report aims to provide evidence that Southeast Asia can pursue green growth and thus sustain the natural capital and environmental services, through of right policies and institutions. OECD actively advises the countries on this challenging task, to shift the on-going and strong economic growth towards green growth and to achieve the integration of a green growth strategy into national development plans. These efforts can be summarised in three key messages (OECD, 2014b), which emerge from the report and are further discussed in Box 3.10.

Box 3.10. Key messages towards green growth in Southeast Asia

Message 1: Green growth is not a separate strategy from long-term economic growth and higher levels of well-being, but rather is a means to achieve them

Economic growth, human well-being and environmental performance are inseparable. The future of the region’s population and the profitability of its economic activities will depend on policy makers and business accepting and acting on this. Evidence from around the region shows that environmental degradation is already undermining human well-being and economic growth. Yet there are ways in which economic and environmental performance can be mutually beneficial.

For example, this is the case of reducing outdoor air pollution. Outdoor air pollution resulted in nearly 200 000 deaths in the region on 2010, costing over USD 280 billion, based on statistical value of life calculations, i.e. the value people attach to not having their lives cut short by pollution-related health problems. By reducing air pollution, better public transport can reduce these costs and benefit the economy by easing congestion and increasing productivity.

Message 2: The window of opportunity for green growth is open now

Southeast Asia is at a turning point. The region is undergoing deep transformation and modernisation underpinned by strong – but unsustainable – economic growth. Today’s decisions by policy makers and business leaders will determine the sustainability of the regions development path for decades – potentially centuries - to come. Delayed action risks missing three golden opportunities: *(1)* To sustain regions natural wealth; *(2)* To lock in clean and resilient infrastructure; *(3)* To become a hub for green investment.

Message 3: Political leadership is the key to putting the right policies and institutions in place

Governments are only as strong as they are courageous: leaders must move beyond today’s incremental and isolated progress to instead embrace a different kind of economy. This will mean: strengthening governance and reforming economic structures; mainstreaming green growth into national development plans and government processes; accounting for the essential ecosystem services provided by natural resources and ending open-access exploitation.

Source: OECD (2014b).

The report can be seen as a guide for Southeast Asian countries, which are seeking for competitive advantages through clean and efficient technologies, the adoption of better standards and regulations and thus pursuing green growth.

3.5 International cooperation on monitoring progress towards green growth

International co-operation is essential to achieve synergies and advance knowledge about the measurement of green growth. It is also essential to help identifying commonalities in international work and to clarify the specific purposes of the various initiatives. Since 2011, OECD has been working closely with other international initiatives to share information and to promote common approaches. Several other international bodies have embarked on work on green growth, with somewhat different emphases and objectives than the work undertaken by the OECD.

The ***United Nations Environment Programme*** (UNEP) launched its Green Economy[53] Initiative in late 2008, including a framework for assessing progress in moving towards a green economy. In December 2012, UNEP published a framework document "Measuring Progress towards an Inclusive Green Economy," (UNEP 2012) and prepared a manual on using indicators to develop green economy policies (UNEP 2014). The manual is to be applied in all the countries where UNEP provides advisory services. UNEP's green economy indicators 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.

The ***World Bank*** report on Inclusive Green Growth (World Bank 2012) recognises that "sustained growth is necessary to achieve the urgent development needs of the world's poor and that there is substantial scope for growing cleaner without growing slower". It emphasises that sound indicators are necessary to monitor economic performance and gauge the effectiveness of policies. Through its Wealth Accounting and Valuation of Ecosystem Services (WAVES)[54] Global Partnership, the World Bank provides technical support and capacity building for implementing the SEEA, including experimental ecosystem accounts.

The ***Global Green Growth Institute*** (GGGI)[55] proposes several categories of GGIs, each corresponding to a specific purpose in GGGI's country programmes. These programmes aim to help developing countries create green growth plans and strategies by incorporating green growth 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. Planning Indicators (PIs), 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 programmes and projects.

The OECD works together with the GGGI, UNEP and the World Bank within the framework of the ***Green Growth Knowledge Platform*** (GGKP)[56]. One outcome of this co-operation has been the preparation of a report, "Moving Towards a Common Approach on Green Growth Indicators" (GGKP 2013) that builds on the OECD green growth measurement framework.

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[53] http://www.unep.org/greeneconomy/
[54] http://www.wavespartnership.org/en
[55] http://gggi.org
[56] http://www.greengrowthknowledge.org/about-us

The ***Inclusive Wealth Report 2012*** by the International Human Dimensions Programme (IDHP) on Global Environmental Change is the first in a series of biennial reports to measure progress toward sustainability. It was then updated in 2014 covering 140 countries over the past two decades (UNU-IHDP and UNEP 2014). It is a joint initiative of the International Human Dimensions Programme on Global Environmental Change of the United Nations University (UNU-IHDP) and UNEP in collaboration with the UN Water Decade Programme on Capacity Development (UNW-DPC) and the Natural Capital Project. The 2012 report (UNU-IHDP and UNEP 2012) introduces an index that measures the wealth of nations by looking into the countries' capital assets, including manufactured, human and natural capital, and its corresponding values: the Inclusive Wealth Index (IWI).

The European Union's 2020 Flagship Initiative for a resource-efficient Europe includes a ***Resource Efficiency Roadmap*** that specifies policy goals and targets, and indicators to measure progress. Several of the indicators listed are similar to those proposed by the OECD[57].

The European Commission's ***IGrowGreen*** assessment framework[58] provides an indicator-based analytical tool to assess how structural reforms can contribute to a competitive, greener economy. Many of the indicators listed, in particular those relating to the environmental efficiency of production and consumption, are similar to the indicators in the OECD green growth set. *IGrowGreen* also enables the construction of aggregated performance scores, an objective that is not pursued in the OECD's work.

3.6 Key findings from the analysis of GGIs application in practice

As a result of examining the country specific progress related to implement a green growth strategy, the following main findings emerge:

- While the original grouping of indicators was altered only marginally, countries attached different importance on the various groups and individual indicators of the OECD set. They either excluded indicators or added new ones, depending on their national circumstances;

- Data sources used to construct the indicators include primarily official statistics, but also data from administrative sources and in some cases data from research studies. The sub-group of policy response indicators was the most problematic part for almost all countries, be they developed, emerging, or developing economies;

- The length of the time series and the number of GGI used by countries vary. Several countries lack data over long periods. The latter limits the indicators' usefulness for assessing the results of policies;

- Several countries used comparison with policy targets and international trends. In this context, an enhanced availability of international databases would be useful for countries;

- In many instances, national statistical agencies took the lead in preparing indicator-based reports. It is not yet clear how these reports have been linked to policy planning and performance monitoring by the entire government;

- A geographic disaggregation of indicators, going to the sub-national level, is missing in all reports prepared so far;

[57] http://ec.europa.eu/resource-efficient-europe/index_en.htm
[58] http://ec.europa.eu/economy_finance/db_indicators/igrowgreen/index_en.htm

- Two pioneers of GGIs testing that produced their first national reports in 2011 – the Netherlands and the Czech Republic – have issued updates of their national indicator-based reports in 2012 and 2013, respectively, and in case of the Netherlands also for 2015.

- Several countries included visual elements in their reporting, such as dashboards, diagrams or charts;

- The process of the national GGI identification has commonly been done in a collaborative way among relevant institutions. At the same time, particularly developing countries may face institutional challenges at the phase of indicator identification when there is a lack of information exchange between departments and institutions;

Continuous feedback from country-level application is important for the further development and refinement of the indicator set. There are several avenues for the sharing of experiences and good practices. An essential one is co-operation within international organisations leading the work on GGIs, such as the OECD, the GGGI, UNEP, UNECE and the World Bank, or joint platforms established by them, for example the GGKP and the UNECE Working Group on Environmental Monitoring and Assessment (WGEMA).

CHAPTER 4: DEVISING NATIONAL SETS OF GREEN GROWTH INDICATORS

4.1 Overall approach

The aim of this chapter is to provide suggestions for setting up a national green growth measurement framework. These have been elaborated based on lessons learned from the practical application of GGIs as well as ongoing work with countries as part of the EaP GREEN programme and the work towards implementing SEIS. It is proposed that interested countries, which have not been applying the OECD green growth measurement framework so far conduct a national pilot testing of the GGI set.

The pilot testing should result in two complementary products:

- An *expert paper* addressing the needs and feasibility for a regular measurement of progress towards green growth in the country;

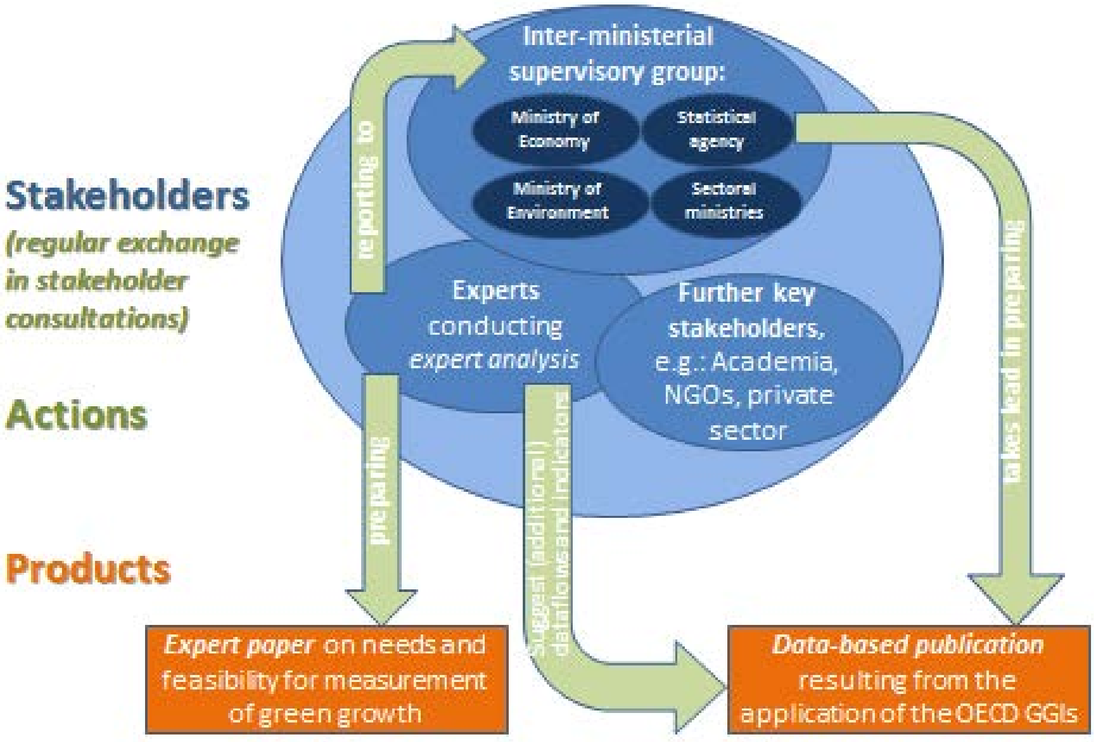
- A *data-based publication* resulting from the pilot application of the OECD set of GGIs based on currently available data.

The process of the national-level reflection on the measurement framework should be structured and participatory, with clear milestones and timeframes. The following main steps are suggested – though the scope of work may need adjustment depending upon the national context:

1. **Step 1:** Identifying awareness and demand;
2. **Step 2:** Setting a schedule for a pilot testing;
3. **Step 3:** Identifying stakeholders;
4. **Step 4:** Expert analysis: Development of a national measurement framework, including
    1. Identifying indicators for the national measurement framework;
    2. Identifying data sources and providers;
    3. Structuring the measurement framework;
    4. Identifying headline indicators;
    5. Analysing steps towards a regular measurement practice;
5. **Step 5:** Stakeholder consultations;
6. **Step 6:** Finalisation of the *expert paper*;
7. **Step 7:** Finalisation of the *data-based publication* on the application of the GGIs;
8. **Step 8:** Dissemination of the results and implementation of follow up action.

The stakeholders to be involved, actions needed and products to be created as part of the process suggested in this chapter are visualised in Figure 4.1. In the following, each of the eight proposed steps for the successful pilot testing of a national green growth measurement framework is discussed in detail.

Figure 4.1. Testing a national measurement framework for green growth: stakeholders, actions and products



Source: figure prepared by authors.

4.2 Identifying awareness and demand

In a first step towards the application of a green growth measurement framework, the awareness and the demand for such an exercise should be assessed. The following questions can guide this assessment:

Awareness

- Are decision-makers in economic, environmental and sectoral ministries aware of the interface between economic and environmental policies, in particular the potential monetary and social costs of policy inaction on environmental challenges, nationally and globally (future shocks to growth)?

- To what degree are decision-makers aware of the impact of inefficient environmental and natural resources management on fiscal revenues, the level playing field for businesses and the investment climate, as well as about the degree to which access to markets may be restricted because of poor environmental and natural resources management?

- Are decision-makers aware about impacts of economic decisions on people's well-being, including on health and health-related costs of inaction and losses from environmental degradation?

- Are decisions makers aware of how green growth can open up new sources of growth?

Demand

- Is there demand for information on the issues mentioned-above that can support policy-making? Where does the demand come from (citizens, businesses…)?

- What data collection needs at the interface of economic and environmental policies stem from the current legislation?

High awareness of the opportunities through green growth and demand for an analytical base measuring it may lead to strong support among decision-makers for the exercise. Where the awareness and demand is still nascent, a pilot application of the OECD set can in fact catalyse such awareness and demand, and the development of green growth policies. Ideally, the process of the application of the green growth measurement should be run in parallel with the development of a Green Growth Strategy. However, for countries that do not have agreed on a Green Growth Strategy yet, the launch of a pilot study on green growth measurement may be a useful way to take stock of the current situation and help to devise such a strategy.

4.3 Setting a schedule for a pilot testing

Experience from OECD countries that went through the pilot testing on green growth measurement shows that good results can be achieved within a relatively short length of time. A prerequisite for a timely implementation is good interagency communication and a clear agreement on milestones and division of responsibilities. At an early stage of the project a timeline for the pilot testing should be defined in general lines, with milestones such as the following:

- Identification of relevant stakeholders;

- Expert analysis;

- Stakeholder consultations;

- Finalisation of the *expert paper*;

- Finalisation of the *data-based publication* on the application of the GGIs;

- Dissemination of results with the policy-makers and the public.

When setting a timeline, it should be taken stock of the internal and external capacities available for the exercise both in terms of human and financial resources, so that realistic targets can be set. It may be useful for the bodies initiating the process to develop a provisional timeline which is then further elaborated in cooperation with national stakeholders. The milestones for the pilot testing can fit into the wider timeframe of developing a Green Growth Strategy.

4.4 Identifying stakeholders

It is highly desirable for the Ministry of Economy to assume leadership in the process since its ultimate goal is to better inform economic decisions and policies. At the same time, the major environmental authority should also have a strong voice in the process and statistical agencies should be involved as their expertise in data collection and reporting can be of benefit for the effective implementation of the process. The involved ministries may wish to establish an inter-ministerial supervisory group for a regular exchange during the process. The group should ensure political support for the project and be able to decide on follow up policy action. Experiences from other countries have shown that continuity and coherence at the level of national stakeholders are key ingredients for a successful exercise. Therefore, the governmental stakeholders should consider obtaining a formal agreement on responsibilities and the schedule (see 4.3) for the exercise.

Leadership in the actual preparation of the *data-based publication* resulting from the pilot application of the GGIs could be taken by an institution within the government or outside it. With respect to experiences in processing and disseminating, the national statistical agency may be a natural choice.

Development partners could usefully contribute through knowledge transfer and assuming a facilitator role in the policy dialogue involving different sectors and stakeholder groups. Furthermore it should be considered to make use of international forums for the exchange of good practices in the measurement of green growth (Chapter 3.6).

Transparency should be an underlying characteristic of the whole exercise. Stakeholders from academia, non-governmental organisations (NGO), and actors of the private sector may wish to contribute to the process. The relevant stakeholders should openly discuss opportunities and constraints for launching green growth measurement in stakeholder consultations (Chapter 4.6).

The case of Kyrgyzstan can serve as an example for the involvement of various stakeholders in the pilot testing of a green growth measurement framework (Box 3.11.).

Box 3.11. Towards measuring the green transformation of the economy in the Kyrgyz Republic

In the Kyrgyz Republic the national programme to measure progress towards green growth was launched in preparation of the Rio+20 Summit in 2012. The Rio+20 Preparatory Conference, convened by the Kyrgyz Government in cooperation with several development partners, the Central Asian Regional Environmental Centre and UNDP, discussed a preliminary vision of the country's progress towards green growth and the need for sound indicators to monitor this process. The group agreed on the need for more detailed debates and planning after the Earth Summit. This process involved numerous governmental and non-governmental stakeholders, including central planning and sectoral ministries, environmental authorities, academia, NGOs, and actors of the private sector.

After the Summit, a scoping meeting on the pilot testing of Green Growth Indicators was convened by the Kyrgyz Ministry of Economy. Its participants included officials from the host Ministry, the State Agency on Environmental Protection and Forestry Management, the National Statistical Committee, UNDP and the Central Asia's Regional Environmental Centre. The group discussed OECD's work on green growth and GGIs and it was decided that the national measurement framework should be based on the OECD framework for measuring green growth.

A close link between this initiative and the UNDP-UNEP "Poverty and Environment" Initiative (PEI) in the Kyrgyz Republic was established. A group of national experts, set up under the UNDP-UNEP Poverty-Environment Initiative (PEI) was tasked to perform the technical work on GGI, while a steering group of high-level officials, PEI Programme Board chaired by the Ministry of Economy, supervises its outcomes. The work on GGI in the Kyrgyz Republic has been possible thanks to the financial support of the PEI. It was developed a package of documents including Matrix of GGI, Road Map, Newspaper indicators, Passport of indicators describing sources, measurements, role of an indicator in green growth etc.

In the country, sustainable development has been identified as a key instrument to tackle poverty and to facilitate growth. Like in other countries in the region, environmental and developmental challenges are closely interlinked, as environmental stressors such as radioactive waste from mining and growth of coal-based power plants continue to exert pressure on the environment.

The following sectors have been identified as a priority for the green growth measurement framework in the Kyrgyz Republic: (i) water; (ii) energy; and (iii) agriculture.

Since 2013 the statistical annual publication "The Environment in the Kyrgyz Republic" of the National Statistical Committee, contains a section on green growth indicators existing in the system of the state statistics and includes data on more than 40 GGIs.

In February 2015 the government of the Kyrgyz Republic approved a set of 65 indicators to monitor and evaluate the country's progress towards a green transformation of the economy, and a corresponding decree was signed by the Prime Minister. The set of indicators is based on the OECD framework. The decree also specifies the data sources as well as the reporting frequency for each indicator.

4.5 Expert analysis: Development of a national measurement framework

Expert analysis is needed to help define the scope and structure of the national green growth measurement framework. While the experts selected for the conduction of the analysis could be government professionals, it may also make sense to consider involving independent experts (e.g. from NGOs or academia). The experts should report to the coordination group and are responsible for preparing the *expert paper* on the needs and feasibility for a regular measurement of progress towards green growth. Moreover, the experts could contribute to preparing the *data-based publication*.

The expert analysis should use the OECD GGI set as a starting point to clarify the following:

- In how far can the suggested OECD indicators be devised based on the currently collected data?

- Which of the OECD GGIs reflect national policy priorities and what indicators are not relevant nationally?

- What additional indicators not being part of the OECD set are needed to reflect national policy priorities?

- What contextual information is necessary in order to interpret the green growth indicators correctly or to supplement them?

- What headline indicators could be used?

This analysis should result in a report assessing the feasibility of aligning a national measurement framework with the OECD set of GGIs. Among others, it should contain a clear expert opinion on feasible GGIs from the OECD list as well as relevant additional GGIs for the national-level use. Moreover, it should be discussed, which steps would be necessary to adjust the procedures for data collection by statistical agencies and other bodies to enable the regular collection of data underpinning the GGIs.

4.5.1 Identifying indicators for the national measurement framework

The expert analysis should start by comparing the existing national framework(s) for the measurement of the state of the environment and the economy with the proposed set of OECD GGIs. An existing national framework could be, for instance, an adopted set of environmental indicators as part of the SEIS, or a preliminary framework for green growth monitoring devised in preparation of the Rio+20 Summit.

For each of the OECD GGIs (Chapter 2), the following selection criteria should be assessed:

Data availability

- Is the indicator already monitored?

- *If so*, are the data regularly updated, and what time series are available?

- *If the indicator is not monitored currently*, would it be relevant for adoption in the country’s context?

International alignment

- Is the definition of this indicator and the methodology for data collection aligned with the SEEA standard or the OECD definitions?

- *If not so*, what are the differences between the national approach and the international standards?

Data validation and analysis

- Are data validation and analysis procedures in place linked to the indicator?

- *If not*, do capacities exist to set these procedures up?

Policy relevance

- Is the indicator easy to interpret and transparent?

- Does it provide a basis for comparisons across countries to enable international benchmarking?

- Is there national policy targets and/or priorities linked to this indicator?
- Is it linked to the interface between economic and environmental policy?

Dissemination

- Is this indicator publicly disclosed?
- *If so*, where is it published and with what periodicity?
- *If it is not disseminated yet*, would it be possible to disclose it?

The selection of the relevant OECD GGIs should be made based on a thorough assessment and weighting of these criteria in accordance with national priorities. At the same time, given that the OECD framework is not exhaustive and may not fully reflect country priorities, it is necessary to define additional nationally monitored indicators that could be added to the set. Examples for country specific circumstances that may need to be reflected would be higher than average vulnerability to climate change and/or erosion due to geographic position. For further examples please refer to Chapter 3.

For any indicator in addition to the OECD set, a feasibility analysis using the selection criteria mentioned above should be performed.

4.5.2 Identifying data sources and providers

For each indicator that is selected for the framework, a detailed analysis of the data sources should be performed. It is important to ensure that the data that are available are actually suitable to underpin the selected indicator in terms of its scope, the methodology of its production and the time-series covered. Contemplable national sources of data include the national statistical offices, sectoral ministries and agencies as well as research studies.

When the suitable data providers are identified, agreements on the exchange of data and information between the relevant agencies should be reached. To ensure a straightforward flow of data and information, it is advisable to include all relevant data providers into the regular stakeholder meetings, so that the exchange can be planned directly between the responsible agencies.

For the EaP countries, potential data sources are discussed for each OECD GGI in chapter 2 (sections on “data sources and availability”).

4.5.3 Structuring the measurement framework

Though the OECD set of indicators is structured around five groups (see Chapter 1), it does not mean that the national set must follow the same logic. A different structuring can be used if a new structure would be more suitable from promoting awareness and knowledge about green growth, facilitating green growth planning in the country, and monitoring progress. A number of countries that have applied the framework made use of this possibility (Chapter 3). It has to be mentioned that the available set and methodologies are tailored, in particular, for a cross-cutting use. Sectoral GGIs may need to be identified, starting with priority sectors.

4.5.4 Identifying headline indicators

To facilitate the communication of results of the green growth assessment with policy makers, the media and citizens, headline indicators should be identified nationally[59]. The selection of headline indicators can be guided by the following five criteria:

9. Covering key national issues/priorities related to green growth;
10. Capturing the nexus between the environment and the economy;
11. Reflecting the multiple dimensions of green growth consistently with the national green growth measurement framework;
12. Strong measurability; and
13. Comparability across countries to enable international benchmarking.

While all of these criteria merit full consideration, the environment-economy nexus needs to be highlighted.

Another key consideration is the ease with which the indicator could be communicated to multiple users. National stakeholders may want to enlarge this list of criteria keeping it manageable. Countries are invited to add to their headline indicators an indicator reflecting economic opportunities arising from green growth. Ideally, the list of headline indicators should be sound and concise at the same tame. It is recommended to select about 5-8 headline indicators.

4.5.5 Analysing steps towards a regular measurement practice

In order to ensure that the pilot testing of green growth indicators is transposed into a regular measurement practice, a thorough analysis of the institutional framework is required. Such analysis should take stock of the institutional procedures for data collection and analysis and suggest steps to adjust the procedures for data collection by statistical agencies and other bodies to enable the regular collection of data underpinning the GGIs. Moreover, it should be assessed which institutional procedures are in place to link the measurement of environmental and economic information to decision-making and disseminate such information regularly.

4.6 Stakeholder consultations

Electronic and face-to-face consultations need to be organised to facilitate the exchange between the stakeholders involved in the project (Chapter 4.4). Regular exchange within the inter-ministerial supervisory group should be held throughout the process.

Moreover, wider consultations should be organised that should take the form of enlarged meetings of the inter-ministerial supervisory group with the involved experts and stakeholders from NGOs, academia and private sector. It is advisable to organise such consultations at different stages of the project, at least

[59] For its analysis on the level of OECD member states, OECD (2014a) suggests six headline indicators: carbon and material productivity, environmentally adjusted multifactor productivity, a natural resource index, changes in land use and cover, and population exposure to air pollution (Chapter 1.5). As national policy priorities and data availability differ, however, it is likely that a nationally adjusted set of headline indicators better represents the specific situation in EaP countries.

14. At an early stage of the project, to discuss the demand for green growth measurement, goals and schedules and to agree on key issues that should be covered by the expert analysis.

15. When the results of the expert analysis are available, to provide feedback to the experts that can be considered for the *expert paper* and to coordinate the dissemination of the results and implementation of follow up action.

4.7 Finalisation of the expert paper

The expert analysis on the needs and feasibility for a regular measurement of progress towards green growth in the country should result in a clear product. The resulting *expert paper* should address the findings in terms of the development and application of the national measurement framework on green growth and share lessons learned from the pilot project. It should be structured around the considerations and criteria outlined in Chapter 4.5. It is recommended that the paper is finalised after the stakeholder consultations, so that input from the various groups involved in the process can be considered.

Based on the experiences from the pilot project, the paper should also present an outline for further steps in monitoring green growth that can be used for the implementation of follow up action (see 4.9).

4.8 Finalisation of the data-based publication on the application of GGIs

A second core product of the process should be a publication (preferably by the National Statistical Agency) resulting from the pilot application of the OECD set of GGIs. It should present the indicators selected for the national framework and show trends and analyses based on currently available data. Although the definition of priorities and style of the document bears with its producers, it is recommended that in accordance with the 2014 OECD report on GGIs and international pilot studies a number of issues are covered for each selected indicator:

- A brief definition of the indicator including the policy context;
- A discussion of data sources and the measurability of the indicator;
- An analysis of the available data that may include trends, assessments of policy targets and international comparisons. The analysis should be supported by visuals such as graphs, charts, and dashboards;
- Links and references for further reading.

4.9 Dissemination of the results and implementation of follow up action

After the core products of the pilot test are prepared, a communication strategy needs to be developed to make the application of GGIs and the *expert paper* known by relevant stakeholders. This should include a shared (one-stop-shop) web site with easy accessible online documents. Findings should also be presented at relevant national and international forums.

At the same time, the communication of results to the public through national media should be supported. It is advisable to centre public communication on the set of selected headline indicators. Those should be regularly disclosed through mass media and other communication channels. Visual elements, such as dashboards, can be used to facilitate public access to complex information.

Based on the suggestions made in the *expert paper*, the supervisory group should coordinate and implement follow up action. This could include, for example, the identification of focal points for green growth measurement in the relevant ministries. Moreover, the green growth measurement framework can be used for regular reporting. The Kyrgyz Republic, for example, includes a section on GGIs in an annual statistical publication. It is recommended that the stakeholders explore how the green growth measurement framework can be included in the reporting system and agree on responsibilities and time frames for the establishment of a regular reporting on green growth.

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ANNEX: THE OECD SET OF GREEN GROWTH INDICATORS - OVERVIEW BY GROUP AND BY THEME

The list of indicators presented includes:

M= Main indicators
(numbered and in bold), and their components or supplements (numbered)
P = Proxy indicators
(bulleted) when the main indicators are currently not measurable

Each indicator is accompanied with an evaluation of the measurability of the underlying data:

S = Short term
basic data currently available for a majority of OECD countries;
M= Medium term
basic data partially available, but calling for further efforts to improve their quality (consistency, comparability, timeliness) and their geographical coverage (number of countries covered)
L = Long term
basic data not available for a majority OECD of countries, calling for a sustained data collection and conceptual efforts.

Group/theme	Proposed indicators	Type	Measurability
The socio-economic context and characteristics of growth			
Economic growth, productivity and competitiveness	**Economic growth and structure**		
	-- GDP growth and structure	M	S
	-- Net disposable income (or net national income)	M	S/M
	Productivity and trade		
	-- Labour productivity	M	S
	-- Multi-factor productivity	M	M
	-- Trade weighted unit labour costs	M	M
	-- Relative importance of trade: (exports + imports)/GDP	M	S
	Inflation and commodity prices		
	-- Consumer price index	M	S
	-- Prices of food; crude oil; minerals, ores and metals	M	S
Labour market, education and income	**Labour markets**		
	-- Labour force participation	M	S
	-- Unemployment rate	M	S
	Socio-demographic patterns		
	-- Population growth, structure and density	M	S
	-- Life expectancy: years of healthy life at birth	M	S/M
	-- Income inequality: GINI coefficient	M	S/M
	-- Educational attainment: level of and access to education	M	S

Group/theme	Proposed indicators	Type	Measurability
The environmental and resource productivity of the economy			
Carbon & energy productivity	**1. CO_2 productivity**		
	1.1. Production-based CO_2 productivity GDP per unit of energy-related CO_2 emitted	M	S
	1.2. Demand-based CO_2 productivity Real income per unit of energy-related CO_2 emitted	M	S/M
	2. Energy productivity		
	2.1. Energy productivity GDP per unit of TPES	M	S
	2.2. Energy intensity by sector (manufacturing, transport, households, services)	M	S/M
	2.3. Share of renewable energy sources in TPES, in electricity production	M	S
Resource productivity	**3. Material productivity (non-energy)**		
	3.1. Demand-based material productivity (comprehensive measure; original units in physical terms) Real income per unit of materials consumed, materials mix	M	M/L
	3.2. Production-based (domestic) material productivity GDP per unit of materials consumed, materials mix - Biotic materials: food, other biomass - Abiotic materials: metallic minerals, industrial minerals	P	S/M
	3.3. Waste generation intensity and recovery ratios by sector, per unit of GDP or value added, per capita	M	M/L
	3.4. Nutrient flows and balances (N, P)	M	L
	• Nutrient balances in agriculture (N, P) per agricultural land area and change in agricultural output	P	S/M
	4. Water productivity Value added per unit of water consumed, by sector	M	M
Multifactor productivity	**5. Multifactor productivity reflecting environmental services** (comprehensive measure; original units in monetary terms)	M	M/L

Group/theme	Proposed indicators	Type	Measurability
The natural asset base			
Natural resource stocks	**6. Index of natural resources** Comprehensive measure expressed in monetary terms	M	M
Renewable stocks	**7. Freshwater resources** Available renewable natural resources (groundwater, surface water) and related abstraction rates (national, territorial)	M	S/M
	8. Forest resources Area and volume of forests; stock changes over time	M	S/M
	9. Fish resources Proportion of fish stocks within safe biological limits (global)	M	S
Non-renewable stocks	**10. Mineral resources: available (global) stocks or reserves** for selected minerals: metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates	M	M
Biodiversity and ecosystems	**11. Land resources: land cover conversions and cover changes from natural state to artificial state**	M	M
	• Land use: state and changes	P	S
	12. Soil resources: degree of topsoil losses on agricultural land, on other land	M	M
	• Agricultural land area affected by water erosion, by class of erosion	P	S/M
	13. Wildlife resources (to be further refined)		
	• Trends in farmland or forest bird populations or in breeding bird populations	P	S/M
	• Species threat status, in % species assessed or known	P	S
	• Trends in species abundance	P	S/M
The environmental dimension of quality of life			
Environmental health and risks	**14. Environmentally induced health problems & related costs** (*e.g.* years of healthy life lost from degraded environmental conditions)	M	L
	• Population exposure to air pollution	P	S/M
	15. Exposure to natural or industrial risks and related economic losses	M	L
Environmental services and amenities	**16. Access to sewage treatment and drinking water** **16.1. Population connected to sewage treatment** (at least secondary, in relation to optimal connection rate) **16.2. Population with sustainable access to safe drinking water**	M	S

Group/theme	Proposed indicators	Type	Measurability
Economic opportunities and policy responses			
Technology and innovation	**17. R&D expenditure of importance to green growth** - Renewable energy sources (% of energy-related R&D) - Environmental technology (% of total R&D, by type) - All-purpose business R&D (% of total R&D)	M	S/M S S S
	18. Patents of importance to green growth (% of country applications under the Patent Cooperation Treaty) - Environment-related and all-purpose patents - Structure of environment-related patents	M	S/M S/M S/M
	19. Environment-related innovation in all sectors	M	M
Environmental goods and services	**20. Production of environmental goods and services (EGS)** - Gross value added in the EGS sector (% of GDP) - Employment in the EGS sector (% of total employment)	P	M
International financial flows	**21. International financial flows of importance to green growth** % of total flows and % of GNI **21.1. Official development assistance** **21.2. Carbon market financing** **21.3. Foreign direct investment**	M	L S S M/L
Prices and transfers	**22. Environmentally related taxation** - Level of environmentally related tax revenue (% of GDP, % of total tax revenues; in relation to labour-related taxes) - Structure of environmentally related taxes (by type of tax base)	M	S S
	23. Energy pricing (share of taxes in end-use prices)	M	S
	24. Water pricing and cost recovery (to be determined)	M	S/M
	To be complemented with indicators on: Environmentally related subsidies Environmentally related expenditure: level and structure		 M/L L
Regulations and management approaches	**25.** *Indicators to be developed*	..	..
Training and skill development	**26.** *Indicators to be developed*	..	..

Source: OECD (2014a).

Measuring the Green Transformation of Economy
Guide for EU Eastern Partnership Countries

A better understanding of drivers of green growth and of related trade-offs and synergies is necessary to gauge the results of green growth policies. In its effort to promote green growth and facilitate exchange of experience on monitoring green growth, the OECD developed a green growth measurement framework with a set of indicators for policymakers and the public at large.

The practical application of this set is now being extended to countries of the European Union Eastern Partnership (EaP) (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine) as part of the EU-funded EaP GREEN project that helps the EaP economies to move towards a green economy.

This guide, developed under the EaP GREEN project, aims to help governments in the EaP countries in establishing national frameworks for monitoring and analysing the transition towards green growth and to support them in producing green growth indicators.

Contents:

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