OECD Green Growth Studies

Green Growth Indicators 2014

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BETTER POLICIES FOR BETTER LIVES

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PREFACE

Green growth is about fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. If governments are going to pursue policies designed to promote green growth, they need indicators that can raise awareness, measure progress and identify potential opportunities and risks.

A first set of green growth indicators was proposed in *Towards Green Growth: Monitoring Progress* in 2011. This report updates and extends those indicators. It charts the progress that countries have made in four areas: the transition to a low carbon, resource efficient economy; maintaining the natural asset base; improving people's environmental quality of life; and implementing policies for, and realising the economic opportunities associated with, green growth.

The overall picture that emerges is mixed: while countries have individually and collectively made some progress in the transition to green growth, much remains to be done. As many of the trends in the report show, the global economic and financial crisis has relieved some of the pressures on the environment. However, there is a risk that, as growth resumes, these pressures will also intensify and quickly exceed the pre-crisis levels unless governments take decisive action to strengthen relevant policies. This requires the concerted action of Finance, Economy, Industry and Agriculture ministries and others depending on how national administrations are organised.

Reflecting the cross-cutting nature of green growth, this report has been prepared through a co-operative process involving the OECD's Economics Department, Environment Directorate and Statistics Directorate. This has ensured the green growth indicators have wide ownership in capitals. Evidence of this is reflected in the fact that to date, 23 countries have used the OECD framework to develop indicators that suit their national circumstances. Fifteen of these were developing or emerging economies. Other international organisations, including those participating in the Green Growth Knowledge Platform (the Global Green Growth Institute, UNEP and the World Bank) have also used the OECD green growth measurement framework and related indicators.

Building on these encouraging developments, we plan to both deepen and broaden our analysis in order to provide governments with a full range of green growth indicators and continue to address methodology, coverage and implementation challenges in practice. For example, we are currently developing new indicators to provide better insights into how measures of economic productivity should be adjusted to take account of the resources used and pollution generated, and to better assess the sustainability of natural resource use. We are participating in the global effort to implement the System of Environmental and Economic Accounts recently adopted at the United Nations. We remain committed to working closely with national and international partners and other stakeholders to ensure that green growth indicators are analytically sound, and that they support policies that enhance the lives not only of this but also future generations .

Paris, January 2014

Rintaro Tamaki
OECD Deputy Secretary-General

FOREWORD

This report updates the 2011 report *Towards green growth - Monitoring progress: OECD indicators* and is published on the responsibility of the Secretary-General. Its elaboration has been drawing upon the OECD's expertise with statistics, indicators and measures of progress. It has been prepared jointly by the OECD Environment and Statistics Directorates, in co-operation with the Economics Department (ECO), the International Energy Agency, the Directorate for Financial and Enterprise Affairs (DAF), the Directorate for Science, Technology and Industry (STI), the Development Cooperation Directorate, the Public Governance and Territorial Development Directorate (GOV) and the Trade and Agriculture Directorate (TAD). This report was prepared by Myriam Linster and Ziga Zarnic with the statistical support of Mauro Migotto and Sarah Sentier. It has benefitted from the expert advice of ministries and statistical offices in countries.

Part One of the report summarises the conceptual framework and the original set of green growth indicators. It describes recent developments, including the agreement on a small set of headline indicators and advances in the measurement agenda. It also presents national and international initiatives related to green growth indicators and the underlying statistics. This includes the System of Environmental and Economic Accounts (SEEA) whose central framework was adopted as a statistical standard at the level of the United Nations, and whose implementation will provide an important basis for improving the quality of green growth indicators.

Part Two of the report charts the progress that countries have made in four areas: the transition to a low carbon, resource efficient economy; maintaining the natural asset base; improving people's environmental quality of life; and implementing policies for, and realising the economic opportunities associated with, green growth. Where possible, the indicators in the 2011 report have been recalculated using more recent data and, in some cases, indicators have been further elaborated. Efforts have been made in particular to further develop indicators on policy responses and economic opportunities.

OECD GREEN GROWTH STUDIES
GREEN GROWTH INDICATORS 2013

Executive summary 11

Reader's guide 13

PART I: MONITORING PROGRESS TOWARDS GREEN GROWTH 15

Chapter 1. The OECD green growth measurement framework and indicators 17

1. The conceptual framework 18
2. The indicator set 19
   - 2.1 Indicator groups 19
   - 2.2 Headline indicators 21
3. Recent developments 22
   - 3.1. Calculation methods and indicators 22
   - 3.2. The System of Environmental-Economic Accounting 25

Chapter 2. Green growth indicators in practice 27

1. Applications of the OECD measurement framework in countries 28
2. Applications of green growth indicators in OECD work 31
3. International cooperation on monitoring progress towards green growth 31

PART II: THE INDICATORS 35

Chapter 3. The socio-economic context and characteristics of growth 37

Chapter 4. The Environmental and resource productivity of the economy 53

Chapter 5. The natural asset base 79

Chapter 6. The Environmental quality of life 101

Chapter 7. Economic opportunities and policy responses 111

ANNEX. The OECD set of green growth indicators 139

List of figures

Chapter 3. The socio-economic context and characteristics of growth 37

Figure 3.1. GDP trends and structure 41
Figure 3.2. Net national income and GDP 41
Figure 3.3. Labour and multifactor productivity growth 42
Figure 3.4. Competitiveness index 42
Figure 3.5. Trade in goods and services 42
Figure 3.6. Consumer and commodity price indices 44
Figure 3.7. General government gross financial liabilities, % of GDP 44
Figure 3.8. Labour participation and unemployment 46
Figure 3.9. Population trends 46
Figure 3.10. Life expectancy and healthy life years at birth 46
Figure 3.11. Educational attainment 47
Figure 3.12. Income inequality 47

Chapter 4. The Environmental and resource productivity of the economy..... 53

Figure 4.1. Production-based CO_2 productivity 58
Figure 4.2. Demand-based CO2 productivity 58
Figure 4.3. Decoupling trends: Production-based CO_2 emissions vs. GDP 59
Figure 4.4. Decoupling trends: Demand-based CO_2 emissions vs. income 59
Figure 4.5. Energy productivity 63
Figure 4.6. Share of renewables in energy supply and in electricity production 63
Figure 4.7. Share of primary energy sources in total supply 64
Figure 4.8. Material extraction 67
Figure 4.9. Domestic material consumption (DMC) 68
Figure 4.10. Non-energy DMC by material group 68
Figure 4.11. Decoupling trends: Non-energy DMC vs. GDP 68
Figure 4.12. Non-energy material productivity 69
Figure 4.13. Decoupling trends by material group, DMC vs GDP 69
Figure 4.14. Decoupling trends: agricultural nutrient balances and agricultural production 72
Figure 4.15. Agricultural nutrient surplus intensities per area of agricultural land 73

Chapter 5. The natural asset base 79

Figure 5.1. Freshwater stocks and abstraction intensities 83
Figure 5.2. Freshwater abstraction by major use 83
Figure 5.3. Forest land and growing stock 86
Figure 5.4. Intensity of use of forest resources 86
Figure 5.5. Round wood production and trade 87
Figure 5.6. Global trends in the state of world marine stocks 89
Figure 5.7. Fish production and supply 89
Figure 5.8. Land use changes 93
Figure 5.9. Land take by artificial land developments in Europe 93
Figure 5.10. Threatened species 96
Figure 5.11. Provisional Wild Bird Indices, for the US and Europe 96

Chapter 6. The Environmental quality of life..... 101

Figure 6.1. Population exposed to air pollution by fine particulates (PM2.5), by WHO thresholds 105
Figure 6.2. Population exposed to air pollution by small particulates (PM_{10}) 105
Figure 6.3. Population exposed to air pollution by ozone 105
Figure 6.4. Population using improved sanitation facilities and connected to a sewage treatment plant 108

Chapter 7. Economic opportunities and policy responses 111

Figure 7.1. Government R&D budget related to energy and environment 115
Figure 7.2. Business R&D investment related to environment 115
Figure 7.3. Patent applications under PCT of importance to green growth, OECD and BRIICS 116
Figure 7.4. Patent applications under PCT of importance to green growth, by type 116
Figure 7.5. Employment and value added in sectors producing environmental goods and services 120
Figure 7.6. Carbon market financing 124
Figure 7.7. Official Development Assistance (ODA) of importance to green growth 125
Figure 7.8. Environmentally related tax revenue 130
Figure 7.9. Labour tax revenue 130
Figure 7.10. Road fuel prices and taxes 131
Figure 7.11. Total support estimates for fossil fuels 132
Figure 7.12. Total support estimates in the agriculture sector 132

EXECUTIVE SUMMARY

The OECD green growth indicators are organised around four main objectives: establishing a low carbon, resource efficient economy; maintaining the natural asset base; improving people's quality of life; and implementing appropriate policy measures and realising the economic opportunities that green growth provides. **Six headline indicators** 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.

Key messages

The global economic and financial crisis relieved some pressures on the environment. As growth resumes, however, these pressures will intensify and quickly exceed pre-crisis levels unless governments strengthen relevant policies.

Stronger, sustained efforts are needed to improve the efficient use of energy and natural resources in order to reverse environmental damage, maintain the economy's natural asset base and improve people's quality of life. This requires concerted action by Finance, Economy, Industry and Agriculture and other ministries whose policies affect the environment and which can promote green growth. Building human capital through education and skills development will be essential.

Are we becoming more efficient in using natural resources and services from the environment?

- Over the past 20 years, the environmental productivity of OECD economies in terms of **carbon, energy and materials** has grown, but with wide variation across countries and sectors. Carbon dioxide emissions and fossil fuel use have decoupled from economic growth, and renewable energy plays a growing role in efforts to diversify and de-carbonise energy supplies. Today, OECD countries generate more economic value per unit of material resources used than in 1990, and efforts to recycle waste are starting to pay off. Nutrient use in agriculture is also improving, with surpluses declining relative to production.
- These developments are due to a combination of factors: policy action; the downturn in economic activity due to the crisis; the rise of the service sector, offshoring resource- and pollution-intensive production, and rising trade volumes.
- In many areas productivity gains are small and environmental pressures remain high: carbon emissions continue to rise; fossil fuels continue to dominate the energy mix, sometimes benefiting from government support; the consumption of material resources to support economic growth remains high, and many valuable materials continue to be disposed of as waste.

Is the natural asset base of our economies maintained?

- The information available to assess countries' natural assets is incomplete and of varying quality. Progress has been made with the management of renewable natural resources in quantitative terms. Global **fish** production from marine capture has stabilised; the commercial use of **forest resources** shows a sustainable picture, and abstraction of renewable **freshwater resources** remains stable despite increasing demand.
- The overall pressure on natural resources however remains high, and important challenges remain regarding the quality of natural resources, the ecosystem services they provide and their integrated management. Biodiversity rich areas are declining and many ecosystems are being degraded. Threats to **biodiversity** are particularly high in countries with a high population density and where land use

changes and infrastructure development lead to an increasing fragmentation of natural habitats. Many **animal and plant species** are endangered; one third of the world's **fish** stocks are overexploited, and many **forests** are threatened by degradation, fragmentation and conversion to other land types. Pressures on water resources remain high; in some cases local **water scarcity** may constrain economic activity.

Do people benefit from environmental improvements?

- Most people in the OECD benefit from improved sanitation; almost 80% benefit from public wastewater treatment. Human exposure to air pollution from sulphur dioxides and particulates is decreasing. At the same time, ground-level ozone, nitrogen oxides and very fine particulates continue to affect human health. Estimates of the cost of air pollution in OECD countries show that the benefits of further pollution mitigation could be considerable. Challenges also remain regarding the upgrade of ageing water supply and sewage systems, and the access to efficient sewage treatment in small or isolated settlements.

Does greening growth generate economic opportunities?

- Country efforts to implement green growth policies by supporting new technologies and innovations, and using economic instruments are accelerating. Comparable information about the economic opportunities, in terms of jobs and competitiveness, arising from green growth policies however remains scarce. The dynamic aspects of green growth are difficult to capture statistically, and many measurement efforts have been focusing on "green activities" rather than the "green transformation" of the economy and global supply chains.
- Sectors producing **environmental goods and services** hold a growing (albeit modest) share of the economy. Public **R&D** spending dedicated to environment and energy efficiency has increased, as has the share of "green" **patents**. The use of **environmentally related taxes** is growing but remains limited compared to labour taxes. The share of support to farmers that exerts the greatest pressure on the environment has decreased, whilst the share that includes environmental requirements has grown.
- **International financial flows** that promote greener growth are evolving. While **carbon markets** shrank due to the financial crisis and reduced industrial output, new opportunities appeared in the field of clean energy, where international **investment** flows have surpassed investment in fossil fuel technology. New opportunities have also emerged with financial institutions issuing **green bonds**, and **export credit agencies** facilitating private investment in projects that undergo environmental impact assessments. **Development aid** for environmental purposes has continued to rise and aid for renewable energy surpassed aid for non-renewables.
- Much development still takes place at the margin though, and policies often lack coherence, thus undermining the transition to green growth. Countries continue to **support fossil fuel** production and consumption in many ways. And variations in **energy tax** rates, low levels of taxation on fuels with significant environmental impacts, and exemptions for fuel used in some sectors impede the transition to a low-carbon economy. Their reform provide important opportunities for countries to generate more tax revenue while achieving environmental goals more cost-effectively.

READER'S GUIDE

The indicators shown in Part Two of the report build on data provided regularly by member countries' authorities to the OECD and on data available from other international sources. They were updated on the basis of international information available up to the beginning of June 2013 and on the basis of comments from national Delegates received by September 2013.

Each group of indicators presented is accompanied by a short text that explains in general terms what the policy context and the main challenges are, and what is measured and why. Those areas where some caution may be needed when comparing indicators across countries or over time are highlighted. A paragraph on measurability describes the most pressing measurement challenges associated with the indicators. This is followed by a description of the main trends that can be observed. The definitions underlying the indicators, the data sources and additional references are given at the end of each section. Issues that cut across the subject areas are described below.

Comparability and interpretation

The indicators presented here are of varying relevance for different countries and should be interpreted taking account of the context in which they were produced. It should be borne in mind that national averages can mask significant variations *within* countries. In addition, care should be taken when making international comparisons:

- Definitions and measurement methods vary among countries, hence inter-country comparisons may not compare the same things.
- There is a level of uncertainty associated with the data sources and measurement methods on which the indicators rely. Differences between two countries' indicators are thus not always statistically significant; and when countries are clustered around a relatively narrow range of outcomes, it may be misleading to establish an order of ranking.

Many of the indicators shown in this publication are expressed on a per unit of GDP basis. The GDP figures used are expressed in USD and in 2005 prices and purchasing power parities (PPPs). PPPs are the rates of currency conversion that equalise the purchasing power of different countries by eliminating differences in price levels between countries. When converted by means of PPPs, expenditures on GDP across countries are expressed at the same set of prices, enabling comparisons between countries that reflect only differences in the volume of goods and services purchased. The data for OECD countries come from the OECD Economic Outlook (OECD (2012), "OECD Economic Outlook No. 91", *OECD Economic Outlook: Statistics and Projections* (database). http://dx.doi.org/10.1787/data-00606-en) and the *OECD Annual National Accounts Statistics* (database). The data for the BRIICS come from the World Bank (World Development Indicators, The World Bank, Washington D.C.).

The population data used in this report come from the "OECD population statistics, historical population data and projections", *OECD.Stat* (database), *http://dx.doi.org/10.1787/data-00285-en*.

Website and online data

- OECD Green growth indicators: www.oecd.org/greengrowth/indicators.
- A database with selected green growth indicators is available on line: http://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH.
- A database with selected environmental data and indicators is available on line; it contains longer time series than the publication and recent updates: *http://dx.doi.org/10.1787/env-data-en*

Acronyms and abbreviations

Signs

The following signs are used in the figures:

n.a. or .. : not available
n. app.: not applicable

Country aggregates

OECD Europe	This zone includes all European member countries of the OECD, i.e. Austria, Belgium, the Czech Republic, Denmark, Estonia,* Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia,* Spain, Sweden, Switzerland, Turkey and the United Kingdom.
OECD	This zone includes all member countries of the OECD, i.e. countries of OECD Europe plus Australia, Canada, Chile,* Israel,* Japan, Mexico, New Zealand, the Republic of Korea and the United States.
BRIICS	Brazil, the Russian Federation, India, Indonesia, China, South Africa.

* Chile has been a member of the OECD since 7 May 2010, Slovenia since 21 July 2010, Estonia since 9 December 2010 and Israel since 7 September 2010.

Country aggregates may include Secretariat estimates.

Country Codes

AUS	- Australia	FRA	- France	NLD	- Netherlands	BRA	- Brazil
AUT	- Austria	GBR	- United Kingdom	NZL	- New Zealand	CHN	- China, People's Republic of
BEL	- Belgium	GRC	- Greece	NOR	- Norway	COL	- Colombia
CAN	- Canada	HUN	- Hungary	POL	- Poland	IND	- India
CHE	- Switzerland	ISL	- Iceland	PRT	- Portugal	IDN	- Indonesia
CHL	- Chile	IRL	- Ireland	SVK	- Slovak Rep.	RUS	- Russian Federation
CZE	- Czech Republic	ITA	- Italy	SVN	- Slovenia	ZAF	- South Africa
DEU	- Germany	ISR	- Israel	SWE	- Sweden		
DNK	- Denmark	JPN	- Japan	TUR	- Turkey		
ESP	- Spain	KOR	- Korea, Rep.	USA	- United States		
EST	- Estonia	LUX	- Luxembourg				
FIN	- Finland	MEX	- Mexico	EU	- European Union		

Abbreviations

cap	Capita
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon dioxide
DAC	Development Assistance Committee, OECD
DEU	Domestic extraction used
DMC	Domestic material consumption
EEA	European Environment Agency
FAO	Food and Agriculture Organisation of the UN
GBAORD	Government budget appropriations on R&D
GDP	Gross domestic product
GHG	Greenhouse gas
GNI	Gross national income
ICES	International Council for the Exploration of the Sea
IEA	International Energy Agency
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classification
IUCN	International Union for Conservation of Nature
IUU	Illegal, unreported and unregulated (fishing)
MFA	Material flow analysis
MFAcc	Material flow accounts
Mt	Million tonnes
Mtoe	Million tonnes of oil equivalent
N	Nitrogen
NO_x	Nitrogen oxides
ODA	Official development assistance
OSPAR	Convention for the Protection of the Marine Environment of the East Atlantic
P	Phosphorous
PCT	Patent Cooperation Treaty
PM	Particulate matter
PPP	Purchasing power parities
REDD	Reducing Emissions from Deforestation and Degradation
TPES	Total primary energy supply
Toe	Tonnes of oil equivalent
UNCED	UN Conference on Environment and Development
UNECE	UN Economic Commission for Europe
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention on Climate Change
UNSD	UN Statistics Division
WCMC	World Conservation Monitoring Centre, UNEP
USD	US dollar

Part I: Monitoring progress towards green growth

CHAPTER 1. THE OECD GREEN GROWTH MEASUREMENT FRAMEWORK AND INDICATORS 17

1. The conceptual framework 18

2. The indicator set 19

2.1 Indicator groups 19

2.2 Headline indicators 21

3. Recent developments 22

3.1. Calculation methods and indicators 22

3.2. The System of Environmental-Economic Accounting 25

CHAPTER 2. GREEN GROWTH INDICATORS IN PRACTICE 27

1. Applications of the OECD measurement framework in countries 28

2. Applications of green growth indicators in OECD work 31

3. International cooperation on monitoring progress towards green growth 31

Chapter 1. The OECD green growth measurement framework and indicators

The OECD measurement framework organises the indicators along four areas that capture the main features of green growth:

- **Environmental and resource productivity**, to capture the need for efficient use of natural capital and to capture aspects of production which are rarely quantified in economic models and accounting frameworks.
- **Economic and environmental assets**, because sustained growth requires the asset base to be maintained and because a declining asset base presents risks to future growth. Particular attention is given to natural assets.
- **Environmental quality of life**, to capture how environmental conditions and amenities interact with people's lives.
- **Economic opportunities and policy responses**, to help discern the effectiveness of policy in delivering green growth.

Indicators describing the socio-economic context and the characteristics of growth complete the picture. A few headline indicators have been selected to facilitate communication with policy makers, the media and citizens.

To improve the indicators, countries, the OECD and other international organisations work together to develop the statistical basis and put in place environmental accounts in accordance with the SEEA.

1. THE CONCEPTUAL FRAMEWORK

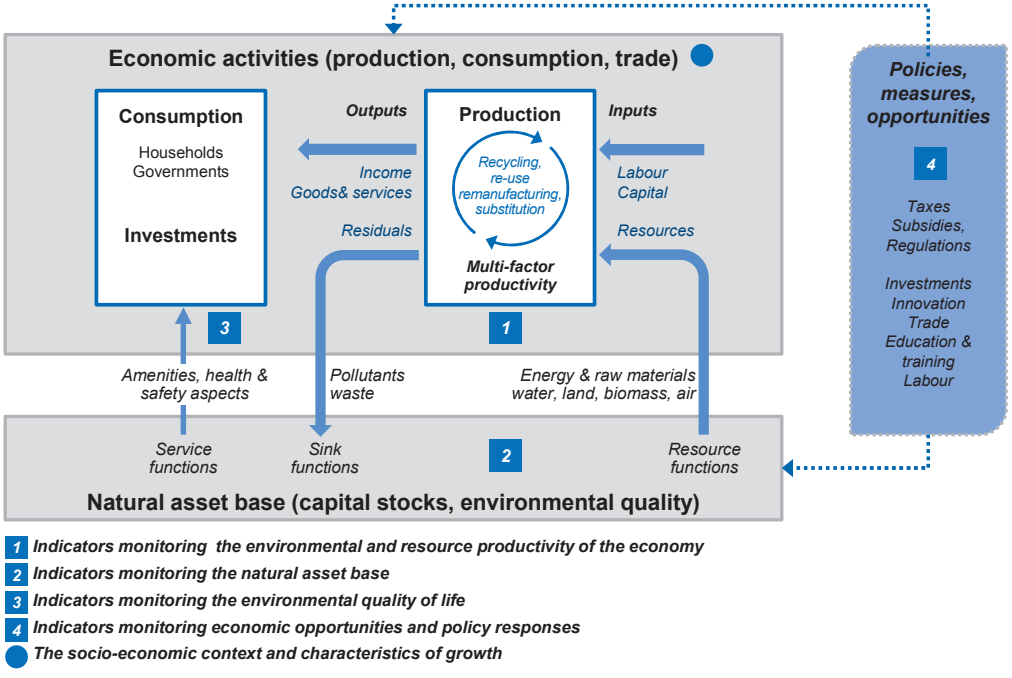
Policies that promote green growth need to be founded on a good understanding of the determinants of green growth and of related trade-offs or synergies. They need to be supported with appropriate information about the results obtained and the progress still to be made. This requires indicators that are capable of sending clear messages which speak to policy makers and the public at large. The indicators need to be embedded in a conceptual framework, selected according to well specified criteria, and based on internationally comparable data.

> Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies. To do this it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities.
>
> *Source:* OECD (2011), *Towards Green Growth.*

The OECD's approach to monitoring progress towards green growth was presented in the 2011 report, "Towards Green Growth: Monitoring Progress." 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 used in environmental reporting and assessment.

The measurement framework is centred on the economy's production and consumption functions, and describes the interactions between the economy, the natural asset base and policy actions (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.

Figure 1.1. Conceptual measurement framework



Source: OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators.*

2. THE INDICATOR SET

2.1 Indicator groups

Using the 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. Indicators that describe the socio-economic context and the characteristics of growth complete the picture (Table 1.1). The proposed set is neither exhaustive nor final. It has been kept flexible enough so that countries can adapt it to different national contexts. The set will be further elaborated as new data become available, as concepts evolve, and as feedback is received from policy applications of the indicators.

Table 1.1. 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
●	**Socio-economic context and characteristics of growth**	• Economic growth and structure • Productivity and trade • Labour markets, education and income • Socio-demographic patterns

Source: OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators.*

1 Indicators monitoring the environmental and resource productivity of the economy.

These indicators capture the efficiency with which economic activities – both production and consumption – use energy, other natural resources and environmental services from natural capital. The indicators in this group reflect key aspects of the transition to a low-carbon, resource-efficient economy, and focus on:

- Carbon and energy productivity – economic output generated per unit of CO_2 emitted or total primary energy supplied.
- Resource productivity – economic output generated per unit of natural resources or materials used.
- Multifactor productivity (MFP) adjusted for the use of environmental services and natural resources. Enhanced productivity through efficient use of natural assets and environmental services can create opportunities for new markets and jobs.

Most environmental and resource productivity indicators are **production-based**; they account for the environmental flows directly "used" or "generated" by domestic production and the subsequent final consumption. They are complemented by **demand-based** indicators that account for environmental flows "used" or "generated" by consumption or final demand (the "footprint" approach). Demand-based indicators include environmental flows that are embodied in imports, and

deduct the environmental flows embodied in exports. The resulting indicators provide insights into the net (direct and indirect) environmental flows resulting from household and government consumption and investment (final domestic demand). The development of new work within the OECD on Trade in Value-added, which compiles data on international trade flows provides an important opportunity to deepen the analysis of demand-based productivity indicators (Box 1.1).

2 Indicators describing the natural asset base.

These indicators reflect whether the natural asset base is being kept intact and within sustainable thresholds in terms of quantity, quality or value. Ideally they should help identify risks to future growth arising from a declining or degraded natural asset base. Progress can be monitored by tracking stocks of natural resources and other environmental assets along with flows of environmental services. The indicators in this group focus on:

- The availability and quality of renewable natural resource stocks including freshwater, forest, and fish resources;
- The availability and accessibility of non-renewable natural resource stocks, in particular mineral resources, including metals, industrial minerals and fossil energy carriers; and
- Biological diversity and ecosystems, including species and habitat diversity as well as the productivity of land and soil resources.

3 Indicators monitoring the environmental dimension of quality of life.

These indicators reflect how environmental conditions and environmental risks interact with the quality of life and wellbeing of people and how the amenity services of natural capital support wellbeing. They can show the extent to which income growth is accompanied (or not) by a rise in overall well-being. The indicators in this group focus on:

- Human exposure to pollution and environmental risks (natural disasters, technological and chemical risks), the associated effects on human health and on quality of life, and the related health costs and impacts on human capital and on labour productivity; and
- Public access to environmental services and amenities, characterising the level and type of access that different groups of people have to environmental services such as clean water, sanitation, green space, or public transport.

They can be complemented by information on people's perceptions about the quality of the environment they live in.

4 Indicators describing policy responses and economic opportunities.

These indicators capture both trends in the use of policy instruments that promote the transition, and tackle obstacles, to green growth (*e.g.* environmentally related taxes and subsidies), and the economic opportunities associated with green growth (*e.g.* growth of the environmental goods and services sector and "green jobs"). The indicators in this group focus on:

- Technology and innovation that are important drivers of growth and productivity in general, and of green growth in particular.
- Production of environmental goods and services that reflect an important, albeit partial aspect of the economic opportunities, which arise in a greener economy.
- Investment and financing that facilitate the uptake and dissemination of technology and knowledge, and contribute to meeting the development and environmental objectives.
- Prices, taxes and transfers that provide important signals to producers and consumers and that help internalise externalities. To be complemented by indicators on regulation and on management approaches.
- Education, training and skills development.

Indicators describing the socio-economic context and the characteristics of growth.

These indicators provide important background information and can be used to track the effects of green growth policies and measures on growth. They also enable the green growth indicators to be linked to social goals, such as poverty reduction, social equity and inclusion.

Box 1.1. OECD trade in value-added data base

To adequately estimate demand-based indicators, the use of multi-regional input-output tables is indispensable. The OECD has compiled worldwide input-output tables, built up from national input-output tables and data on international trade in goods and services. These tables are useful for many types of analyses that assess the flows of goods and services within global production and value chains.

The joint OECD-WTO initiative on Measuring Trade in Value Added (*TiVA*) is a prominent example. It considers the value added by each country in the production of goods and services that are consumed worldwide. The resulting indicators are designed to provide new insights into the commercial relations between nations. Mainstreaming the TiVA data in international statistics has the potential of facilitating the development of trade-related green growth indicators as well as demand-based measures of environmental and resource productivity. The TiVA database covers 57 countries (all OECD countries, Brazil, China, India, Indonesia, Russian Federation and South Africa) and the years 1995, 2000, 2005, 2008 and 2009; the data are broken down by 18 industries (see www.oecd.org/trade/valueadded).

Box 1.2. OECD Guidelines on Measuring Subjective Wellbeing

Being able to measure people's quality of life is fundamental when assessing the progress of societies. There is now widespread acknowledgement that measuring subjective well-being is an essential part of measuring quality of life alongside other social and economic dimensions. As a first step to improving the measures of quality of life, the OECD has produced Guidelines which provide advice on the collection and use of measures of subjective well-being. These Guidelines have been produced as part of the OECD Better Life Initiative, a pioneering project launched in 2011, with the objective to measure society's progress across eleven domains of well-being, ranging from jobs, health and housing, through to civic engagement and the environment.

The Guidelines represent the first attempt to provide international recommendations on collecting, publishing, and analysing subjective well-being data. They provide guidance on collecting information on people's evaluations and experiences of life, as well as on collecting "eudaimonic" measures of psychological well-being. The Guidelines also outline why measures of subjective well-being are relevant for monitoring and policy making, and why national statistical agencies have a critical role to play in enhancing the usefulness of existing measures. They identify the best approaches for measuring, in a reliable and consistent way, the various dimensions of subjective well-being, and provide guidance for reporting on such measures. The Guidelines also include a number of prototype survey modules on subjective well-being that national and international agencies can use in their surveys.

Source: OECD (2013) Guidelines on Measuring Subjective Wellbeing.

2.2 Headline indicators

The 2011 OECD report on green growth indicators (GGI) foresaw the development of a small set of headline indicators to facilitate communication with policy makers, the media and citizens. The report recognised that presenting a large set of indicators, while helpful for describing the multi-dimensional nature of green growth, ran the risk of not presenting a clear message. The idea of developing a single,

composite indicator was considered but rejected. While this type of indicator is easy to communicate, this advantage is offset by difficulties of aggregating the data components; how the components are chosen and weighted depends on judgements which may legitimately differ (OECD 2002). Thus it was decided to develop a small, well-balanced, representative set of 'headline' indicators to track a few central elements of the green growth concept. A small Reflection Group was set up for this purpose, comprising member country representatives with environmental, economic and statistical expertise[1]. They established the following criteria to guide their selection:

- Capture the interface between the environment and the economy
- Easy to communicate for multiple users and audiences
- Aligned with the OECD measurement framework for Green Growth
- Measurable and comparable across countries

On this basis, six headline indicators were identified, plus a placeholder for a future headline indicator on economic opportunities and policy responses. As for the full indicator set, the proposed list of headline indicators is not necessarily final. As the measurement agenda advances, new data may become available and the list of headline indicators may need to evolve accordingly. Some of the proposed headline indicators are not yet fully measurable, but were retained nonetheless to drive the measurement agenda (Table 1.2).

Table 1.2. Overview of proposed headline indicators

Environmental and resource productivity	
Carbon productivity	**1. CO_2 productivity**
Resource productivity	**2. Non-energy material productivity**
Multifactor productivity	**3. Multifactor productivity including environmental services**
The natural asset base	
Renewable and non-renewable stocks	**4. Natural resource index**
Biodiversity and ecosystems	**5. Changes in land use and cover**
Environmental quality of life	
Environmental health and risks	**6. Air pollution (population exposure to PM 2.5)**
Economic opportunities and policy responses	
Technology and innovation, environmental goods and services, prices and transfers, etc.	*Placeholder – no indicator specified*

3. RECENT DEVELOPMENTS

3.1. Calculation methods and indicators

Current efforts are focused on further developing the demand-based indicators for carbon and material productivity, and developing new indicators for adjusted multifactor productivity (Box 1.3) and a natural resource index (Box 1.4). Further work is also being done on changes in land use and cover, on population exposure to air pollution, and on "green" foreign direct investment. Elaborating these indicators requires methodological development as well as the compilation of new data. Finally, cooperation is developing with the private sector which also has an interest to develop metrics to help

[1] Representatives from three OECD bodies: the Committee on Statistics (CSTAT), the Working Party on Environmental Information (WPEI) of the Environment Policy Committee, and the Working Party No.1 of the Economic Policy Committee (WP1). The proposals and criteria for headline indicators were subsequently endorsed by the three OECD bodies as a basis for further work.

assess the sustainability of their operations and supply chains. The issue here is what could be done to bring the top-down approaches developed by national governments and international organisations in line with the bottom up approaches used by industry.

Box 1.3. Adjusting multi-factor productivity estimates to account for environmental services

Commonly used indicators of economic performance, such as multi-factor productivity (MFP), do not fully account for the role of the environment in production. They omit:

- *Environment-related inputs.* The underlying production function generally includes only labour and produced capital as inputs, not the use of natural resources and other environmental services. Yet, income generated through the use of natural assets (including *e.g.* minerals, fossil fuels, timber and water) is captured in gross domestic product (GDP).
- *Environment-related outputs or environmental 'bads'* generated by production (such as pollution and degradation). The benefits of investing in pollution reduction are thus reflected only to a very limited extent, while the total costs in terms of inputs (labour and capital) are captured.

As a result of these omissions, traditional MFP growth estimates give an incomplete picture of the economy. This may lead to erroneous assessments of future productivity developments and hence potential growth, and hence to inappropriate policy conclusions.

Some of these problems can be addressed by deriving a measure of MFP that is adjusted for the use of natural resources and other environmental services. The OECD has started research, developed a calculation method and applied it to selected countries. The work builds on the literature on productivity measurement with undesirable outputs (Pittman, 1983; Repetto *et al.* 1997). It integrates selected natural resources (land, timber, subsoil assets) as input factors and selected pollutant emissions (carbon dioxide, sulphur and nitrogen oxides) as undesirable outputs in the production function. The absence of data on resources such as water and fish stocks, preclude their inclusion in the analysis at this stage.

The framework is based on a standard production function, whereby output Y is derived using labour and capital input factors. This function is complemented by natural capital and the negative effect of bad output on production. Two adjustments are made to the standard production function. First, natural capital inputs (including minerals, oil, gas, coal and timber) are aggregated into a natural resource index and enter the production function as a third input factor. Second, 'bad outputs', essentially air pollutant and CO_2 emissions, are added to Y to derive effective output Q. In formal terms, effective output is defined as:

$$Q(R_t, Y_t) = f(K_t, L_t, S_t)$$

Where Q denotes effective output, Y output, R are the undesirable or bad outputs, K capital input, L labour input and S the flow of natural resources. S is an aggregate of different natural resource inputs.

The biggest **challenge** is data availability regarding the use of environmental inputs in production and the associated costs, in particular, the cost of the depletion and degradation of natural resources and their use in consumption and production. As a first step, the techniques to compute the monetary value of natural resources are consistent with the 2008 SNA and the 2012 Central Framework of the System of Environmental Economic Accounts (SEEA). No attempt is made to estimate the value of other environmental services, particularly for "non-uses" such as regulating services. The SEEA *Experimental Ecosystem Accounts* will, in the longer term, provide further guidance on techniques for valuations.

Although subject to limitations in its practical implementation, this extension of productivity measurement can allow for a more accurate assessment of economic performance. Preliminary **results** of the OECD's work show that the productivity growth of an economy can be overestimated in countries where output growth relies to a large extent on the depletion of natural resources in production or where production costs are held down by relying on heavily polluting technologies. While this can generate additional output of goods and services in the short run, it also generates higher external costs, which can impinge on future well-being and the sustainability of economic development. Conversely, the economic performance and sustainability of an economy that invests in a more efficient use of environmental services in production may be underestimated, as some inputs do not serve to increase the current production of goods and services, but to reduce the associated negative externalities *e.g.* from greenhouse gas or pollutant emissions.

Source: Brandt, N.P. Schreyer and V. Zipper (2013).

Box 1.4. Calculating an index of natural resources

Work is underway in the OECD on an index of natural resources that could be used to monitor the evolution of a country's natural asset base and to help assess whether the use of its natural resource stocks is sustainable.

Economic theory provides a criterion for tracking the sustainable use of one or several natural resources between two points in time: the asset base is used sustainably if the aggregate social value of the net change in assets is non-negative. Net change is defined as the difference between additions and reductions to stocks of natural resources. For a single homogenous natural resource, this can be expressed in physical units. For multiple assets, it gets more complicated. To aggregate the net changes of different types of assets, a common unit must be chosen. Ideally, this common unit would be the value of the net changes in stocks using social shadow prices. In practice, social prices are not available for all natural assets therefore proxy measures to capture and weight depletion across resources have to be used. In line with the 2008 SNA and the 2012 Central Framework of the SEEA, it is proposed to value resource stocks using the net present value (NPV) method that sums up discounted future flows of resource rents. The key feature of the index is reliance on aggregation weights that reflect private valuations of the assets in the form of discounted flows of resource rents for extractors. A discussion of valuation methods as well as the details of the NPV approach can be found in Chapter 5 of the SEEA.

The proposal is to construct a quantity index of natural resources $I^{t/t-1}$ that tracks the average rate of changes in stocks across natural assets over a given period of time (between t and t-1). The quantity change of each asset is weighted by the share that this asset occupies in the total value of assets at the beginning of the period, valued at mid-period prices.

$$I^{t} = \sum_{i} \frac{\bar{p}_i^{t} X_i^{t-1}}{\sum_i \bar{p}_i^{t} X_i^{t-1}} \frac{X_i^{t}}{X_i^{t-1}} = d^{t} + 1$$

where $\bar{p}_i^{t}$ is the average price of the period, X_i^{t-1} stands for the opening stock of the natural resource (in physical units); X_i^{t} stands for the closing stock of the natural resources (in physical units).

When used in an international context, the index would be adapted to countries' specific circumstances and resource endowments by using country-specific weights. It could be expressed so that a number equal or greater than 1 would indicate that the natural asset base is being maintained or growing, while a number less than 1 would indicate that it is being depleted.

The natural resource index is currently being tested and its calculation method refined. The scope of natural assets covers energy and non-energy mineral resources, soil, timber, and water resources. Aquatic resources such as fish stocks are within the scope in principle, but are excluded in practice because national resource ownership cannot be clearly delineated. Biodiversity and ecosystems are not included to date because of data gaps and complexities in valuation.

A crucial issue is data availability. The information required includes data on the stocks and flows of the assets in physical units; unit revenues and unit costs to compute resource rents; and information about the expected extraction profile or the remaining asset life, to compute each asset's net present value (see the table below). While preliminary results show that a lot of information is available for many countries, important information gaps remain, in particular for assets such as soil and water. It is expected that the compilation by the OECD of a set of core tables in line with the SEEA will help closing gaps. Eventually the implementation in countries of SEEA asset accounts will become the source for most elements of the table. In the short run, existing information could be gathered at the international level, from OECD sources, industry sources, and from other international organisations, such as the World Bank.

Information requirements for the construction of the natural resource index

Resource	Asset, physical units (Class A: commercially recoverable)			Unit revenues from sales of extracted resource during period	Unit costs of extraction/prod. during period	Expected extraction rate or remaining asset life
	Stock beginning or end of period	Reductions	Additions			
Mineral and energy resources						
Oil resources						
Natural gas resources						
Coal & peat resources						
Non-metallic mineral resources						
Metallic mineral resources						
Soil resources						
Timber resources						
Water resources						

Source: OECD (forthcoming), "Aggregate index of natural resources: Methodological note", *OECD Statistics Working Paper*.

3.2. The System of Environmental-Economic Accounting

The 2011 OECD GGI report identified the combination of economic and environmental data as a key challenge. This is often due to differences in classification, terminology or timeliness. It suggested that the System of Environmental-Economic Accounting (SEEA) provides an important framework for addressing this challenge. In February 2012, the Central Framework of the SEEA was adopted by the United National Statistical Commission as a worldwide statistical standard. Two other documents are to follow: SEEA Experimental Ecosystem Accounts, and SEEA Applications and Extensions.

The SEEA Central Framework is a multi-purpose, statistical framework that describes the interactions between the economy and the environment, and changes in stocks of environmental assets. It uses concepts, definitions, classifications and accounting principles that are in line with those of the system of national accounts (SNA). This makes the SEEA a valuable tool for deriving indicators that monitor the interactions between the economy and the environment. 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.

Indicators that benefit most from the SEEA accounting framework are those that monitor (Table 1.3):

- the environmental and resource efficiency of the economy.
- environmental assets and their role in the economy.
- environmentally-related activities and instruments, and their role in the economy.

Table 1.3. 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

Placing green growth measurement efforts within the SEEA framework requires a programme of work for the implementation of the SEEA and the co-operation of various international and national

agencies. To support this effort, the OECD is developing a small set of SEEA core tables that will help compiling internationally comparable data for calculating its green growth indicators.

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Chapter 2. Green growth indicators in practice

Since 2011, practical applications of green growth indicators have progressed. Governments use the OECD framework to develop indicators appropriate for their national circumstances and to assess the state of their economy in terms of green growth. Green growth indicators are also being integrated into OECD work, including country reviews and policy analysis. A *database* bringing together the indicators has been established to this end.

Feedback from these applications is important to further elaborate and refine the indicator set, and to share experiences and good practices.

To achieve synergies at a broader scale, international co-operation is essential. The OECD works with the Global Green Growth Institute, UNEP and the World Bank within the framework of the ***Green Growth Knowledge Platform*** to promote common approaches and advance knowledge about the measurement of green growth.

1. APPLICATIONS OF THE OECD MEASUREMENT FRAMEWORK IN COUNTRIES

A number of countries are using the OECD framework to assess the state of their economy in terms of green growth and have developed indicators appropriate for their national circumstances. Among these are OECD countries, as well as countries in Latin America and the Caribbean (LAC), in Eastern Europe, Caucasus and Central Asia (EECCA) and in East-Asia.

Feedback from these applications is important for the further development and refinement of the indicator set, and for the sharing of experiences and good practices. It also shows that different countries and regions place more or less emphasis on aspects such as economic opportunities, social issues and the environmentally sound management of the natural asset base.

- The **Netherlands** published a first set of 20 green growth indicators in 2011 based on the preliminary OECD set. They were elaborated 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. The indicators cover the four main dimension of green growth and are updated at regular intervals. A graphical profile is available on the CBS website. An updated report was released in 2013.

- The **Czech Republic** published a set of 27 green growth indicators building on the OECD framework. The indicators cover the four main dimensions of green growth, as well as the socio-economic context with emphasis on sustainability and equity issues. The work is carried out by the Czech Statistical Office in cooperation with the Charles University Environment Centre. An updated report was released in 2014.

- **Korea** used the OECD framework to develop 30 green growth indicators as part of its five-year plan for green growth adopted in 2009. The indictors assess the economy from a green growth perspective and monitor the implementation of the 5-year plan. The focus is on climate and energy issues in line with the Framework Act on Low Carbon Green Growth. Less attention is given to the natural asset base. Additional country specific indicators relate to: greenhouse gas sinks, self-sufficiency rates for energy and food, access to public transport and to green space, environmental certification of businesses, government budget for disaster prevention. The work is carried out by Statistics Korea in cooperation with the Seoul National University and the Presidential Committee on Green growth.

- **Denmark** uses the OECD measurement framework to develop indicators on economic opportunities and policy responses in the field of climate change and energy efficiency. Special attention is given to green production and to the environmental goods and services sector. The data underlying the indicators are elaborated in accordance with European statistical guidelines. The results are published jointly by the Danish Energy Agency of the Ministry of Climate, Energy and Building, the Danish Business Authority of the Ministry of Business and Growth and the Danish Environmental Protection Agency of the Ministry of the Environment.

- **Germany** has tested the OECD set of green growth indicators building on the German experience with sustainable development indicators and with environmental accounting. The resulting 27 indicators cover the four main dimensions of green growth. For some indicators the definition was adjusted. The work was carried out by the Statistical Office.

- The **Slovak Republic** has initiated work to develop a national set of green growth indicators building on the OECD framework, and has published first results. The work is led by the Slovak Environmental Agency in cooperation with the environment ministry and the statistical office. It is to be accompanied with the establishment of an intergovernmental data collection and processing scheme to ensure a regular updating of the indicators.

- **Slovenia** has initiated work on green growth indicators using the OECD framework and building on its experience with sustainable development indicators. The work is carried out by the Statistical Office of the Republic of Slovenia.
- In **Chile,** the Ministry of Finance and the Ministry of the Environment jointly developed a Green Growth Strategy to promote economic growth while protecting the environment, creating jobs, and encouraging social equity. The strategy involves monitoring and measurement through green growth indicators building on the OECD framework, supplemented with behavioural and wellbeing indicators.
- **Mexico** is applying the OECD Green Growth indicators, 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).
- 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 2.1). 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.
- In **Eastern Europe, Caucasus and Central Asia**, a pilot application of the OECD Green Growth indicators is underway in **Kyrgyzstan**. The work is carried out under the EAP Task Force, a body for which the OECD serves as secretariat and which supports the implementation of green growth policies in this region. The work also aims to contribute to the establishment of a Shared Environmental Information System in the pan-European region. Emphasis is put on the long-term prospects for a commercially viable exploitation of natural assets. **Kazakhstan**, which holds about 3% of the world's recoverable oil reserves, is interested in applying the OECD measurement framework to support its move towards cleaner energy sources for power generation.
- In **East Asia**, eight emerging and developing ASEAN countries, Malaysia, Thailand, Indonesia, the Philippines, Vietnam, Lao PDR, Cambodia and Myanmar participate in a project on the promotion of green growth in the region supported by Korea and led by the OECD. A database with green growth indicators for participating countries is being established. Particular attention is given to business opportunities for SMEs and to productivity issues.

The 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 length of the time series varies among countries. Several countries lack data over long periods, which limits the indicators' usefulness for assessing the results of policies.

The feedback received so far indicates that the use of green growth indicators in developing countries requires some special considerations. Developing countries 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 2.1. 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 related to indicator applications

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: based on CAF-OECD-UNIDO (forthcoming), *Monitoring Green Growth in the LAC Region: Progress and Challenges*.

2. APPLICATIONS OF GREEN GROWTH INDICATORS IN OECD WORK

Following the delivery of the Green Growth Strategy to Ministers in May 2011, green growth, including green growth indicators, is being integrated into relevant OECD work. For example, green growth considerations are being built into national policy surveillance, such as Economic Surveys, Environmental Performance Reviews, Investment Policy Reviews, Innovation Reviews and the Green Cities programme. These cover OECD, emerging and other economies. Green growth considerations are also being built into multilateral structural policy surveillance, into sectoral and thematic assessments in areas such as energy, agriculture, fisheries, transport, water, territorial policies, employment and local development, and development cooperation.

Green growth indicators play an important role in supporting this work. A *database* bringing together the data needed to calculate the indicators and to support policy analysis has been established to this end. And the report on *OECD Green Growth Indicators* will be published regularly.

Two areas where green growth indicators are figuring prominently are in the OECD's work on environment and on the economy:

- Green growth and green growth indicators are being integrated into the OECD's core economic advice, notably through regular analytical publications such as the ***Economic Country Surveys***. Economic Surveys analyse policies that have an important environmental dimension and their interaction with growth policy recommendations, and assess the overall costs and benefits.

- The OECD's ***Environmental Performance Reviews*** of countries have been restructured to place a greater emphasis on green growth and the related indicators. Green growth indicators complement and reinforce the OECD core set of environmental indicators and the set of key environmental indicators endorsed by Ministers for use by the OECD. A first chapter uses the main elements of the green growth measurement framework to present a snap-shot of the reviewed countries' progress in the transition to a low-carbon, resource-efficient economy (environmental and resource productivity), managing the natural asset base, and environmental quality of life.

As the indicators are further developed and their linkages with economic and environmental outcomes are better explored – green growth indicators will also assist in identifying policy opportunities that both strengthen growth and improve environmental outcomes or in identifying policies that address possible trade-offs between green and growth objectives. This is particularly useful for mainstreaming green growth considerations into the OECD ***Going for Growth*** project. Going for Growth uses the OECD's expertise on structural policy reforms and economic performance to provide concrete 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 policy recommendations on two other aspects of well-being, income distribution and the environment.

3. 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 Program*** (UNEP) launched its *Green Economy* 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," and is preparing a manual on using indicators to develop green economy policies. The manual is to be applied in all the countries where UNEP provides advisory services. 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 emphasizes 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*) Global Partnership, the World Bank provides technical support and capacity building for implementing the System of Environmental-Economic Accounting (SEEA), including experimental ecosystem accounts.

- ***The Global Green Growth Institute*** (*GGGI*) proposes several categories of green growth indicators, 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 programs and projects.

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

- The ***Inclusive Wealth Report 2012*** by the International Human Dimensions Programme on Global Environmental Change is the first in a series of biennial reports to measure progress toward sustainability. It is a joint initiative of the United Nations University International Human Dimensions Programme on Global Environmental Change (UNU-IHDP) and the United Nations Environment Programme (UNEP) in collaboration with the UN Water Decade Programme on Capacity Development (UNW-DPC) and the Natural Capital Project. The 2012 report 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. (http://ec.europa.eu/resource-efficient-europe/index_en.htm).

- The European Commission's ***IGrowGreen*** assessment framework (*European Commission, 2011*) 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.

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Part II: The Indicators

CHAPTER 3. THE SOCIO-ECONOMIC CONTEXT AND CHARACTERISTICS OF GROWTH 37

3.1 Economic growth, productivity and competitiveness 40
3.2 Labour market, education and health 45

CHAPTER 4. THE ENVIRONMENTAL AND RESOURCE PRODUCTIVITY OF THE ECONOMY 53

4.1 Carbon productivity 56
4.2 Energy productivity 62
4.3 Resource productivity: Materials 66
4.4 Resource productivity: Nutrients 71

CHAPTER 5. THE NATURAL ASSET BASE 79

5.1 Freshwater resources 82
5.2 Forest resources 85
5.3 Fish resources 88
5.4 Biodiversity and ecosystems: Land resources 91
5.5 Biodiversity and ecosystems: Wildlife resources 95

CHAPTER 6. THE ENVIRONMENTAL QUALITY OF LIFE 101

6.1 Environmental health and risks: Air quality 104
6.2 Environmental services and amenities: Access to sewage treatment 107

CHAPTER 7. ECONOMIC OPPORTUNITIES AND POLICY RESPONSES 111

7.1 Technology and innovation 114
7.2 Environmental goods and services 119
7.3 International financial flows 123
7.4 Environmentally related taxes and transfers 128

Cut-off date

This part is based on information and data available to the OECD Secretariat up to the beginning of September 2013.

All indicators presented here are extracted from OECD and other international work.

CHAPTER 3.

THE SOCIO-ECONOMIC CONTEXT AND CHARACTERISTICS OF GROWTH

Economic growth, productivity and competitiveness

Labour market, education and health

THE SOCIO-ECONOMIC CONTEXT AND CHARACTERISTICS OF GROWTH

Green growth indicators bear on the interaction between economic growth and the environment. This section provides information on the socio-economic context, 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.

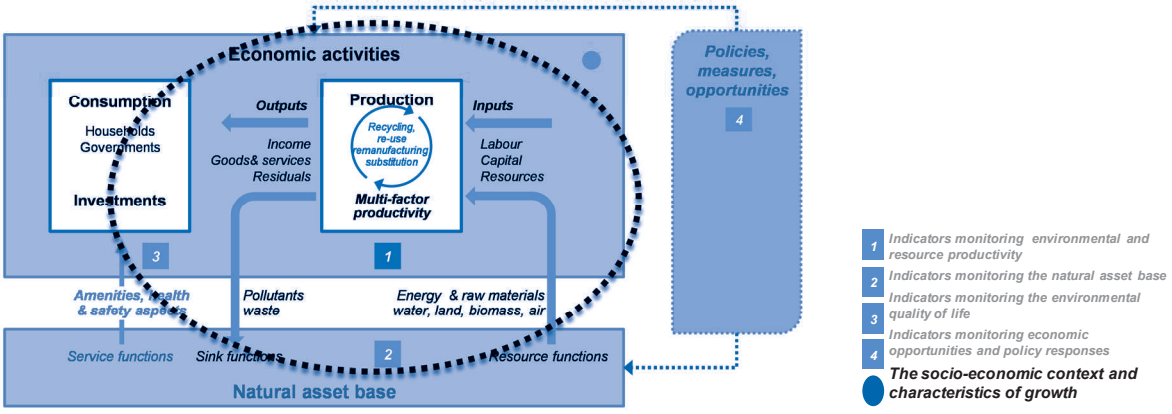
Such information is useful to:

- track the effects of green growth policies on growth;
- establish links to social concerns such as poverty reduction, social equity and inclusion;
- interpret green growth indicators in the light of national socio-economic circumstances, and complement them with additional detail.

  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.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

FRAMEWORK



PROPOSED INDICATORS

Group/theme	Proposed indicators	Type	M
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.

ECONOMIC GROWTH, PRODUCTIVITY AND COMPETITIVENESS

PROVIDING CONTEXT THROUGH INDICATORS

The indicators presented here inform about:

Economic growth and structure

- **Gross domestic product** to measure market and government production and the associated economic activity. This indicator relates to the sphere of production. As a "gross" measure, it takes no 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.
- **Net national income** to capture the average material well-being of individuals and households. These income flows can differ from GDP because they take into account the depreciation of produced capital, and income flows between residents and the rest of the world. Real income is also influenced by changes in the terms of trade, the development of export prices relative to import prices. Rising terms of trade permit more imports to be purchased for a given value of exports, thereby increasing the purchasing power of nominal income.

Productivity and trade

- **Labour productivity,** a key driver of economic growth and living standards, expressed as GDP per hour worked.
- An important source of **labour productivity** is multifactor productivity growth – the increase in economic output that cannot be explained by increases in economic inputs – that raises the rate of output growth and therefore domestic income. **Multifactor productivity** is often associated with technological change and innovation that allow for new ways of addressing environmental problems. It is an important driver of output growth and therefore domestic income. It should be noted that the measure presented here recognises only labour and capital inputs and not primary inputs of natural capital that also feed into production.
- **Trade-weighted unit labour costs** (ULCs) in manufacturing as a proxy measure of international price competitiveness. Unit labour costs reflect the combined effects of wage development and labour productivity. ULCs are defined as the average cost of labour per unit of output produced. Changes in unit labour costs approximate output price developments as labour accounts for a significant share of final output. 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, expressed as exports and imports of goods and services, over GDP. This measure indicates exposure to international competition abroad and domestically.

Inflation and commodity prices

- **Commodity prices** are directly related to important natural resources such as minerals or fossil fuels. 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.

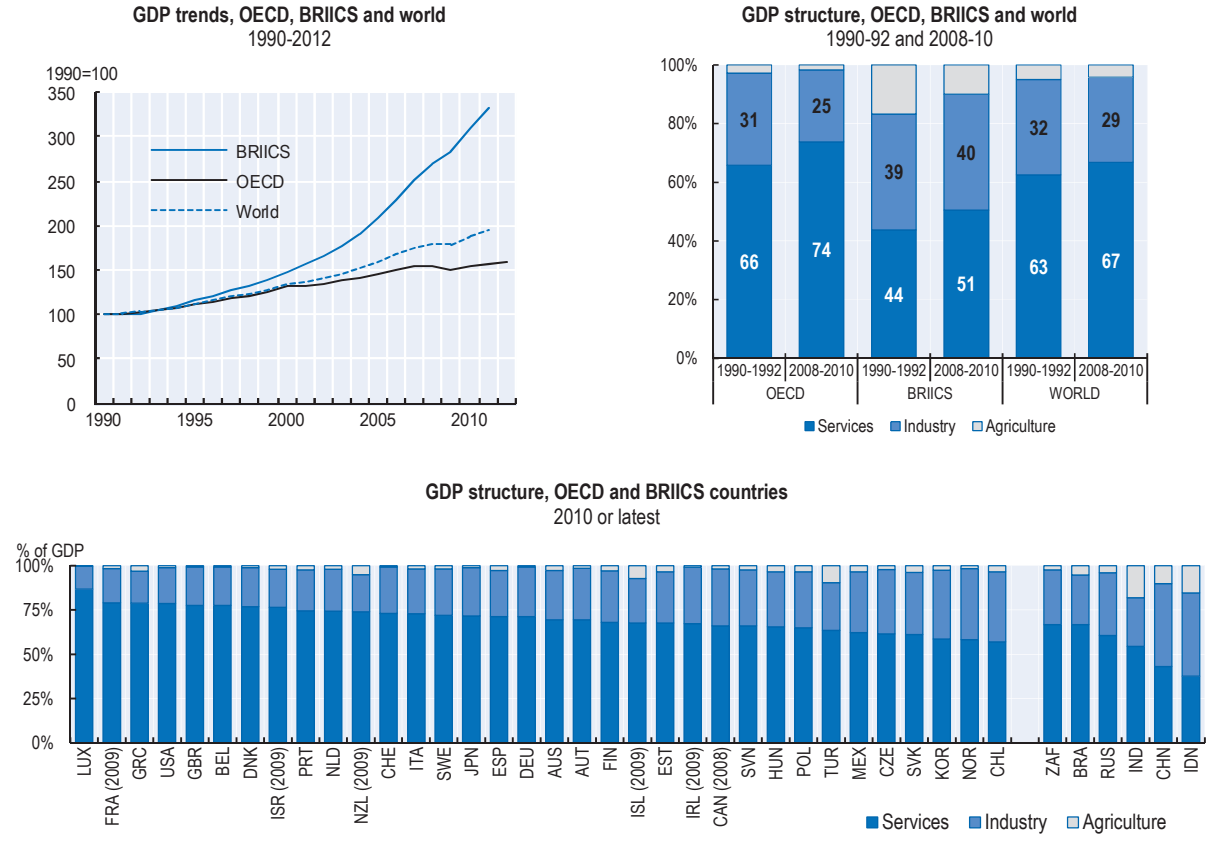
MEASURABILITY

Data on economic indicators used here are available across a wide range of countries and based on international statistical standards such as the System of National Accounts. Some uncertainty exists about all aspects of methodology for BRIICS 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. See also *Definitions and notes* page 50.

ECONOMIC GROWTH AND STRUCTURE

Figure 3.1. GDP trends and structure

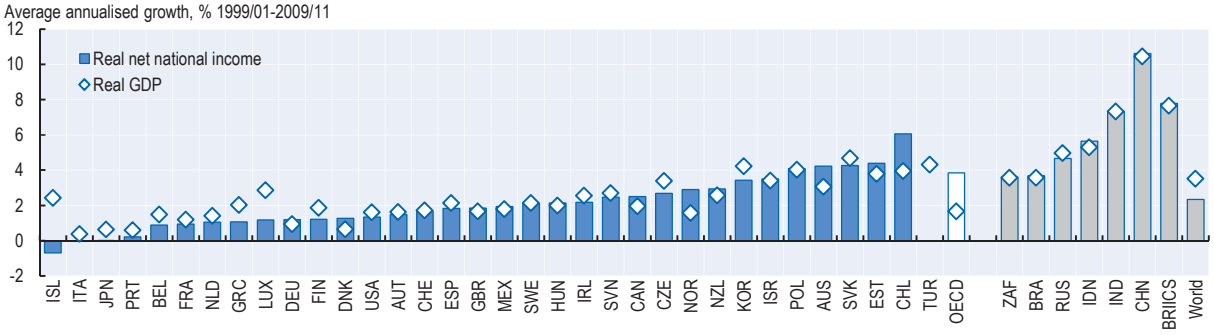


Source: OECD Economic Outlook: Statistics and Projections (database), *OECD National Accounts Statistics* (database), World Bank, *World Development Indicators*.

StatLink http://dx.doi.org/10.1787/888932924951

Figure 3.2. Net national income and GDP

OECD and BRIICS countries, annualised growth 1999-2001 to 2009-11



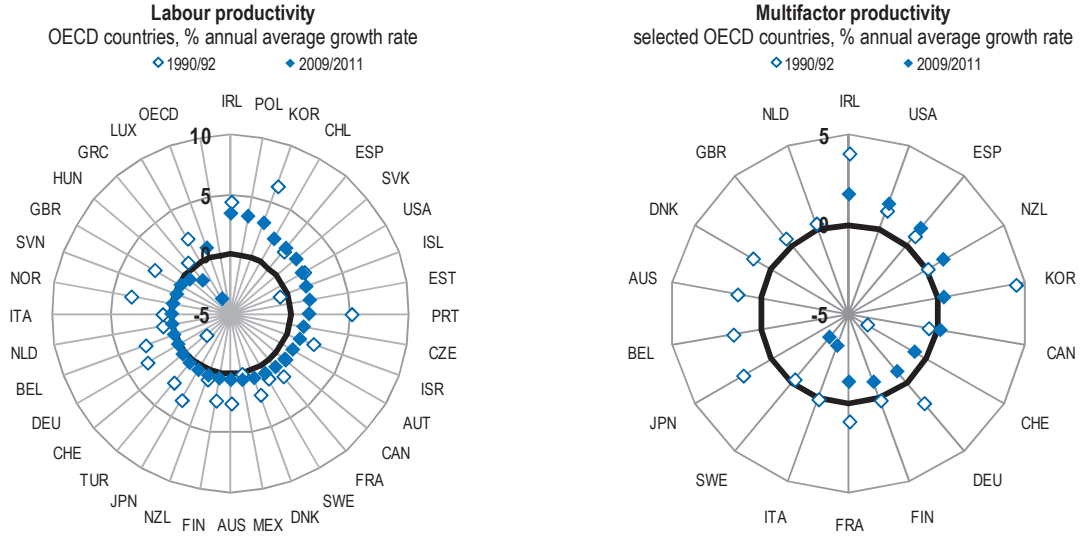
Notes: Real net national income for OECD countries; GNI for BRIICS countries.

Source: OECD National Accounts Statistics (database). *OECD Economic Outlook: Statistics and Projections* (database), World Bank, *World Development Indicators*.

StatLink http://dx.doi.org/10.1787/888932924970

PRODUCTIVITY AND TRADE

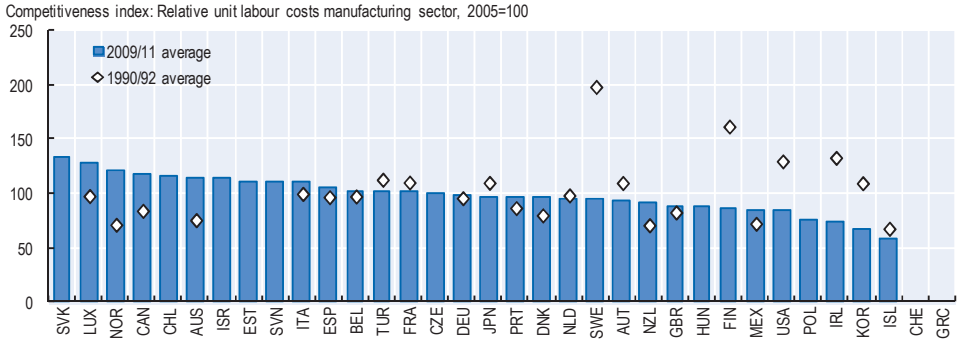
Figure 3.3. Labour and multifactor productivity growth



Source: OECD Productivity Statistics (database).

StatLink http://dx.doi.org/10.1787/888932924989

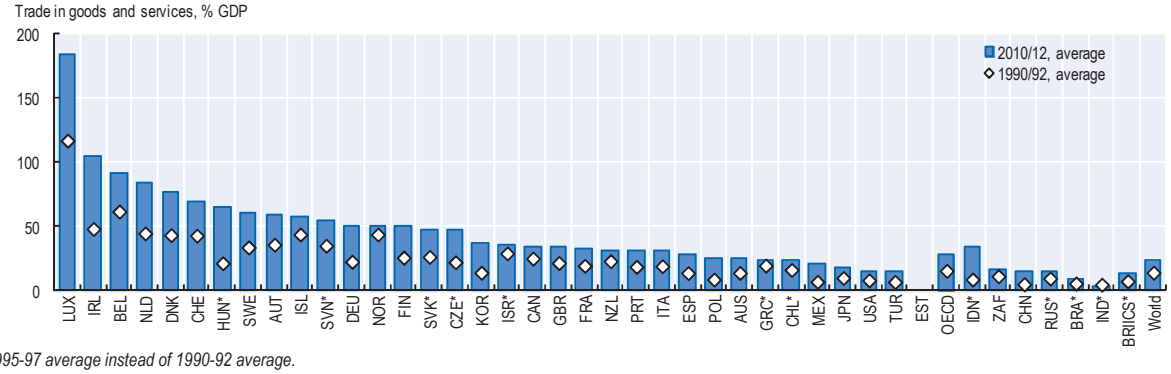
Figure 3.4. Competitiveness index
OECD countries, 1990-92 and 2009-11



Source: OECD Economic Outlook: Statistics and Projections (database).

StatLink http://dx.doi.org/10.1787/888932925008

Figure 3.5. Trade in goods and services
OECD and BRIICS countries, 1990-92 and 2010-12



** 1995-97 average instead of 1990-92 average.*

Source: OECD Economic Outlook: Statistics and Projections (database).

StatLink http://dx.doi.org/10.1787/888932925027

MAIN TRENDS

Marked differences in economic growth rates…

Global economic growth since 1990 has been marked by large differences between countries. The output growth in BRIICS has exceeded the average growth in the OECD (the former at 6.2%, compared to 1.4%, average annual growth, 1990-2011). Strong growth in emerging markets has environmental implications due to increased demand for energy, raw materials and intermediate products. Differences in growth patterns between OECD countries and the BRIICS countries are less striking when growth is measured on a per capita basis (2.2% for the OECD, 5.9% for BRIICS, average annual growth, 1990-2011). This reflects diverging demographic trends between the two groups.

Four years after the start of the financial crisis, GDP growth in the OECD area has begun to gradually strengthen. But the pace has varied across countries and a sustainable recovery does not appear to have yet been established in all OECD countries. Differences in GDP per capita remain significant, though some countries with initially lower GDP per capita levels have converged towards average income levels in the OECD. Differences in GDP per capita growth across OECD countries can be mainly attributed to differences in labour productivity.

Real income grew at similar rates as GDP over the last decade, with only a few exceptions among OECD countries. The countries that gained most in terms of material well-being, as measured by real net income, were those that saw improvements in their terms of trade, which allowed higher domestic consumption of goods and services at a given level of domestic production.

… with changes in the structure of output

Growth in income and increased participation of countries in global trade were followed by expansion of the **services sector** in terms of value added to the economy. Between 1990-92 and 2008-10, the share of services in GDP rose from 66% to 74% for the OECD and from 44% to 51% for BRIICS. The higher contribution of services to GDP was reflected by a shrinking agricultural sector, particularly in the BRIICS economies (-8 percentage points) and an output contraction of the industrial sector, particularly, in OECD countries (also -8 percentage points).

In BRIICS, the relative share of **industry** expanded in Indonesia (from 39% to 47%) and China (from 41% to 47%), while it contracted in Brazil (from 39% to 28%), the Russian Federation (from 48% to 37%) and South Africa (from 40% to 31%).

Greater specialisation in global supply chains and potential displacement effects to emerging economies

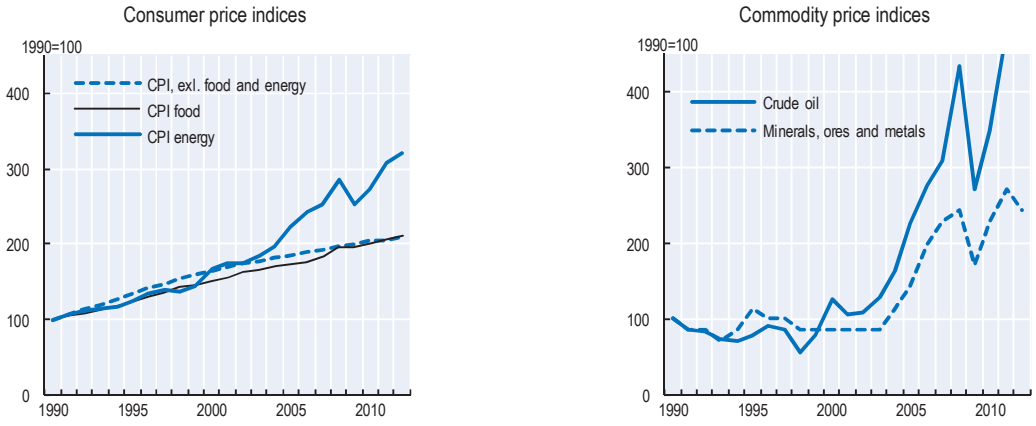
Trade is one of the key contributors to economic growth. It is closely associated with foreign investment, developments in the international chain of value added and trends towards greater specialisation and interconnectedness of producers and consumers. When tasks that are environmentally intensive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

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.

Multifactor productivity (MFP) grew more slowly in the 2000s than the 1990s in those OECD countries for which data are available. After the economic crisis, there was a sharp fall in some countries, and there are risks that this could herald declining longer term trends in labour productivity growth.

INFLATION AND COMMODITY PRICES

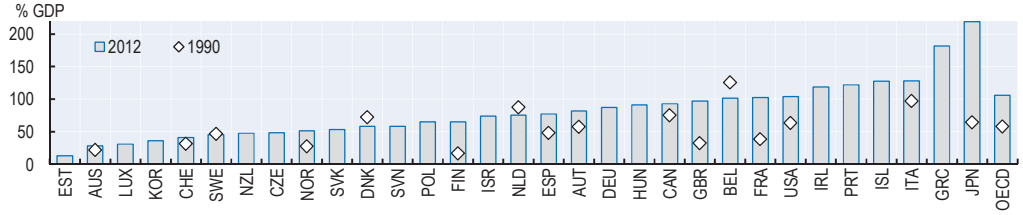
Figure 3.6. Consumer and commodity price indices
OECD, 1990-2011



Source: OECD Economic Outlook: Statistics and Projections (database)

StatLink http://dx.doi.org/10.1787/888932925046

Figure 3.7. General government gross financial liabilities, % of GDP
OECD countries, 1990, 2012



Source: OECD Economic Outlook: Statistics and Projections (database)

MAIN TRENDS

Highly volatile commodity prices…
…can discourage investment that favours greener growth

Commodity prices showed increased volatility and an upward trend, particularly after 2000. Volatility of aggregate output is related to the composition of output. Manufacturing, mining and agriculture are more responsive to demand and supply shocks, while non-financial services are less so. Swings in economic activity are thus likely to be more correlated with swings in environmental pressures when countries are oriented towards energy-intensive manufacturing and resource-intensive primary sectors.

Rising input costs along with resource constraints bear potentially adverse implications for the environment. Trends in food prices have been influenced by changing climatic conditions and by increased production of biofuels.

Commodity prices affect demand for important natural resources such as minerals and fossil fuels, as well as their alternatives. Although long-term trends inform about the scarcity or abundance of natural resources, overly volatile price movements may discourage environment-friendly investment. When associated with unbalanced macroeconomic conditions and high government debt this may hamper countries' progress towards greener growth.

LABOUR MARKET, EDUCATION AND HEALTH

PROVIDING CONTEXT THROUGH INDICATORS

The indicators presented here inform about:

Labour markets

- **Labour force participation** rates, measuring the part of an economy's working-age population that is economically active. This provides an indication of the relative size of the supply of labour available for the production of goods and services.
- **Unemployment rates** which represent the share of people unemployed relative to the persons in the labour force. High and persistent unemployment rates signal underutilisation of an economy's single most important resource, labour and human capital. By implication, there is unexploited growth potential.

Socio-demographic patterns

- **Population density**, the number of inhabitants per square kilometre.
- **Ageing ratio**, the ratio between population over age 64 years and population below age 15.
- **Life expectancy at birth**, the average number of years that a newborn can expect to live.
- **Healthy Life Years** (HLY), the number of years spent free of activity limitation by gender.

Education and income

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

  Information on the reading, mathematics and science performance is given as complement.
- **Income inequality**, measured by the Gini coefficient. This standard measure ranges from 0 (meaning everybody has identical incomes) to 1 (all income goes to only one person). Higher values thus indicate higher income inequality.

MEASURABILITY

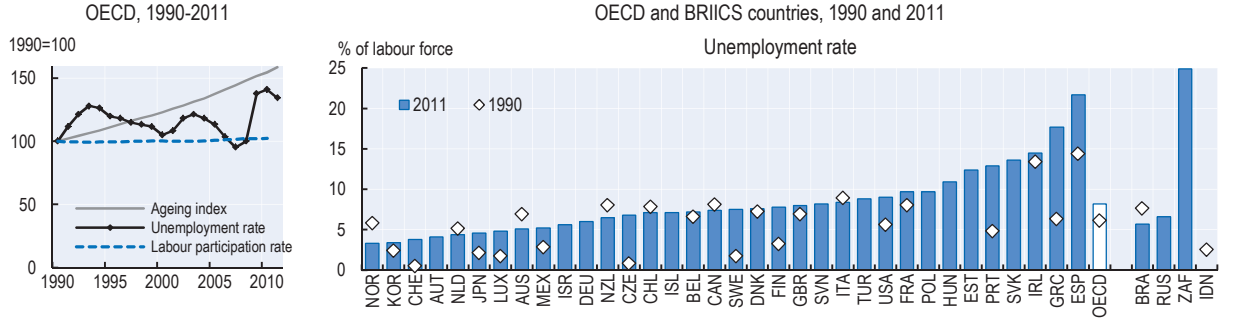
Comparable data for non-OECD countries on labour market conditions are difficult to obtain for long time series. Efforts are being made to further develop measures of income dispersion, job creation and worker reallocation.

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.

See also *Definitions and notes* page 50.

LABOUR MARKETS

Figure 3.8. Labour participation and unemployment

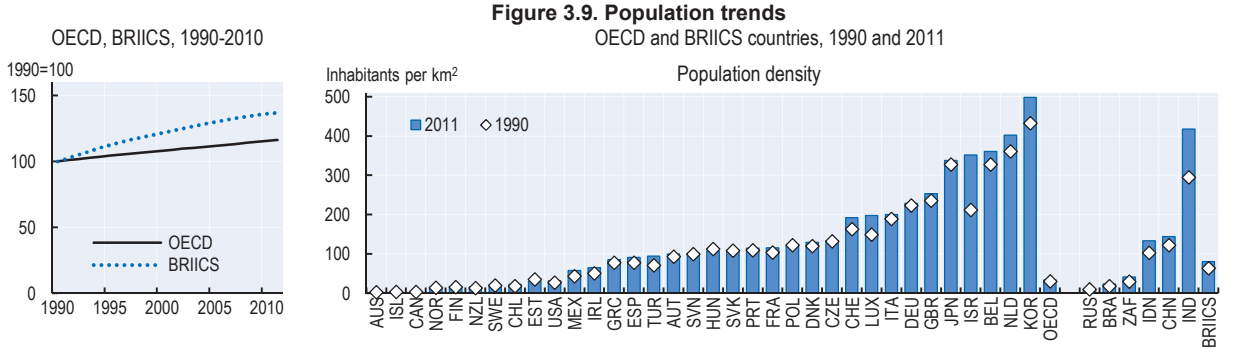


Source: OECD Employment and Labour Market Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925065

SOCIO-DEMOGRAPHIC PATTERNS

Figure 3.9. Population trends

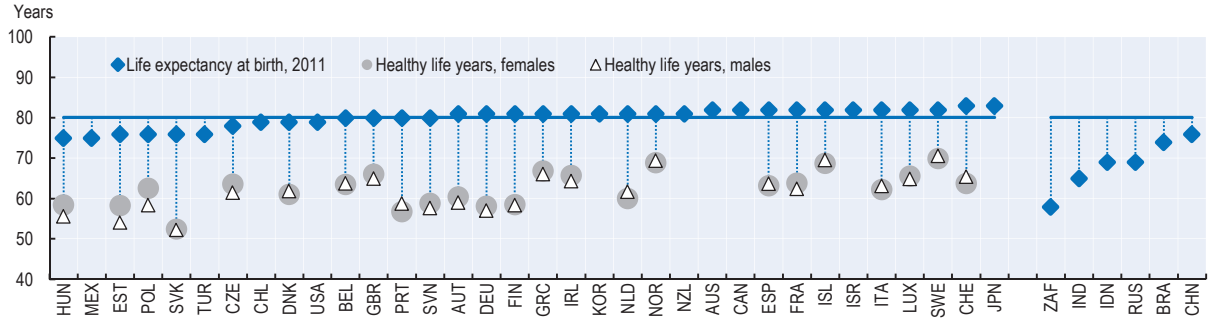


Source: OECD Employment and Labour Market Statistics (database); *OECD Historical Population Data and Projections* (database); FAO, *FAOSTAT* (database).

StatLink http://dx.doi.org/10.1787/888932925084

Figure 3.10. Life expectancy and healthy life years at birth

OECD and BRIICS countries, latest year available



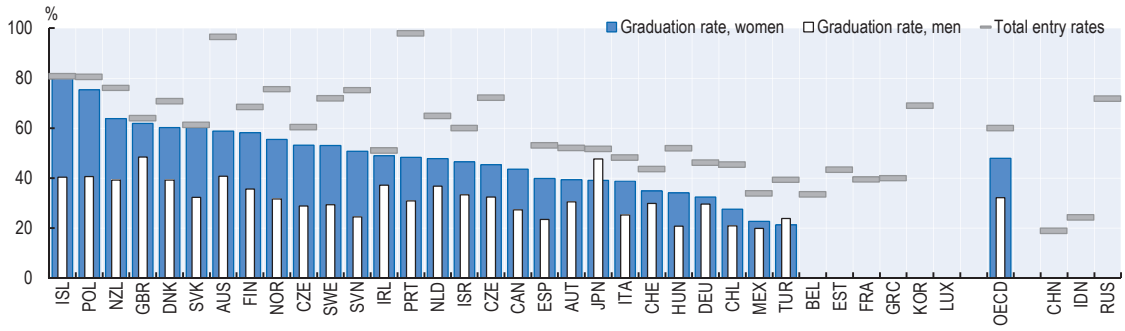
Source: *OECD Health Statistics* (database); Eurostat Statistics Database; Joint Action European Health and Life Expectancy Information System.

StatLink http://dx.doi.org/10.1787/888932925141

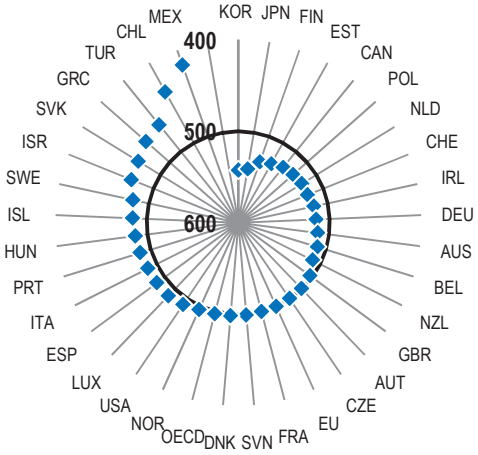
EDUCATION AND INCOME

Figure 3.11. Educational attainment

Tertiary-type A graduation and entry rates
OECD and BRIICS countries, 2011



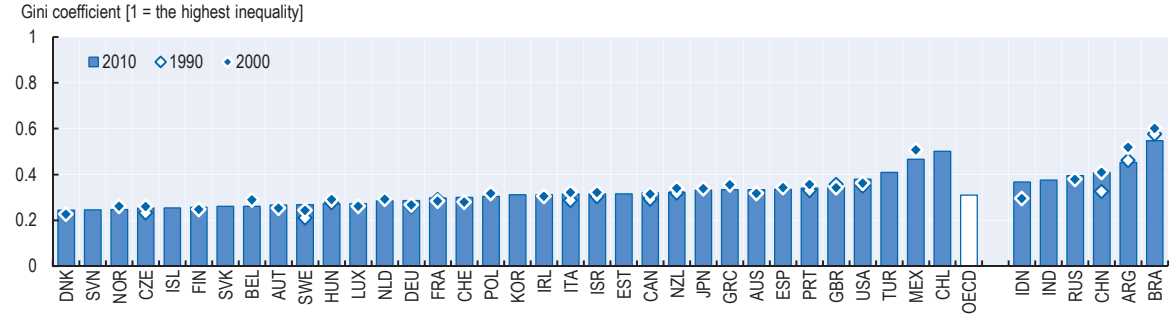
Mean reading, mathematics and science performance
OECD countries, average PISA score, 2011



Source: OECD (2013), Education at a Glance 2013: OECD Indicators; "OECD PISA 2011", *OECD Education Statistics* (database).

StatLink http://dx.doi.org/10.1787/888932925103

Figure 3.12. Income inequality
OECD and BRIICS countries, 1990, 2000 and 2010



Source: OECD Social and Welfare Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925122

MAIN TRENDS

Population and its structural elements (age classes, active population, size of households, *etc.*) influence production and consumption patterns, and are important determinants of environmental conditions. Population growth poses challenges for social and economic policies; it puts pressure on natural resources and adds to the challenge of providing sanitation and other environmental infrastructure.

- OECD countries account for about 18% of the world's population. By comparison, China alone accounts for a further 18% and India for 19%.
- Since 1990, population density has increased in high-birth and net-immigration OECD countries, and remained modest in others.
- Demographic ageing curbs growth prospects in OECD countries, and is also of some concern in emerging economies, such as China.

Labour demand has adjusted to the economic crisis

Labour demand has adjusted to the fall in aggregate demand that took place during the global recession. Between 2008 and 2011 – unemployment rates climbed steeply in most countries and have remained high ever since (8.2%, OECD average, 2011). Young people have been particularly hard-hit by un- and underemployment. In 2011, the average proportion of 15-29 year-olds neither in employment nor in education or training (NEET) across OECD countries was 16%; among 25-29 year-olds, this proportion was 20%.

There are still considerable differences across OECD countries, with unemployment persisting longer in some. Labour participation, on average, has remained stable in the OECD at around 73% of the working age population.

Rising income inequality poses social, environmental 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. This occurred even when countries were going through periods of sustained economic and employment growth.

- 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% – a ratio of 9 to 1. 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.
- Changes in the structure of households due to population ageing or the trend towards smaller household sizes also play a role though to a lesser extent than changes in the labour market.

Rising income inequality poses social, environmental and economic challenges, and needs to be taken into account when policies are designed and implemented (*e.g.* when the distributional effects of an environmental fiscal reform affect low income households whose expenditure share on water and energy is already higher than that of wealthier households).

Improving human capital contributes to competitiveness by enhancing absorption capacity and innovation

Building human capital through education and training is particularly important. Young people who complete secondary education will likely face fewer difficulties finding work and moving to environment-oriented sectors. Educational attainment has a huge impact on employability, and the crisis has strengthened this impact even further.

Between 2008 and 2011 the unemployment gap in the OECD area between those with low levels of education and those with high levels of education widened: across all age groups, the unemployment rate for low-educated individuals increased by almost 3.8 percentage points, while it increased by only 3.5 percentage points for highly educated individuals.

- Entry rates to university-level education rose substantially across OECD countries over the past decade. In OECD countries with comparable data, the proportion of young adults entering university-level programmes increased by 12 percentage points in 2000-09 and by nearly 25 percentage points in 1995-09.
- On average, graduation rates from university-level education have increased by 21% since the mid-1990s across OECD countries, though with important variations. Disparities in graduation rates are large between men and women, with more women (46%) obtaining university-level qualifications than men (31%).

Environment-related health risks reduce well-being and have economic costs Risk factors to health are increasingly linked to lifestyle.

Health is an essential element of well-being and economic development. Health risks associated with poor environmental conditions, such as chronic diseases, injuries and infectious diseases, reduce people's well-being and impose economic costs on households, companies and governments.

The past 50 years have been marked by:

- Remarkable gains in life expectancy, which has increased on average across OECD countries by more than 11 years and has stabilised at 80 years. Since the 1980s, the gender gap in life expectancy has narrowed in most OECD countries because of higher gains in longevity for men.
- Changes in the nature of risk factors to health: today much of the burden of diseases in OECD countries is linked to lifestyle factors.
- Steady growth in health spending, which has significantly exceeded GDP growth: health spending accounts for a high and growing share of public budgets, accounting for about 10% of GDP on average across OECD countries as a group.

Definitions and notes: the socio-economic context

Data on economic indicators used here are available across a wide range of countries and based on international statistical standards such as the System of National Accounts. Some uncertainty exists about all aspects of methodology for the BRIICS countries, although the basic indications arising from the data would seem robust. Comparable data for non-OECD countries on labour market conditions are difficult to obtain for long time series. Efforts are being made to further develop measures of income dispersion, job creation and worker reallocation.

GDP

Gross domestic product is a central measure of market and government production and associated economic activity, but takes into account neither the depreciation of produced assets nor the depletion of natural assets. Aggregate real GDP index: based on chained constant USD and constant purchasing power parities (PPPs, base year 2005).

GDP structure: Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting and fishing, as well as cultivation of crops and production of livestock. Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing, construction, electricity, water and gas. Services corresponds to ISIC divisions 50-99 and includes value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional and personal services such as education, health care and real estate services. Also included are imputed bank service charges, import duties and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

Net national income

Net national income captures the average material well-being of individuals and households. Unlike GDP, it 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 net national income (NNI) at market prices. Aggregate net national disposable income: based on chained constant USD and constant PPPs (base year 2005 for the OECD). Real income has been obtained through deflation with a consumer price index. BRIICS: gross national income, base year 2000.

Labour productivity

Defined as GDP per hour worked, with GDP expressed in national currency, at constant prices, OECD base year (2005) for individual countries; and expressed in US dollars, at constant prices, constant PPPs, OECD base year (2005) for country groups/zones. Labour input is defined as total hours worked by all persons engaged.

Multifactor productivity

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 here only recognises labour and capital inputs and not primary inputs of natural capital that also feed into production. Some of the contribution of such natural capital to output growth is thus wrapped in with the productivity measure.

Competitiveness index: trade-weighted labour costs

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). This is a proxy measure of international price competitiveness.

Relative importance of international trade

The indicator 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.

Inflation, commodity and stock market prices

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.

Gross financial liabilities

Gross financial liabilities include all financial liabilities as defined by the system of national accounts and cover the general government sector, which is a consolidation of central, state and local governments and the social security

sector. Primary balance is defined as government net borrowing or net lending excluding interest payments on consolidated government liabilities.

Labour markets

The labour force participation rate measures the part of an economy's working-age population that is economically active. It provides an indication of the relative size of the supply of labour available for the production of goods and services. The unemployment rate is the ratio of number of persons unemployed and number of persons in the labour force. The labour force participation rate is defined as the ratio of the labour force to the working age population, expressed as a percentage. The criteria for status as unemployed or employed are defined by the ILO guidelines. High and persistent unemployment rates signal underutilisation of an economy's single most important resource, labour and human capital. The ageing index is defined as population above age 64 years relative to population below age 15.

Education

- PISA is the Programme for International Student Assessment.
- Level of education is measured by graduation rates of men and women from tertiary-type A programmes. 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. High graduation and participation rates in tertiary education imply that a highly educated labour force is being developed and maintained. 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.
- Users of the data must be aware that they may no longer fully reflect the current situation in fast-reforming countries.

Population

Population density expressed as inhabitants per square kilometre of total area. Population is defined here as all nationals present in or temporarily absent from a country, and aliens permanently settled in the country.

Ageing ratio

The ratio between population over age 64 years and population below age 15.

Income inequality

- Measured by the Gini coefficient, which ranges between 0 and 1, with higher values related to higher income inequality.
- OECD total: 24 OECD countries.

Life expectancy at birth

The average number of years a newborn 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

The number of years spent free of activity limitation. In Europe, HLYs are calculated annually by Eurostat for EU countries and some EFTA countries using the Sullivan method (Sullivan, 1971). The corresponding disability measure is the Global Activity Limitation Indicator, which comes from the EU-SILC survey. GALI measures limitation in usual activities due to health problems.

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CHAPTER 4.

THE ENVIRONMENTAL AND RESOURCE PRODUCTIVITY OF THE ECONOMY

Carbon productivity

Energy productivity

Resource productivity: materials

Resource productivity: nutrients

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 like the atmosphere. Tracking trends in decoupling of inputs to production from economic and sectoral growth is an important focus for monitoring.

Relative or absolute decoupling from a production perspective in some OECD countries can partly be offset by displacement effects, particularly when imported pollution- or resource-intensive goods or services are substituted for those produced domestically. The net effect at the global level may or may not imply decoupling. The limitations in production-based measures can be addressed by analysing the pollution generated and resources consumed from a demand perspective.

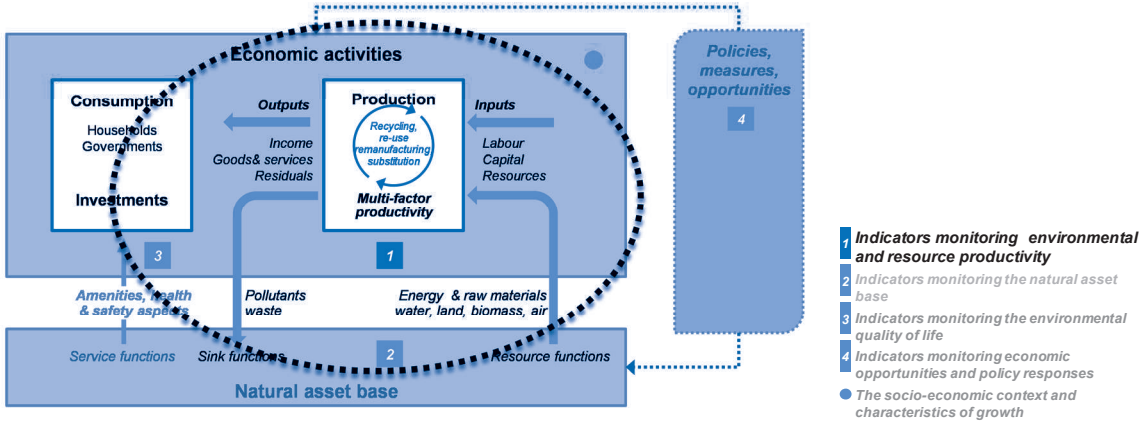
The OECD Green Growth indicators in this area focus on:

- **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 cleaner energy.
- **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. 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** to give a more complete picture of the productivity of an economy by accounting for inputs from natural resources and for the generation of pollution.

Other issues of importance include consumer behaviour, household and government consumption patterns, and societal responses. Examples of related response indicators are given as complements to illustrate their link with environmental and resource productivity indicators.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	M	Indicators presented here
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) 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	☑
	3.2. Waste generation intensity and recovery ratios By sector, per unit of GDP or value added, per capita	M	M/L	☑ municipal waste
	3.3. 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 (for agriculture: irrigation water per hectare irrigated)	M	M	–
Multifactor productivity	**5. 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.

CARBON PRODUCTIVITY

POLICY CONTEXT

The issue

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 total GHG emissions, CO_2 determines the overall trend and is a key factor 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.

Challenges

The main challenges are to limit emissions of CO_2 and other GHGs and to stabilise the concentration of GHGs in the atmosphere at a level that would limit their adverse effects on the climate system.

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. This requires an appropriate policy framework and mix of instruments that drive structural and technological change and leverage innovation.

The increasing interdependency of international production networks and supply chains means, in addition, that such efforts must be placed in a global context and build on a good understanding of carbon flows associated with international trade among countries and world regions. National emissions are affected by changes in the geography of global demand and supply with increasing trade flows and the relocation of carbon-intensive production. Reductions in domestic emissions can thus be partially or wholly offset elsewhere in the world.

MONITORING PROGRESS

Progress towards green growth can be assessed against trends in CO_2 emission productivity from production and demand perspectives, and the level of decoupling achieved between CO_2 and other GHG emissions and economic growth. These can further be related to domestic objectives and international commitments, and to changes in atmospheric concentrations of GHG.

The indicators presented here relate to:

- **Production-based CO_2 productivity**, *i.e.* 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, sinks and indirect effects.
- **Demand-based CO_2 productivity**, *i.e.* 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. They 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. Since reductions in national emissions can be achieved by offshoring domestic production and thus the related emissions, evidence of decoupling gained from production-based measures may reveal only part of the story.

  Information on carbon pricing is given as a complement.

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. 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. However, some care is needed when considering the policy implications. The links between trade, economic growth and the environment are complex and policies need to weigh all these factors together, including the benefits of trade in enabling growth and development.

These indicators should be read in connection with information on total GHG emissions, energy productivity and efficiency, renewable energy sources, energy prices and taxes, and carbon pricing. Their interpretation should take into account the structure of countries' energy supply, trade patterns and climatic factors.

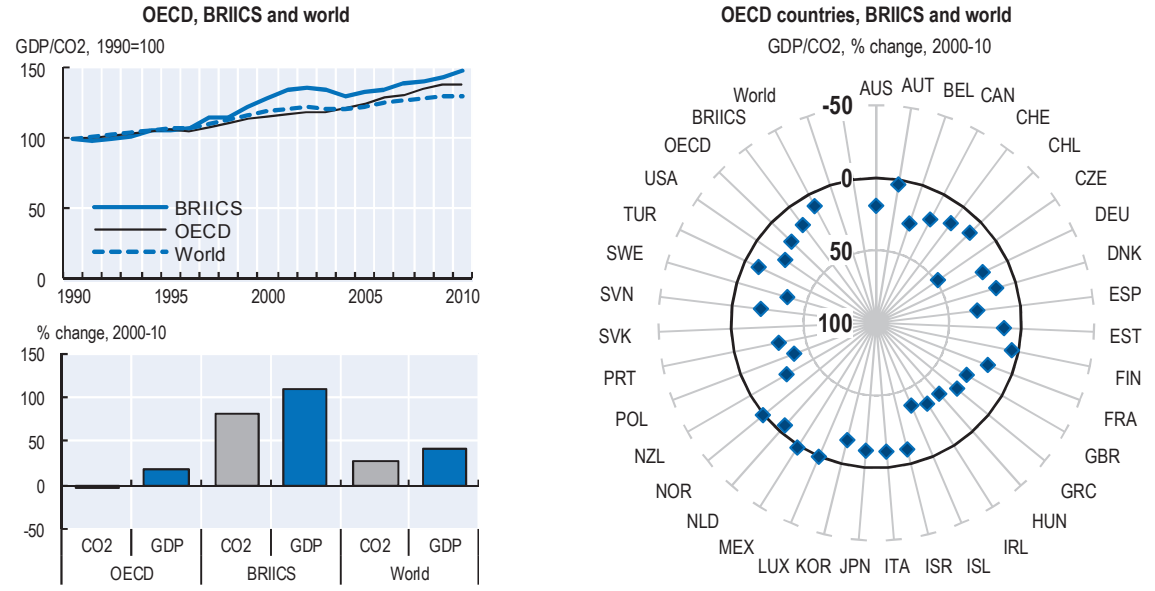
MEASURABILITY

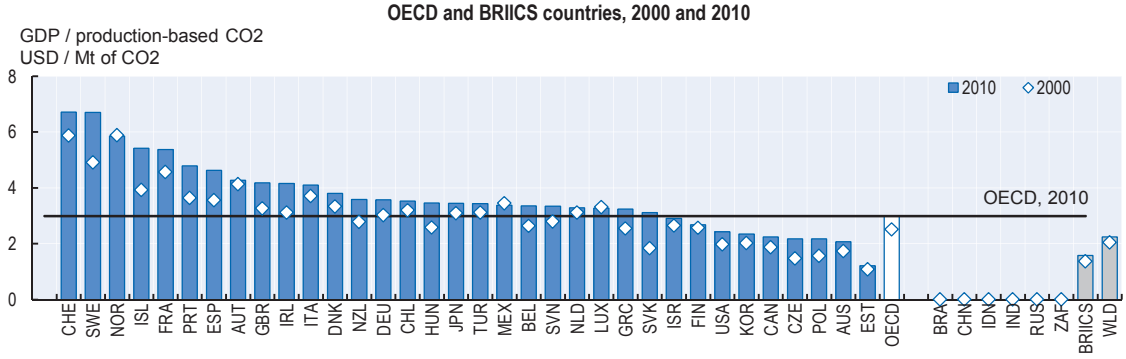
Continued efforts are being made to further improve national GHG inventories, particularly to better evaluate sinks and indirect effects and to calculate comparable net GHG emissions, including for non-Annex I countries. More needs to be done to monitor the effects of domestic demand and the use of international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

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.

See also *Definitions and notes* page 75.

Figure 4.1. Production-based CO_2 productivity





Source: IEA CO2 emissions from fuel combustion statistics (database)

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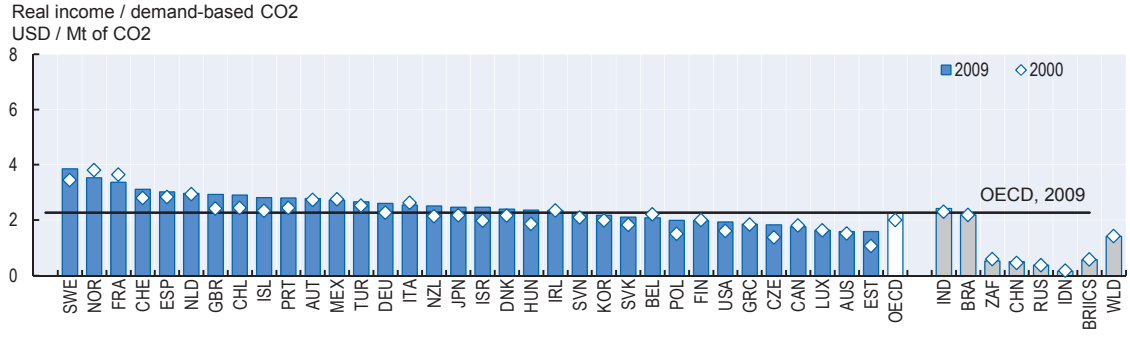
Figure 4.2. Demand-based CO2 productivity

OECD and BRIICS countries, 2000 and 2009



Notes: Real net national disposable income for OECD countries; GNI for BRIICS countries.
Source: *OECD Carbon Dioxide Emissions Embodied in International Trade* (database)

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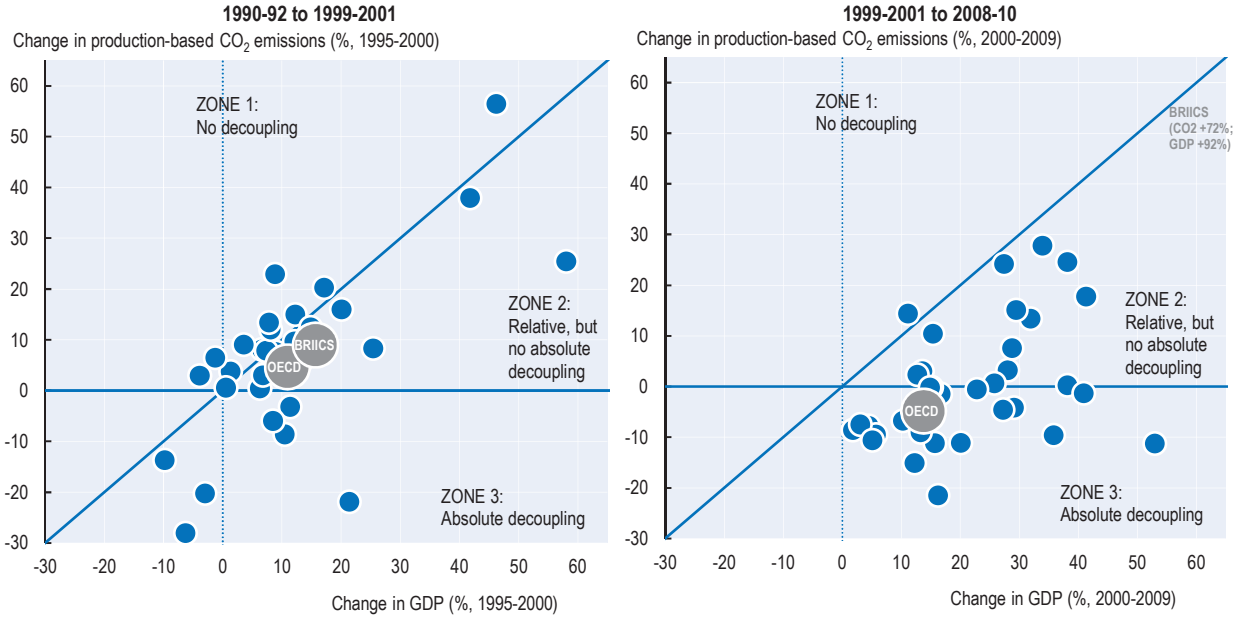
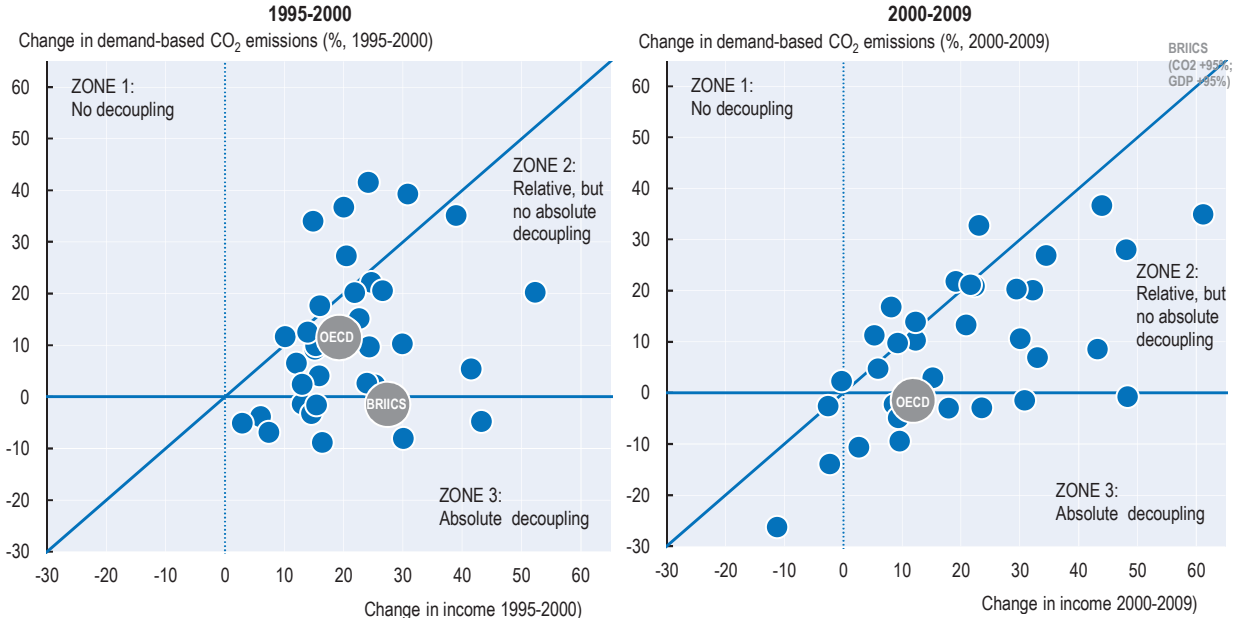
Figure 4.3. Decoupling trends: Production-based CO_2 emissions vs. GDP
OECD countries



Source: IEA CO2 emissions from fuel combustion statistics (database), *OECD Economic Outlook: Statistics and Projections* (database)

StatLink http://dx.doi.org/10.1787/888932925198

Figure 4.4. Decoupling trends: Demand-based CO_2 emissions vs. income
OECD countries



Source: OECD Carbon Dioxide Emissions Embodied in International Trade (database), *OECD National Accounts Statistics* (database); World Bank, *World Development Indicators*.

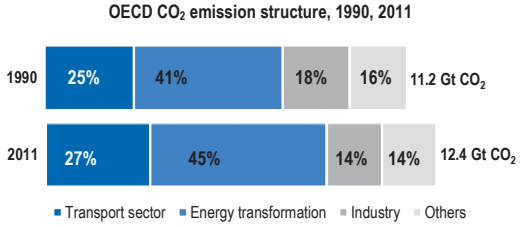
StatLink http://dx.doi.org/10.1787/888932925217

MAIN TRENDS

Global CO_2 emissions are growing …

CO_2 emissions from energy use are still growing worldwide, mainly due to increases in the transport and the energy transformation sectors. In 2010, global energy-related CO_2 emissions reached a record high of 31.3 billion tonnes.

Since 1990, however, emissions have grown more slowly in the OECD countries as a group than they have worldwide. This trend was emphasised by the rapid growth of emissions in emerging economies.



Source: IEA CO2 emissions from fuel combustion statistics (database).

The progress of individual OECD countries in reducing CO_2 emissions, and their contributions to global emissions, vary substantially, regardless of whether they are considered in absolute numbers, per capita amounts or carbon productivity. Despite an overall improvement in energy efficiency of industrial processes, CO_2 emissions from energy use continued to grow, particularly in OECD Asia-Pacific and in North America. This can be partly attributed to locked-in production and consumption patterns driven by low end-user energy prices. In OECD Europe, CO_2 emissions from energy use have stayed more or less stable due to changes in economic structures and the energy supply mix, as well as energy savings and policy implementation.

Progress with decoupling OECD emissions from economic growth…

Overall, the 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.

… with large differences across sectors

High carbon productivity may either reflect an abundance of non-fossil fuel energy resources or the results of ambitious policies. Other factors that play a role include improvements in energy efficiency and shifts in the industrial structure away from energy-intensive activities. Disaggregating the emission estimates shows uneven progress across sectors. Since 1990, the combined share of transport and electricity and heat generation has continued to grow and now represents 72% of total CO_2 emissions in OECD.

… and with potential displacement effects to other countries

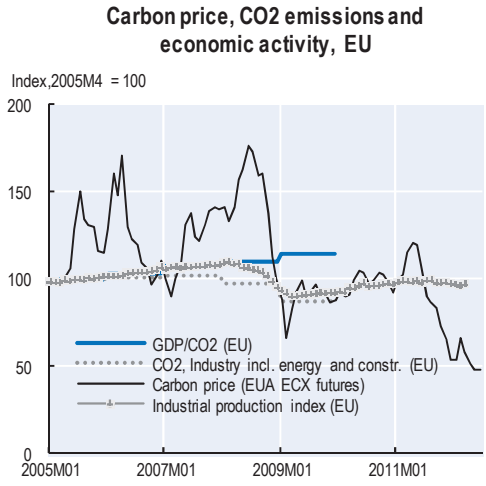
A more nuanced picture emerges when emissions are considered from the perspective of final demand.

- Total emissions generated to satisfy domestic demand (final consumption plus investment) in OECD countries rose quicker than emissions related to production. Over 1995-2009, only seven OECD countries achieved absolute decoupling of demand-based emissions of CO_2. In five countries, demand-based CO_2 emissions increased faster than the average increase of income.
- The relatively higher levels of demand-based CO_2 emissions can be partly explained by the displacement of energy-intensive domestic production and by growing imports of goods with a higher carbon footprint. They reflect a host of factors, including changes in the international pattern of production, specialisation in production and the relative comparative advantages of countries.

Box 4.1. Pricing carbon and CO_2 emissions mitigation: An example from the EU ETS

Setting a price on carbon through policy instruments – such as taxes or tradable permits – is considered to be a cost-effective policy option. An example from the EU Emissions Trading System (ETS) illustrates how price signals complemented with tax incentives can help to mitigate CO_2 emissions.

Initially, in the first trading period of the ETS, the price signal was weak as the average emission allowance price fluctuated from below EUR 10/tonne to EUR 29/tonne (2005-07). In most member states, this was partly due to over-allocation of allowances to installations covered by the ETS (EEA, 2008). The carbon market showed more maturity in the second trading period of the ETS (2008-12), when the carbon price was related more closely to market fundamentals, including economic growth and energy prices. Since 2009, the carbon price has trended around the average CO_2 and industrial activity trends in the EU.



Source: Eurostat. IntercontinentalExchange (ICE).

To strengthen the carbon price signal, some countries have considered complementary tax measures. Germany, for example, introduced an environmentally related tax reform in 1999 to mitigate CO_2 emissions while creating economic opportunities. A distinctive feature of this reform was that taxes were not set against the CO_2 content of fuels, but differentiated by fuel type. When expressed per tonne of carbon, the levels of the taxes varied widely. The tax rates (*i.e.* the additional tax applied to the original excise duties) on diesel and petrol were much higher than the average emission allowance price under the EU ETS, while rates for natural gas used for transport or heating were broadly in line with that price. The tax rates on other heating fuels were below the ETS CO_2 average price (around EUR 15-20 per tonne for most of the second trading period).

In the context of rising world oil prices, the tax reform has been rather effective as energy use decreased particularly in the transport sector, with emission reductions in the range of 2-3%, or 20-25 Mt CO_2 by 2010 (see OECD, 2012). The economy was boosted by 0.5% over five years because of this reform, which also promoted development and market penetration of energy-saving technological innovations. However, the negative impact on CO_2 emissions from energy-intensive sectors has been marginal due to earmarking of carbon tax revenue for the public pension fund as well as tax exemptions and partial derogations that have distorted the price signal.

Source: OECD (2012), *OECD Environmental Performance Reviews: Germany 2012.*

ENERGY PRODUCTIVITY

POLICY CONTEXT

The issue

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. 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 energy security.

Challenges

The main challenge is to further decouple energy use and related emissions from economic growth. This implies improvements in energy efficiency and the development and use of cleaner fuels and renewable energy sources, and requires the use of a mix of instruments including extended reliance on economic instruments.

MONITORING PROGRESS

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 commitments that have implications for domestic energy policies and strategies.

The indicators presented here relate to:

- **The energy productivity** of the economy, expressed as GDP in constant prices per unit of total primary energy supply (TPES). Energy productivity measures how much national revenue is generated for each unit of primary energy supplied. Data availability permitting energy productivity can also be calculated for sectors.
- **The share of renewables** in TPES and in electricity generation. The main renewable forms are hydro, geothermal, wind, biomass, waste and solar energy.

The overall energy mix (*i.e.* the structure of energy supply by primary source), final energy consumption by sector, and energy end-user prices are given as complements.

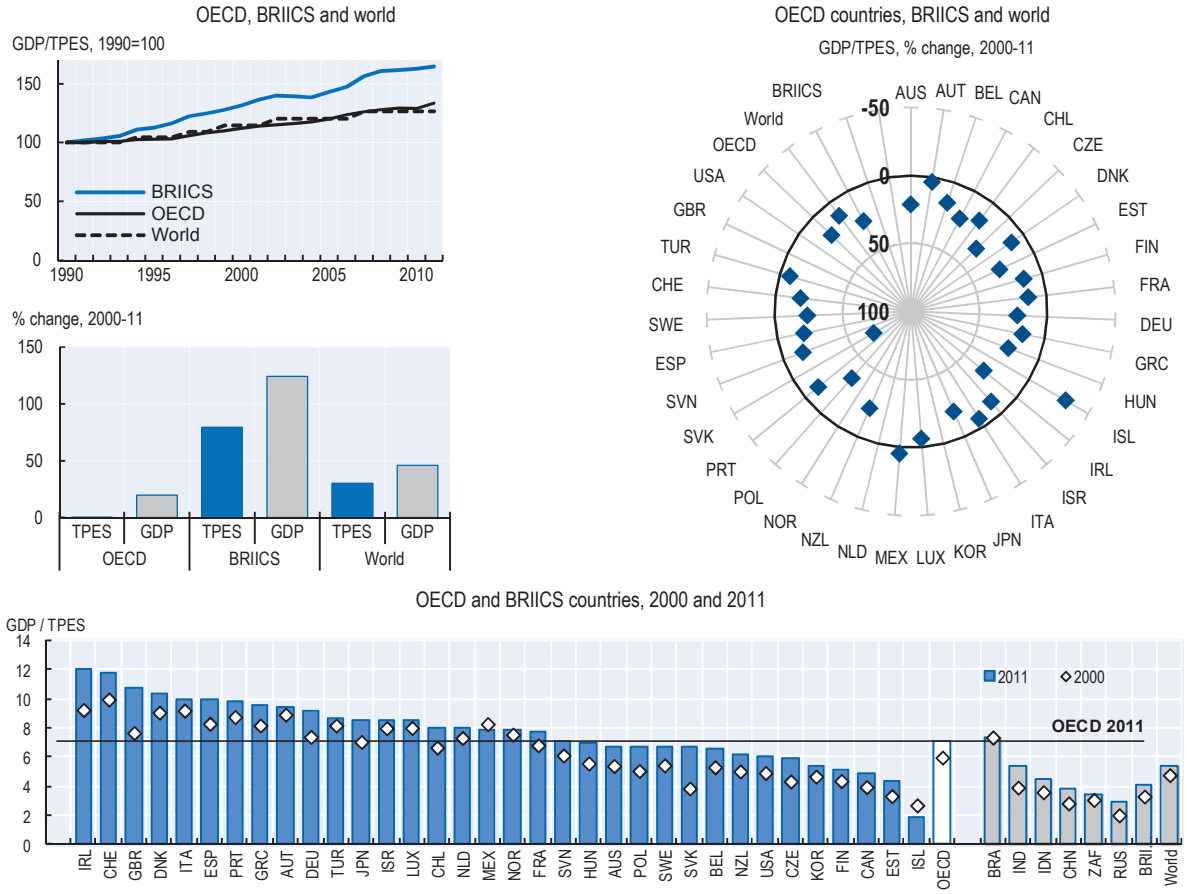
These indicators should be read together with indicators on CO_2 productivity, energy-related R&D and patents, energy prices and taxes, and carbon pricing. It has to be kept in mind that:

- Energy productivity should not be used to assess how efficient the use of energy is in a country. Efficiency is a contributing factor in productivity, but many other elements need to be considered: the structure of the economy (presence of large energy-consuming industries, for instance), the size of the country (influencing demand from the transport sector), the climate (affecting demand for heating or cooling) and outsourcing of goods produced by energy-intensive industries. Cross-country comparisons also need to consider countries' endowment in energy resources.
- 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.

MEASURABILITY

Data on energy supply and consumption are available from the IEA for all OECD countries and others. Efforts are being made to further develop measures of energy efficiency and to improve their reporting. See also *Definitions and notes* page 76.

Figure 4.5. Energy productivity

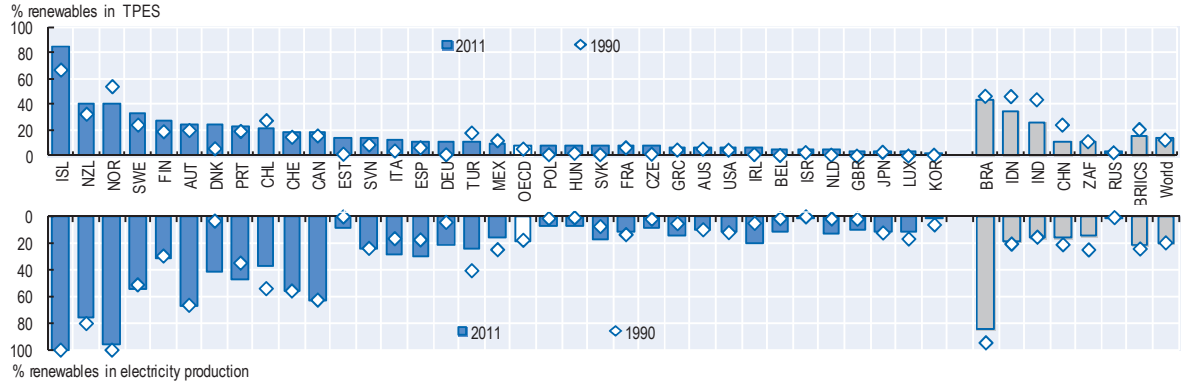


Source: IEA World Energy Statistics and Balances (database).

StatLink http://dx.doi.org/10.1787/888932925236

Figure 4.6. Share of renewables in energy supply and in electricity production

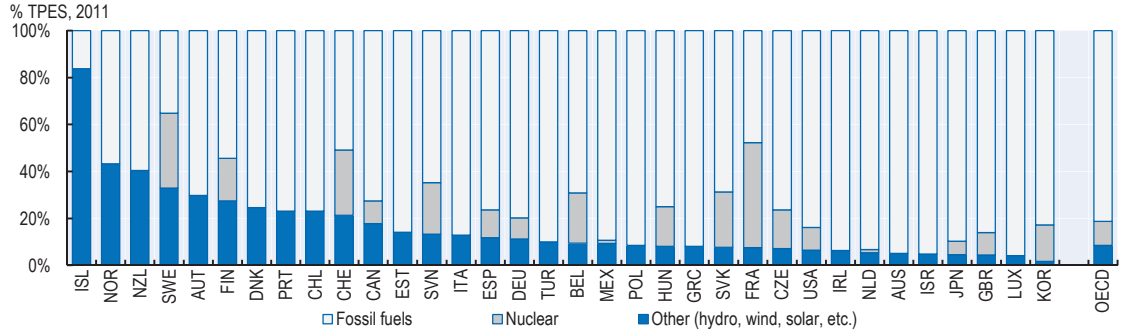
OECD and BRIICS countries, 1990 and 2011



Source: IEA World Energy Statistics and Balances (database).

StatLink http://dx.doi.org/10.1787/888932925255

Figure 4.7. Share of primary energy sources in total supply
OECD countries, 2011



Source: IEA World Energy Statistics and Balances (database). StatLink http://dx.doi.org/10.1787/888932925274

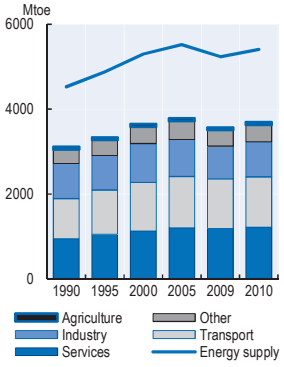
MAIN TRENDS

Energy productivity increased overall, with wide variations by country

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.

Results remain insufficient, however, to reduce air and GHG emissions from energy use. Progress in per capita terms has been slow. A person living in an OECD country uses, on average, about 78% more energy than a person living in an emerging economy and about 65% more than the global average. This reflects higher overall energy supply and demand for transport and services, whose energy consumption has increased by 25 and 29%, respectively, since 1990. Over 1990-2010, the share of industry in final energy consumption decreased by more than 4 percentage points while those of transport rose by 2 percentage points and of other services by 3 points.

Total final energy consumption by sector, OECD



Source: OECD; IEA.

Renewable energy sources provide one-fifth of the electricity generated…
…but fossil fuels continue to dominate the energy mix…

The supply structure varies considerably by country, influenced by demand from industry, transport and households, national energy policies, and national and international energy prices. In the 1990s, growth in primary energy supply was accompanied by changes in the fuel mix: the shares of coal and oil fell, while those of gas and other sources rose. In the 2000s, the energy mix did not change much. The OECD is still more than 80% reliant on fossil fuels. Several countries have progressed in promoting renewables in their energy mixes, but the share of renewables has remained relatively stable at about 8% of total supply, though a few countries exceed 20%. Biomass and hydropower hold the largest shares, but bioenergy, liquid biofuels, solar and wind play a growing role.

The share of renewables in electricity generation increased slightly over the decade to reach 19.8% for the OECD as a whole in 2011, mainly thanks to government policies supporting deployment of wind, solar and, to a lesser extent, biomass. Solar photovoltaic (PV) and wind power technologies are growing in the OECD and have expanded rapidly in recent years, despite continuing economic and policy turbulence in the sector. Emerging economies (*e.g.* Brazil, China, India) are also stepping up efforts to support renewables-based electricity.

...and expansion of low-carbon energy technologies has stalled

Many obstacles remain and greater efforts are needed to foster technology improvement. The expansion in low-carbon energy technologies has stalled, and the average unit of energy produced today is basically as polluting as it was 20 years ago. In 1990, the average amount of CO_2 emitted to provide a given unit of energy stood at 2.39 tonnes of CO_2 per tonne of oil equivalent (tCO_2/toe); by 2010 it had barely moved.

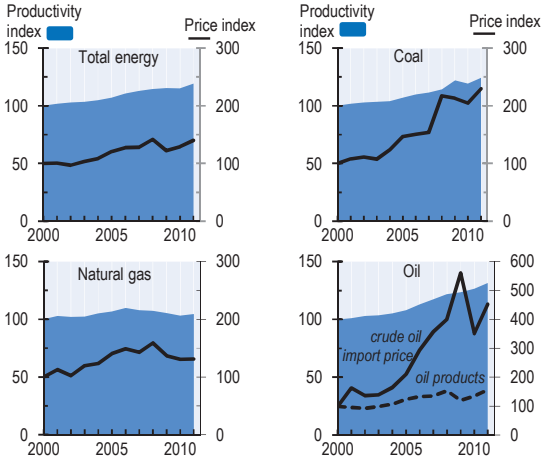
Box 4.2. Energy productivity and real energy prices by source: An example

Energy productivity is influenced by a host of factors, among which are energy prices and taxes. Overall, energy productivity has been positively related to real energy end-use prices in the OECD, particular since 2000. The link between prices and productivity improvements appears to be stronger for crude oil and coal than for natural gas. The following observations can be made:

- Real end-use energy prices increased in most OECD countries between 2000 and 2008, mainly due to a rise in crude oil prices, then dropped due to the economic crisis before rebounding more recently.
- Oil prices have been volatile, partly due to a tightening of supply and demand fundamentals, combined with political uncertainty in the Middle East and North Africa.
- Natural gas prices in OECD countries have been correlated to oil prices through indexation clauses in long-term supply contracts, or indirectly through competition between gas and oil products in power generation and end-use markets.
- While coal prices followed oil and gas prices in the 1990s, they weakened relatively to oil and gas prices in the 2000s. This was partly due to variations in market conditions for various fuels and growing environmental constraints on coal use in some OECD countries. Surging demand in large emerging economies has contributed to a rebound in coal prices, reflected by an increased productivity ratio in terms of GDP per coal-driven energy supply.
- Deregulation of electricity supply led to increased price volatility over the decade. The average OECD price has followed an upward trend, reflecting also the increasing cost of commodity inputs, particularly of coal, oil and natural gas.

Energy prices vary widely across OECD countries and tend to be higher for households than for industry. High energy prices may affect inflation rates and weigh on household and business expenditures.

Energy productivity and real prices by source, OECD



Source: IEA World Energy Statistics and Balances (database); *IEA Energy Prices and Taxes Statistics* (database).

RESOURCE PRODUCTIVITY: MATERIALS

POLICY CONTEXT

The issue

Material resources 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 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.

Efficient use of material resources all the way through the economy and the supply chain is critical not only from an environmental perspective, but also from a trade and economic perspective.

Challenges

The main challenge is to improve resource productivity and ensure that materials are managed well and used efficiently at all stages of their life cycle (extraction, transposition, transport, consumption, disposal) so as to avoid waste of resources and reduce the associated negative environmental impacts. Resource productivity has an impact on the production process and on economic growth through impacts on capital stocks, and through impacts on costs, especially in resource-intensive industries. Improving resource productivity will also help reduce demand pressures on primary natural resource stocks and increase the long-term availability (and quality) of resources for everyone.

Improving resource productivity and ensuring sustainable materials management requires integrated life-cycle-based waste, materials and product policies, such as circular economy or 3R-related initiatives, and the use of instruments aimed at stimulating technological change. It implies internalising the costs of waste management into prices of consumer goods and of waste management services. It also means ensuring greater cost-effectiveness, full public involvement in designing measures and greater involvement of stakeholders throughout the supply chain.

MONITORING PROGRESS

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. This can further be related to available resource stocks and extraction rates, and to information on resource scarcity. It can also be assessed against international objectives and national targets concerning material productivity and resource efficiency. Examples of international initiatives include the 3R Action Plan, the 2004 and 2008 OECD Council Recommendations, the UNEP International Resource Panel, the EU thematic strategy on the sustainable use of natural resources, and the EU Resource Efficiency Roadmap.

The indicators presented here relate to domestic material consumption (DMC) and the related productivity ratios for material groups and for aggregates. Productivity is expressed as the amount of economic output generated (in terms of GDP) per unit of materials consumed (in terms of DMC). The focus is on non-energy materials. DMC measures the mass of the materials that are physically used in the domestic economy, *i.e.* direct apparent consumption. Information on the material extraction is given as a complement.

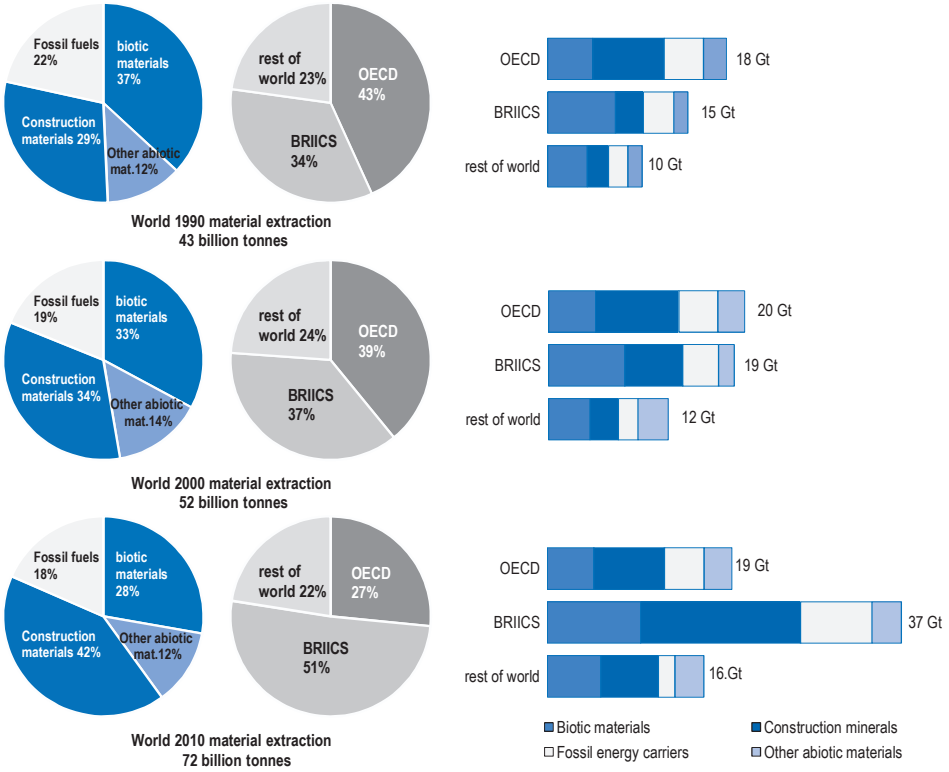
Measures of material productivity extend productivity measurement and analysis to material resources and complement such existing productivity measures as labour productivity and capital productivity. They should be read in conjunction with information on commodity prices, flows of secondary raw materials, waste management practices and costs, and consumption levels and patterns. In general, caution needs to be exercised when drawing conclusions based on country-level data. Interpretation should take into account the properties and composition of material groups, as well as countries' endowment in natural resources and the structure of their economy. It should also be kept in mind that the indicators presented here do not reflect environmental impacts. They are initial approximations of potential environmental pressure; more information is needed to describe the actual pressure.

MEASURABILITY

The indicators presented here are estimates. The data coverage and completeness vary by variable and by country. 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. In particular, more needs to be done 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. See also *Definitions and notes* page 77.

MATERIAL EXTRACTION

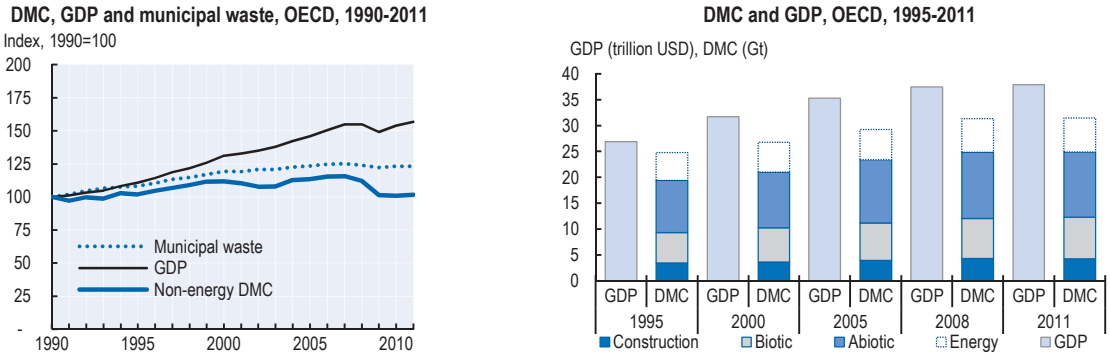
Figure 4.8. Material extraction
OECD and world, 1990, 2000 and 2010



Source: SERI and Dittrich, M., *Global Material Flow Database*.

StatLink http://dx.doi.org/10.1787/888932925293

Figure 4.9. Domestic material consumption (DMC)

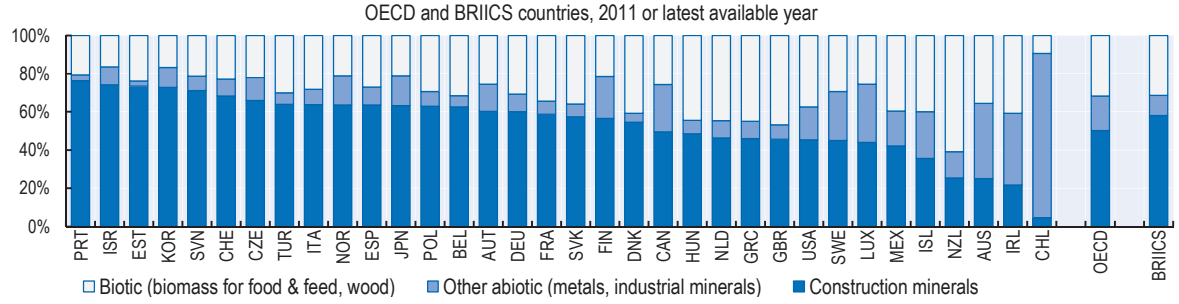


Source: OECD Environment Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925312

Figure 4.10. Non-energy DMC by material group

OECD and BRIICS countries, 2011 or latest available year

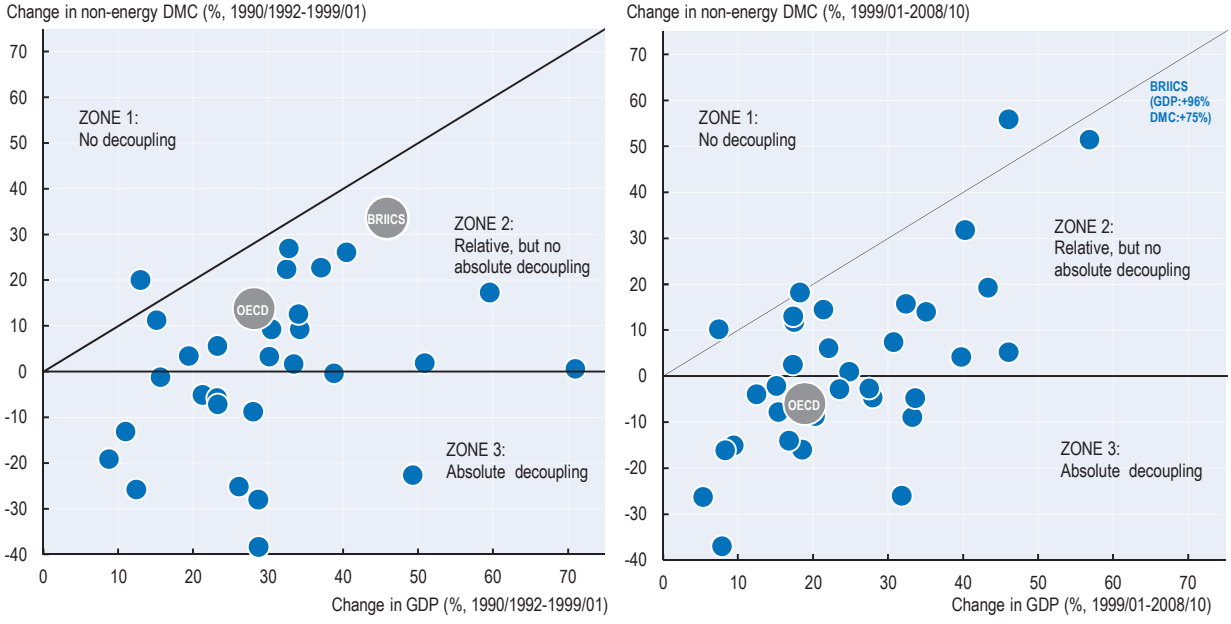


Source: OECD Environment Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925388

Figure 4.11. Decoupling trends: Non-energy DMC vs. GDP

OECD countries, 1990/1992 to 2008/10

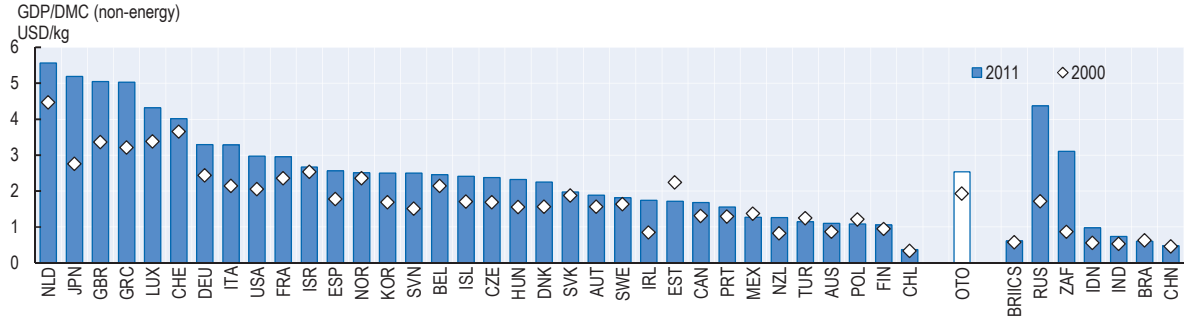


Source : OECD Environment Statistics (database). *OECD Economic Outlook: Statistics and Projections* (database)

StatLink http://dx.doi.org/10.1787/888932925331

Figure 4.12. Non-energy material productivity

OECD and BRIICS countries, 2000 and 2011 or latest available year

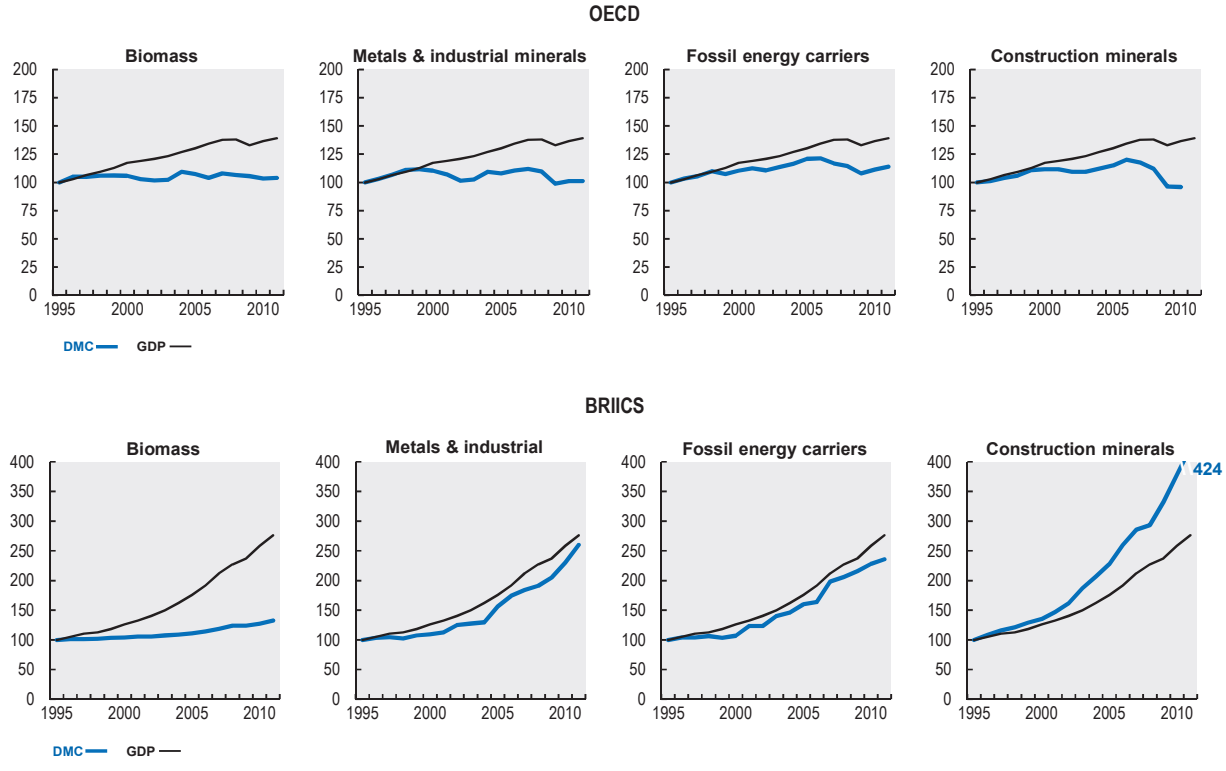


Source: OECD Environment Statistics (database)

StatLink http://dx.doi.org/10.1787/888932925350

Figure 4.13. Decoupling trends by material group, DMC vs GDP

1995-2011, Index 1995=100



Source: OECD Environment Statistics (database)

StatLink http://dx.doi.org/10.1787/888932925369

MAIN TRENDS

Global resource extraction is rising, though more slowly 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. In spite of fluctuations in the rate of material extraction in accordance with economic cycles, increased demand in emerging economies and continued high levels of consumption in OECD countries accelerated the trends over the 2000s.

Productivity gains have been achieved, but material consumption remains high…

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.

Non-energy materials represent more than 70% of the materials mix. Given their weight, construction minerals dominate the material mix and account for most of the absolute developments in material consumption in OECD countries.

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. Productivity gains have come mainly in recent years due to improved efficiency, but also to the rise of the service sector and the economic recession. The strongest gains were in construction materials.

…and progress is moderate once indirect flows associated with trade are considered

Other factors that play a role are changing trade patterns and the displacement of resource-intensive production to other countries. Once indirect flows (raw materials embodied in traded goods) are considered, improvements in countries that are net importers are more moderate. Indirect flows of materials take into account the life-cycle dimension of the supply chain, including the upstream natural resource requirements, though the materials are not physically imported. Their environmental consequences occur in the countries where the imports originate.

Relocation of production may also bring traditional gains from trade, such as the ability to exploit comparative advantages to increase productivity of relatively scarce materials and specialise in trading relatively abundant resources. Further in-depth analysis is needed to examine the drivers of material productivity, related to structural effects, policies or resource endowments.

Many materials end up as waste, but efforts to move from waste to resources are starting to show results

Over the last two decades, OECD countries have put significant efforts into curbing municipal solid waste generation. More and more waste is being diverted from landfills and incinerators and fed back into the economy through recycling. Landfilling nonetheless remains the major disposal method in many OECD countries. A person living in the OECD generates, on average, 530 kg of municipal waste per year; 30 kg less than in 2000, but still 30 kg more than in 1990.

Recycling rates have increased for some high-volume materials, such as glass, steel, aluminium, paper and plastics, but remain low for many others. Many valuable materials continue to be disposed of as waste and, if not recovered, are lost to the economy. This implies that unexploited “urban mines” (*e.g.* electric and electronic equipment) could be an important source of minerals and metals for industry and a potentially important domestic source of raw materials in the future. The extent of the potential for recovering valuable materials from such sources is not yet well known; information gaps limit detailed analysis.

RESOURCE PRODUCTIVITY: NUTRIENTS

POLICY CONTEXT

The issue

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.

Challenges

The main challenge is to progressively decrease negative impacts and increase environmental benefits associated with agricultural production so that ecosystem functions can be maintained and food security ensured for the world's growing population.

This implies *(i)* improving the productivity and sustainability of agro-food systems, for example through reduction of animal and human waste in supply chains, better management of fisheries, attention to land management practices and reduction of pollution discharges from agriculture through better management of nutrients (fertilisers and manure), and *(ii)* addressing agricultural support policies linked to production that can encourage intensity of production beyond what would occur in the absence of these policies. This is also a key ingredient in stemming the rate of biodiversity loss in the world.

MONITORING PROGRESS

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.

The indicators presented here relate to agricultural nutrient balances. They are:

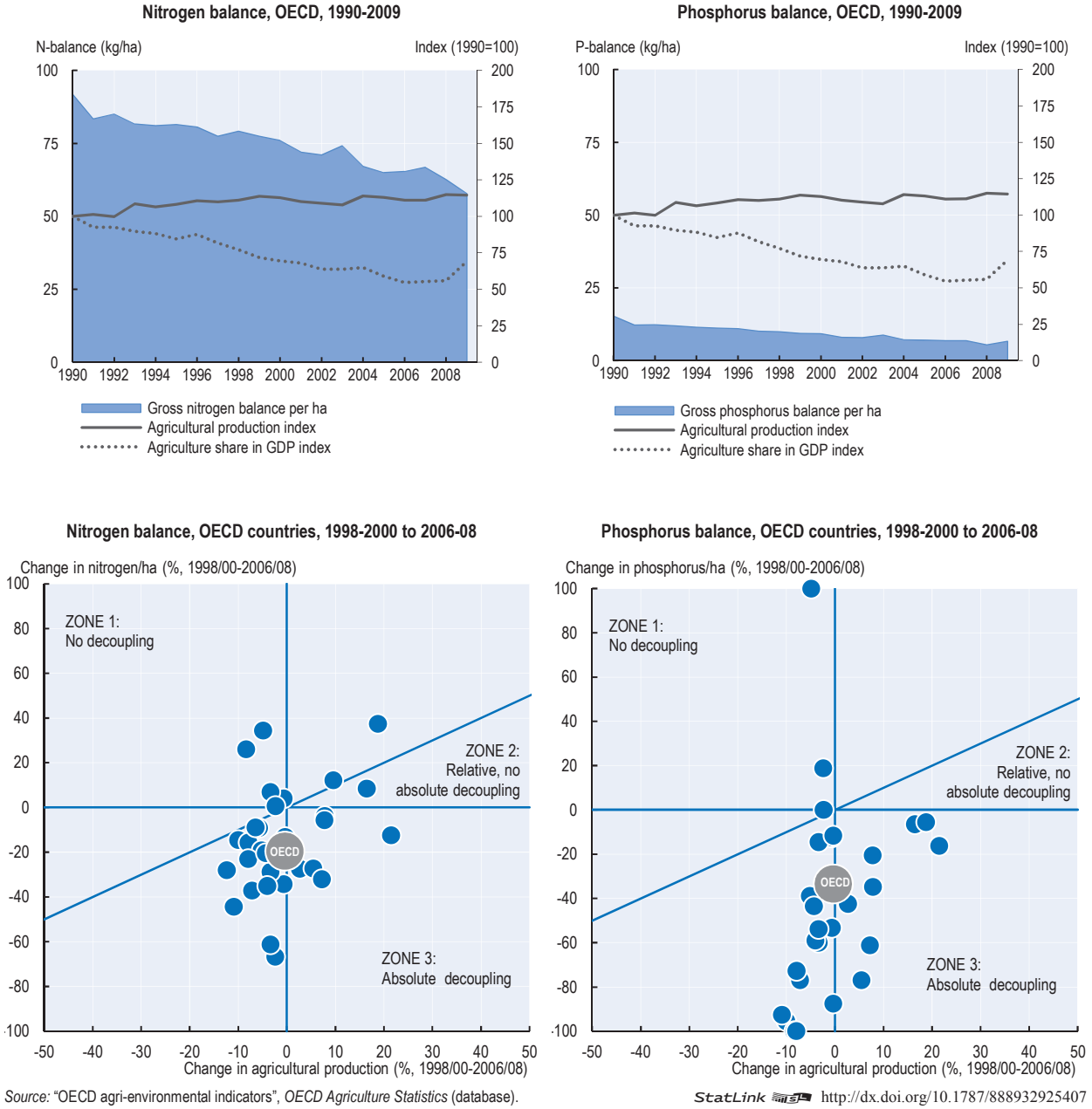
- nitrogen and phosphorus surplus intensities, expressed as the gross N and P balance per hectare of agricultural land
- agricultural nutrient intensity related to changes in agricultural output, expressed as changes in the gross N and P balance per hectare of agricultural land versus changes in agricultural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

These indicators describe 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. They should be read with information on water use in agriculture, soil quality, biodiversity, land use, commodity prices and farm management. Cross-country comparisons of change in nutrient surplus intensities over time should take into account the absolute intensity levels during the reference period.

MEASURABILITY

Data on nitrogen and phosphorus balances are available for OECD countries until 2009. Improvements to the underlying methodology were made recently by OECD countries in co-operation with Eurostat and the FAO. In the long term, nutrient balances should be further expanded to cover nutrient inputs and outputs from other sources and economic activities. See also *Definitions and notes* page 78.

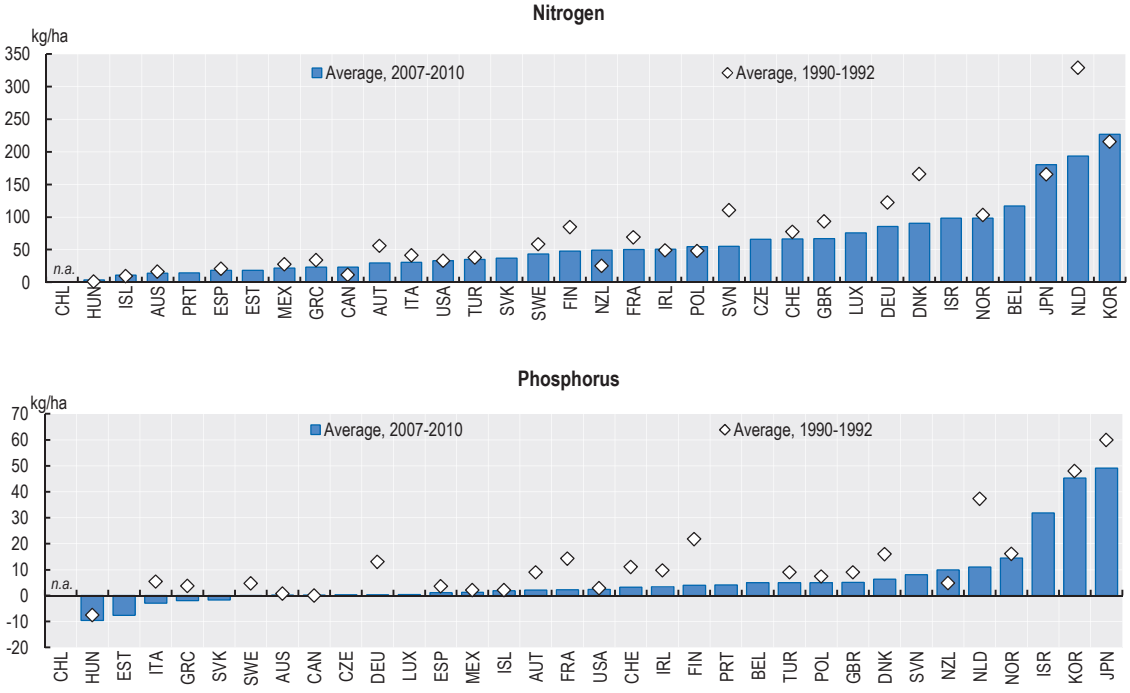
Figure 4.14. Decoupling trends: agricultural nutrient balances and agricultural production



Source: "OECD agri-environmental indicators", *OECD Agriculture Statistics* (database).

StatLink http://dx.doi.org/10.1787/888932925407

Figure 4.15. Agricultural nutrient surplus intensities per area of agricultural land
OECD countries, 1990-92 and 2007-10



Source: "OECD agri-environmental indicators", *OECD Agriculture Statistics* (database).

StatLink *http://dx.doi.org/10.1787/888932925426*

MAIN TRENDS

Nutrient surpluses declined relative to agricultural output

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.

This decline signals a process of relative decoupling of agricultural production from N- and P-related environmental pressure. It reflects improvement in nutrient use efficiency by farmers and slower growth in agricultural output for many countries.

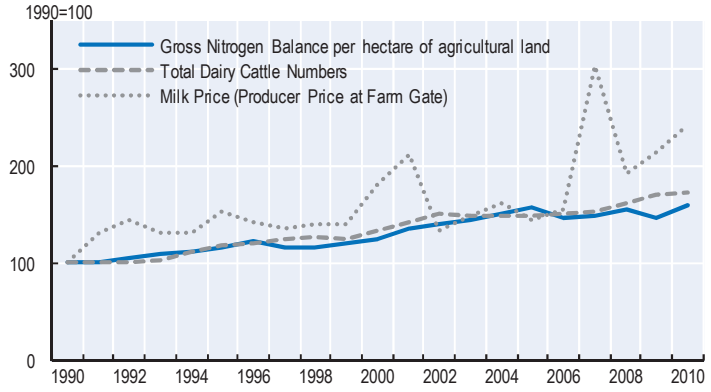
There are, however, sizeable variations within and between countries in terms of the intensity of and trends in nutrient surpluses. Territorial variations within countries are explained by the spatial distribution of intensive livestock farming and cropping systems that require high nutrient inputs, 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.

Box 4.3. Commodity prices and the environment in agricultural systems: An example from New Zealand

In recent years, international agricultural commodity markets have been strongly marked by higher and more volatile prices. Rising real prices have provided incentives to farmers to increase the scale and intensity of their production, including increasing consumption of inputs such as fertilisers, pesticides, energy and water for irrigation, where prices of these inputs have risen more slowly than commodity prices. This in turn acts to raise the opportunity cost of adopting environmentally beneficial farming practices, which affects the trade-off between production incentives and environmental benefits.

Illustrative of these developments has been the influence of rising world dairy product prices on the dairy industry in New Zealand and the consequences for the environment, specifically nitrate pollution of water. Between 1990 and 2010 the national nitrogen balance surplus increased at a very similar annual rate to that for the national dairy cattle herd, the main source of the surplus (from manure and slurry). At the same time, the international price of milk grew rapidly (the price is used as proxy for international dairy product prices; see definitions in the "OECD Producer and Consumer Support Estimates" dataset). The rise in world dairy commodity prices in recent decades, especially since the mid-2000s, has provided a considerable incentive to New Zealand livestock producers to intensify production in dairy farming rather than other livestock sectors such as beef cattle and sheep rearing.

Trends in world milk price, dairy cattle numbers and nitrogen balance surplus: New Zealand, 1990-2010



These developments present a major challenge for New Zealand policy makers and the agriculture sector (OECD, 2013). In brief, the challenge involves achieving a sustainable dairy industry that can capture the economic and social benefits from higher dairy prices for farmers and the wider rural community while minimising pollution of rivers, lakes and groundwater from excess nutrients, as well as reducing other environmental impacts of dairying such as GHG emissions, especially methane.

Source: OECD (2013), *Compendium of OECD Agri-environmental Indicators*.

Definitions and notes: Carbon productivity

Production-based CO_2 emissions from fuel combustion

Emissions calculated using IEA energy databases and the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. The estimates are affected by the quality of the underlying energy data. For example, some countries, both OECD and non-OECD, have trouble reporting information on bunker fuels and incorrectly define bunkers as fuel used abroad by their own ships and planes. Since emissions from bunkers are excluded from the national totals, this affects the comparability of the estimates across countries. On the other hand, since these estimates have been made using the same method and emission factors for all countries, in general, the comparability across countries is quite good.

The high per-GDP emissions of Estonia result from the use of oil shale for electricity generation. Oil shale has a high carbon emission factor. The very high per capita emissions of Luxembourg result, to a large degree, from the lower taxation of gasoline and diesel oil compared to neighbouring countries. The price differential attracts drivers from Belgium, France and Germany, as well as transiting freight, to refuel in the country. As emissions are calculated based on fuel deliveries, Luxembourg is accountable for emissions from the totality of those sales.

Demand-based CO_2 emissions and carbon embodied in trade

The estimates of CO_2 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, described above. The approach uses the bilateral trade data in conjunction with national input-output tables for 58 countries (with an input-output table modelled for the rest of the world) to create a global input-output table that shows trade flows in goods and services between countries. 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. Emissions from bunkers and fugitive emissions from fuel extraction are excluded.

Gross domestic product and net national income

For comparative purposes, real GDP (expenditure approach) and net national income for OECD countries are expressed in constant USD prices at PPPs (base year 2005). The aggregate volumes for real GDP and gross national income for Brazil, Russian Federation, India, Indonesia, China and South Africa are in constant USD prices at PPPs (base year 2005 for GDP, 2000 for GNI).

CO_2 price

The CO_2 price in the EU ETS is based on the price for EUA ECX futures, which are managed by the European Climate Exchange (ECX) through ICE Futures Europe, a pan-European platform for carbon emission trading. Its futures contract, based on the underlying EU allowances (EUAs) and certified emission allowances (CERs), attracts over 80% of the exchange-traded volume in the European market. ECX contracts (EUA and CER futures, options and spot contracts) are standardised exchange-traded products and all trades are cleared by ICE Clear Europe.

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Definitions and notes: Energy productivity

Total primary energy supply and productivity

TPES equals production plus imports minus exports minus international marine and aviation bunkers plus or minus stock changes. The world total includes international marine and aviation bunkers. Energy productivity is calculated as the amount of economic output generated (GDP) per unit of energy used (TPES).

Total final energy consumption by sector

Agriculture includes forestry and fishing; Services includes residential and commercial and public services; Other includes non-energy use and non-specified (other); 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.

Share of renewable energy sources in TPES and in electricity generation

Renewables include hydro, geothermal, solar, wind and tide/wave/ocean energy, as well as combustible renewables and waste.

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%.

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.

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.

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.

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).

Energy mix

The methodology used to calculate the TPES corresponding to a given amount of final energy has important implications on the share of each contributing energy source. This is particularly true for calculation of the shares of renewable energy sources. The IEA Secretariat uses the "physical energy content" methodology to calculate TPES. For combustibles, TPES is based on the net calorific value of the fuels. For other sources, the IEA assumes an efficiency of 10% for geothermal electricity, 33% for nuclear, 50% for geothermal heat and 100% for hydro, wind and solar PV. As a result, for the same amount of electricity produced, the TPES calculated for combustible renewables will be several times higher than the TPES for hydro, wind or solar PV.

Energy prices
End-user energy prices in constant terms refer to real indices for industry and households (1990=100) by product. These include the average OECD prices of imported crude oil (CIF, USD per barrel), of natural gas (Mwh), of coal and of total energy. Real end-user energy prices by sector are also used individually for industry and for households.

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Definitions and notes: Material productivity

All data on materials: The materials are aggregated using mass-based weights and are classified as biotic materials (biomass for food and feed, wood), construction minerals, and other abiotic materials (industrial minerals and metals). Energy carriers are accounted for separately in this report.

Material extraction
Domestic extraction used (DEU) measures the flows of materials that originate from the environment 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.

Material consumption
Domestic material consumption measures the total amount of materials used in an economy (apparent consumption) and is calculated as DEU minus export plus imports.

Municipal waste
Municipal waste is household and similar waste collected by or on behalf of municipalities. It includes waste originating from households, 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. The OECD aggregate includes estimates.

Sources

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Definitions and notes: Nutrient balances

Agricultural nutrient balances

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 (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.

The OECD total excludes Chile, Estonia and Israel.

Sources

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CHAPTER 5.

THE NATURAL ASSET BASE

Freshwater resources

Forest resources

Fish resources

Biodiversity and ecosystems: land resources

Biodiversity and ecosystems: wildlife resources

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 produced, 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:

- ensuring adequate supplies of renewable and non-renewable resources to support economic activities and economic growth
- managing environmental impacts associated with extracting and processing natural resources to minimise adverse effects on environmental quality and human health
- preventing natural resource degradation and depletion
- maintaining non-commercial environmental services.

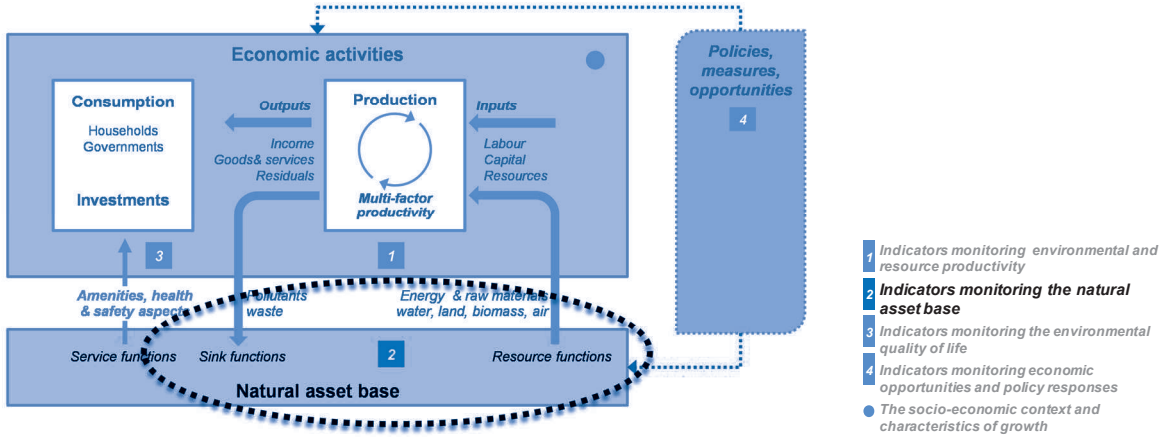
Progress can be monitored by looking at stocks of natural resources and of other environmental assets along with flows of environmental services, and by using indicators that reflect the extent to which the asset base is being maintained, in terms of quantity, quality or value.

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.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	M)	Indicators presented here
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 of selected minerals: metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates	M	M/L	–
Biodiversity and ecosystems	11. **Land resources** Land cover types, conversions and cover changes from natural state to artificial state	M	M/L	☑ example
	• Land use: state and changes	P	S/M	☑
	12. **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	–
	13. **Wildlife resources** (to be further refined)			
	• Trends in farmland or forest bird populations or in breeding bird populations	P	S/M	☑ example
	• Species threat status: mammals, birds, fish, vascular plants in % species assessed or known	P	S	☑ selected groups
	• 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.

FRESHWATER RESOURCES

POLICY CONTEXT

The issue

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.

Challenges

The main challenges are to ensure sustainable management of water resources, avoiding overexploitation and degradation so as to maintain adequate supplies of freshwater of suitable quality for economic activities and human use, and to support aquatic and other ecosystems. Water use efficiency is key in matching supply and demand. Reducing losses, using more efficient technologies and recycling are all part of the solution, but it is essential to apply the user-pays principle to all types of users and take an integrated approach to the management of freshwater resources by river basin. Social aspects, such as the affordability of the water bill for low income households, also need to be considered.

MONITORING PROGRESS

Progress towards green growth can be assessed against domestic objectives and international commitments. 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. In arid regions, freshwater resources may at times be so limited that demand can be met only by going beyond sustainable use.

The indicators presented here relate to:

- Available **renewable freshwater resources** expressed as the long term annual average availability in cubic metres per capita.
- 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 percentage of internal freshwater resources (precipitation minus evapotranspiration).

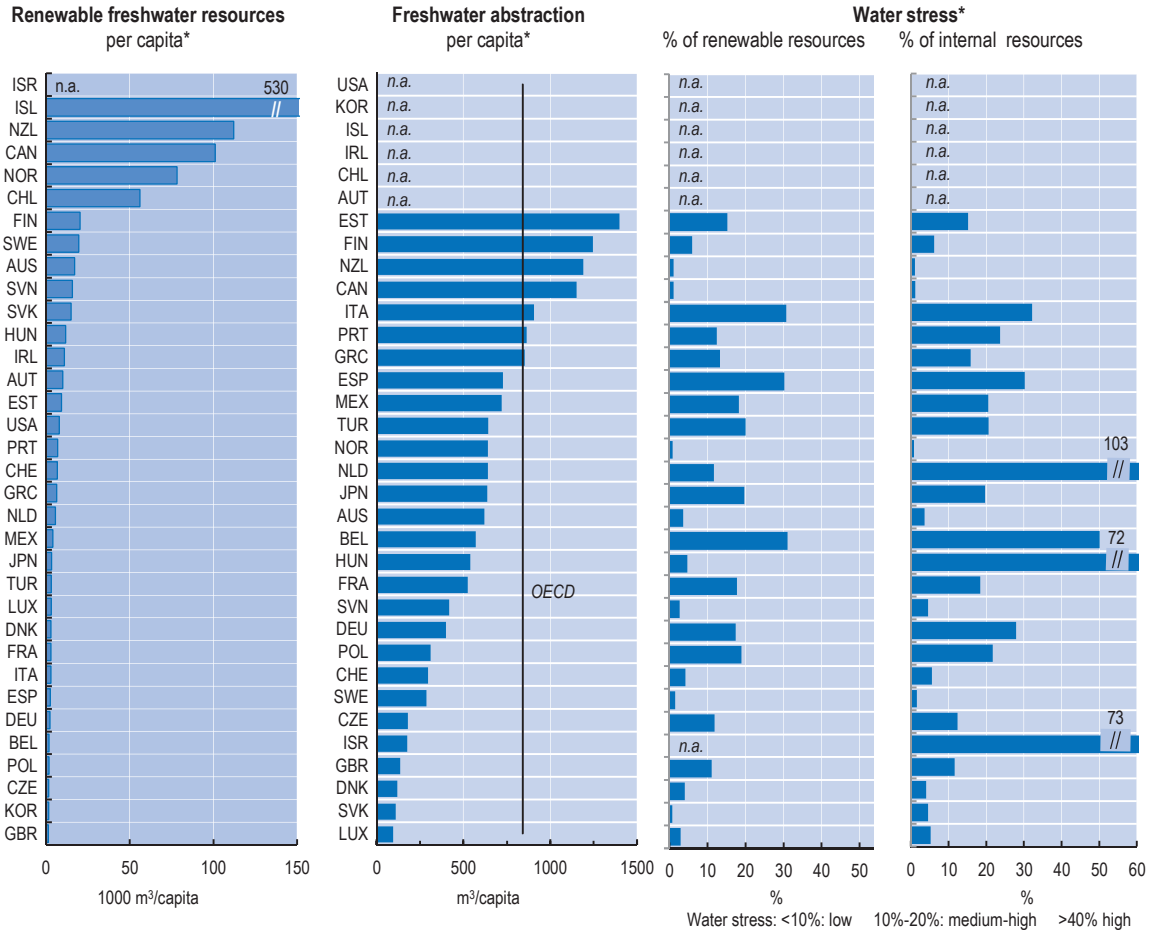
Trends in water abstractions by major use, intensity of water abstractions per capita, and water supply prices in selected cities are given as complements.

It should be kept in mind that these indicators only give insights into quantitative aspects of water resources and that a national level indicator may hide significant territorial and seasonal differences and should be complemented with information at sub-national level. They should be read in connection with indicators on cost recovery ratios, water productivity and water quality.

MEASURABILITY

Information on freshwater resources can be derived from water resource accounts. It is available for most OECD countries, though 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. More work is also needed to adequately reflect the spatial distribution of resource use intensity. See also *Definitions and notes* page 98.

Figure 5.1. Freshwater stocks and abstraction intensities



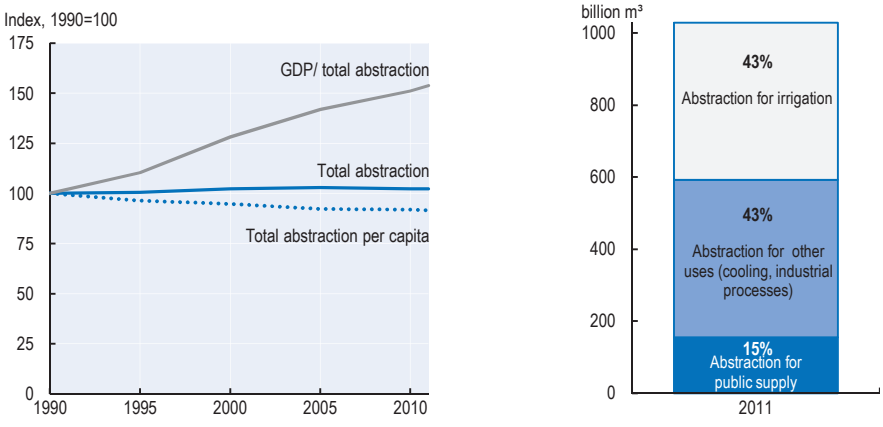
* Latest available year. Data prior to 2006 were not considered. OECD totals are estimated and exclude Chile and Ireland.

Source: OECD Environment Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925445

Figure 5.2. Freshwater abstraction by major use

OECD, 1990-2011



Source: OECD Environment Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925464

MAIN TRENDS

Water abstraction is stabilising and has decoupled from GDP growth in many 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.

At world level, it is estimated, the growth in water demand over the last century was more than double the rate of population growth. Agriculture remains the largest user of water. In about half the OECD countries, agricultural water use has increased since 2000, driven by expansion in the irrigated area. But compared to agricultural production, the use of irrigation water slightly declined in the OECD overall.

Water stress levels vary greatly and local water scarcity remains of concern

Water stress levels – intensity of use of available resources – show 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. The national indicator may conceal unsustainable use in some regions and periods, and high dependence on water from other basins. If a significant share of a country's water comes from transboundary rivers, tensions between countries can arise, especially if water availability in the upstream country is less than in the downstream one. In a few countries, water resources are abundant and population density is low.

Water prices cover more of the costs of providing water services, but tariffs vary across and within countries.

Policies for pricing water supply and waste water treatment are important in matching water supply and demand, and improving the cost-effectiveness of water services. Price levels and tariff structures for water supply vary across and within countries. Diversity within a country reflects the degree of decentralisation of the tariff-setting process, as well as the varying costs of providing water services in different locations. These costs depend on the proximity of water sources, the degree of purification needed and the settlement density of the area served, among other factors.

Today OECD countries are covering more of the costs associated with water service provision. This is reflected in the level of prices, which have increased, at times substantially, over the last decade, and in the structure of tariffs, which better reflect consumption and treatment costs. An emerging trend in some OECD countries is the increasing use of fixed charges alongside volumetric components, or the progressive increase in the weight of fixed charges in the overall bill. Water pricing is also increasingly complemented by a range of other approaches, including abstraction and pollution charges, tradable water permits, smart metering, water reuse and innovation.

FOREST RESOURCES

POLICY CONTEXT

The issue

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.

Challenges

The main challenge is to ensure sustainable management of forest resources. This includes avoiding overexploitation and degradation so as to maintain timber value and an adequate supply of wood for production activities, and to maintain the provision of essential environmental services, as well as social and aboriginal values. It implies defining optimal harvest rates – not too high to avoid excessive use of the resource, and not too low (particularly where age classes are unbalanced) to maintain the productive capacity of the resource – and integrating environmental concerns into forestry policies, including through measures such as eco-certification and carbon sequestration. The UNFCCC mechanism for Reducing Emissions from Deforestation and Degradation (REDD) in developing countries helps mobilise finance to mitigate deforestation and thus GHG emissions.

MONITORING PROGRESS

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 international initiatives are the Ministerial Conferences for the Protection of Forests in Europe (Strasbourg, 1990; Helsinki, 1993; Lisbon, 1998; Vienna 2003; Warsaw 2007), 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.

The indicators presented here are for the period since 1990 and relate to:

- the area of **forest land** in percentage of total land area and in square kilometres per capita, and related changes
- the volume of **forest resource stocks**, in cubic metres, and related changes.

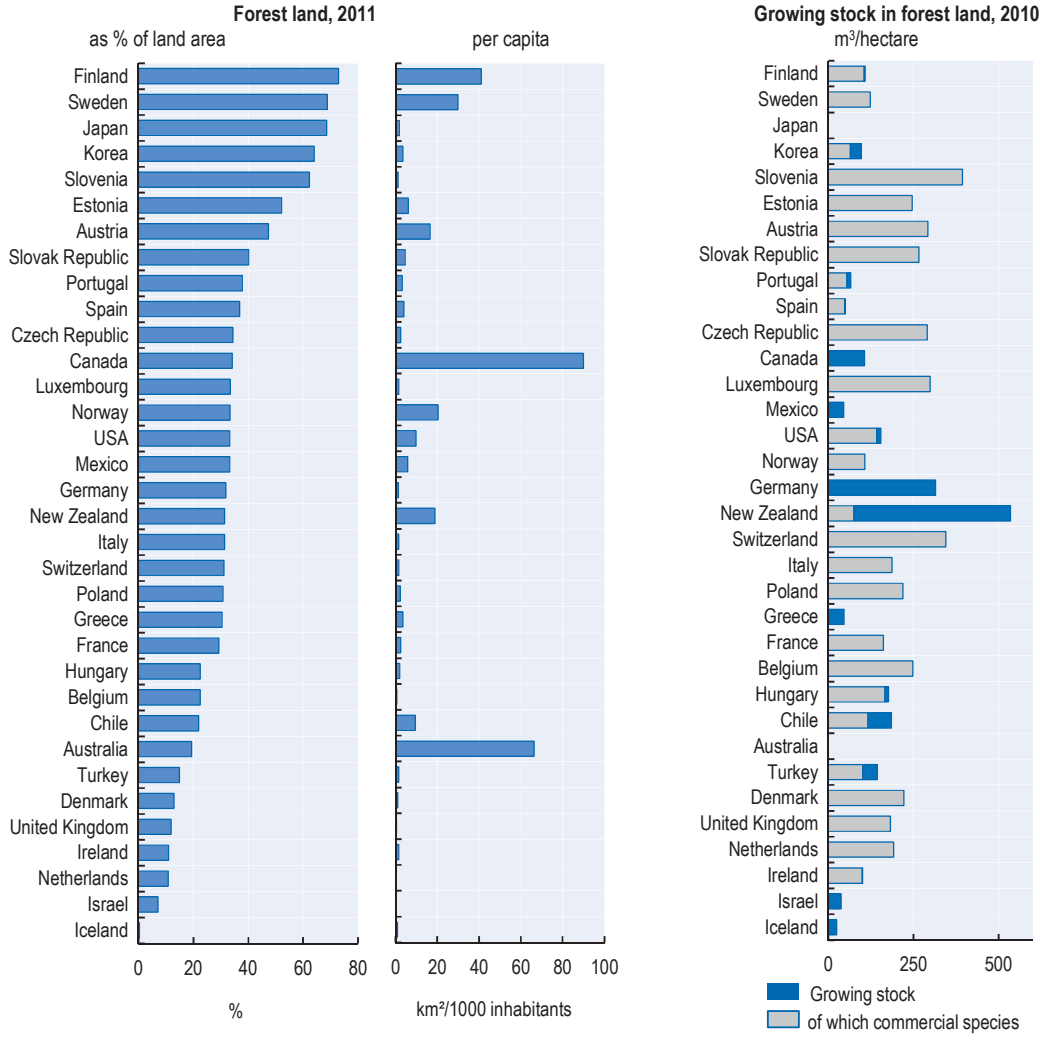
Round wood production, exports of forestry products and intensity of use of forest resources are given as complements.

These indicators give insights into quantitative aspects of forest resources and into the forests' timber supply functions. They present national averages that may conceal important variations among forests. They should be read with information on forest quality (*e.g.* species diversity, including tree and non-tree species; forest degradation; forest fragmentation) and on output of and trade in forest products, and be complemented with data on forest management practices and protection measures.

MEASURABILITY

Data on the area of forests and wooded land are available for all countries with varying degrees of completeness. Data are best for forests used for wood supply. Data on forest resources and the intensity of their use can be derived from forest accounts and from international Forest Resource Assessments (FAO, UNECE) for most OECD countries. Interpretability is limited, however, due to differences in the variables monitored. Historical data often lack comparability or are not available over longer periods. See also *Definitions and notes* page 98.

Figure 5.3. Forest land and growing stock

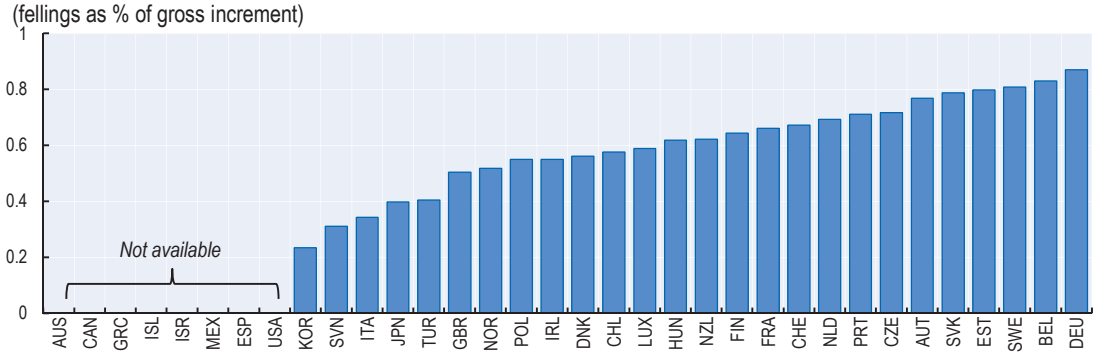


Source: FAOSTAT (database); *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888932925483

Figure 5.4. Intensity of use of forest resources

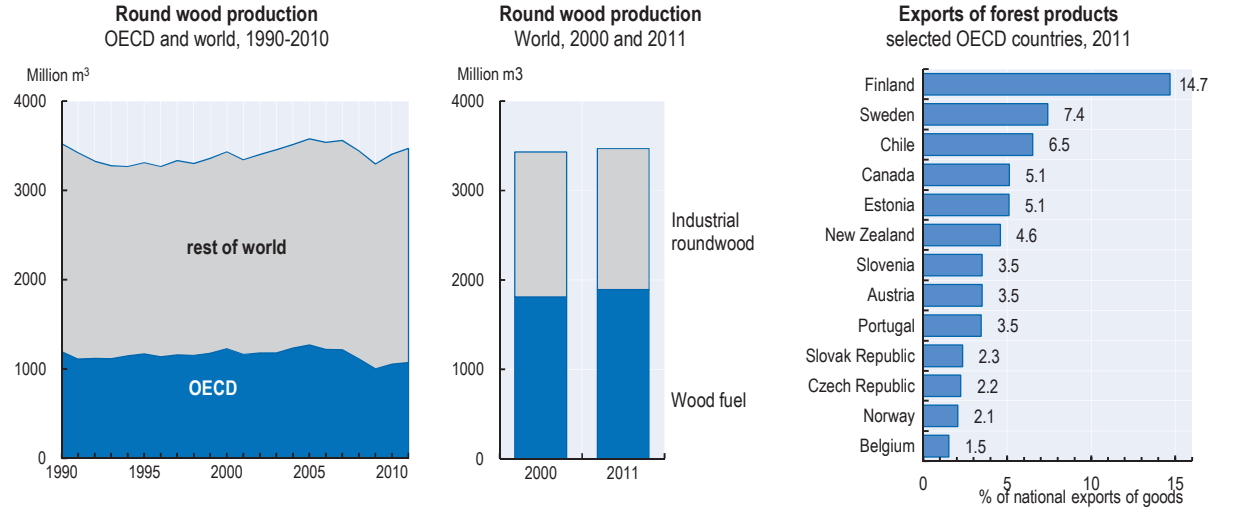
2011 or latest



Source: FAO (2010), Global Forest Resource Assessment; *OECD Environment Statistics* (database)

StatLink http://dx.doi.org/10.1787/888932925502

Figure 5.5. Round wood production and trade



Source: FAOSTAT (database); *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888932925521

MAIN TRENDS

Forest area has remained stable in most OECD countries, but decreased at world level

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. Forests are unevenly distributed: the ten most forest-rich countries account for two-thirds of the world's forest area. OECD countries account for about one-fourth of the world's forest area. Forests are increasingly protected; the area of protected forests has increased by 94 million ha since 1990, and two-thirds of this increase has happened since 2000.

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. The Economics of Ecosystems and Biodiversity study has indicated that the aggregate loss of biodiversity and ecosystem service benefits associated with the global loss of forests is between USD 2 trillion and USD 5 trillion per year.

The intensity of forest use for wood supply is relatively stable

At national level, most OECD countries present a picture of sustainable use of their forest resources in quantitative terms, but there is significant variation among and within countries. For countries in which longer-term trends are available, intensity of forest resource use does not generally show an increase and has even decreased in most countries since the 1950s. In recent years, wood requirements to achieve policy objectives for renewable energy resources have played an increasingly important role.

FISH RESOURCES

POLICY CONTEXT

The issue

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. In certain countries, including at least two OECD countries – Iceland and Japan – fish is the main source of animal protein intake.

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.

Challenges

The main challenge is to ensure sustainable, ecosystem-based management of fish resources so that resource extraction does not exceed stock renewal over an extended period and does not undermine ecosystem sustainability. This implies strengthening international co-operation and setting and enforcing limits on total catches, which may include managing both the types of fishing methods employed and the areas in which and/or times during which fishing may occur. Economically, sustainable fisheries are fundamental to achieving not only the restoration of fish stocks and preservation of biodiversity, but also improved livelihoods, trade, fish food security and economic growth.

MONITORING PROGRESS

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 of illegal, unreported and unregulated (IUU) fishing.

The indicator presented here relates to the proportion of **fish stocks within safe biological limits** (global). 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 the International Council for the Exploration of the Sea (ICES). This indicator is also included in the Millennium Development Goal monitoring framework.

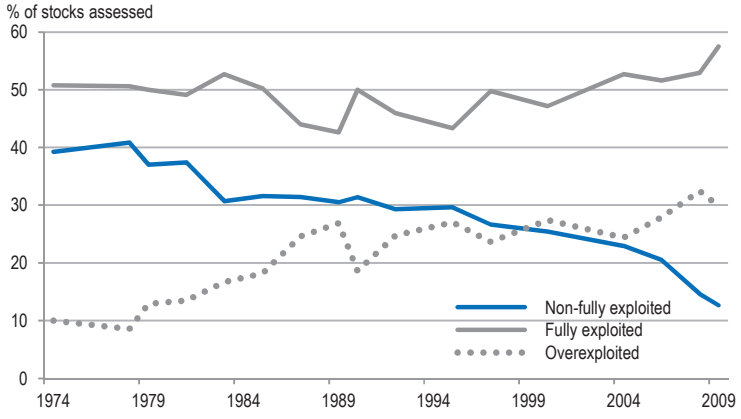
Trends in fish production from aquaculture, along with trends in fish production from capture fisheries, presented worldwide, are given as complements.

This indicator gives insights into the biological status of fish resources. It 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.

MEASURABILITY

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 ICES. More needs to be done to better evaluate the status of fish stocks and to relate it to captures. See also *Definitions and notes* page 99.Definitions and notes: Fish resources

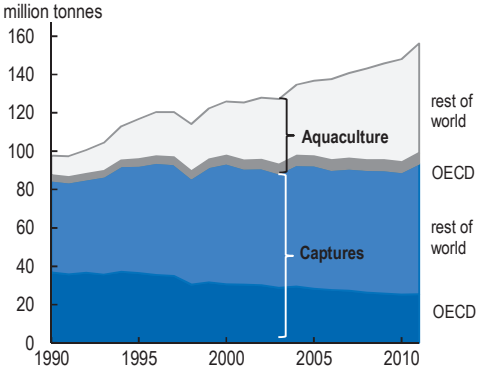
Figure 5.6. Global trends in the state of world marine stocks
since 1974



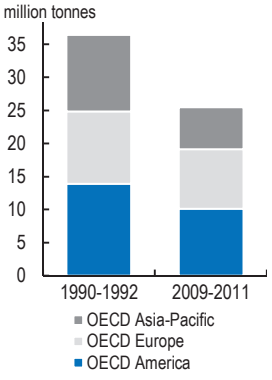
Source: FAO (2012), *The State of World Fisheries and Aquaculture.*

Figure 5.7. Fish production and supply

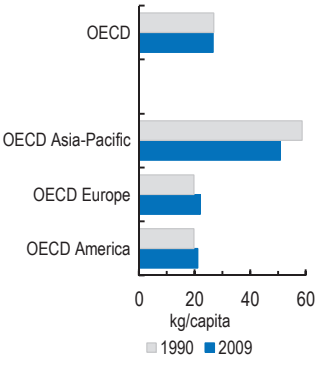
Fish production, OECD and world



Fish captures, OECD

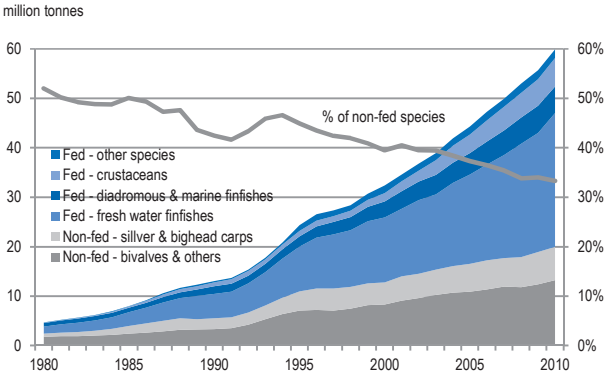


Fish supply, OECD

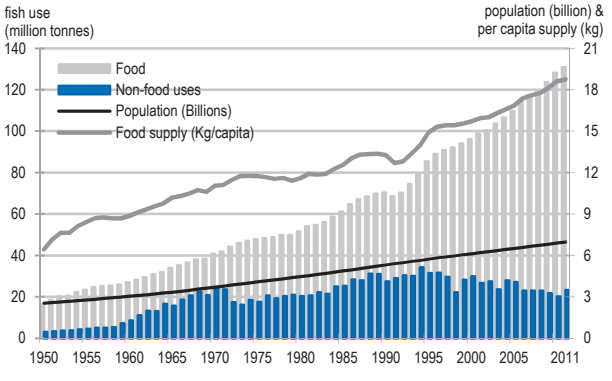


Source: FAO, FISHSTAT (database)

Aquaculture by major species groups, world since 1950



Fish use and food supply, world, since 1950



Source: FAO (2012), *The State of World Fisheries and Aquaculture.*

StatLink http://dx.doi.org/10.1787/888932925540

MAIN TRENDS

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. IUU fishing remains widespread and hinders the achievement of sustainable fishery management objectives.

Capture fisheries and aquaculture supplied the world with about 160 Mt of fish in 2011 and provided an apparent per capita supply of 18.5 kg in 2009 (in live weight equivalent). Some 86% of total fish production is used for direct human consumption. In OECD countries, fish captures have decreased from about 37 Mt to 25 Mt since 1990. This decrease was accompanied by increased aquaculture production and fish imports, and a stable fish supply per capita of around 27 kg. OECD countries account for about 9% of world aquaculture production and about 27% of world marine captures.

Fish production from marine capture has stabilised recently… …though 30% of fish stocks are overexploited

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. The most caught species at global level remains the anchoveta.

- The proportion of stocks that are not fully exploited, *i.e.* moderately exploited or underexploited, declined from 40% to 13%. Slightly more than half of stocks (57%) are fully exploited, producing catches at or close to their maximum sustainable limits. The percentage was stable at around 50% from 1974 to 1985, dropped to 43% in 1989 and increased gradually to 57.4% in 2009.
- The remaining stocks are overexploited. They account for 30% of all stocks, a significant increase from the 10% that fell into this category in 1974. These stocks yield less than their maximum potential due to excess fishing pressure in the past.

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. Many European fisheries today depend on young (and smaller) fish, which are caught before they can reproduce.

Aquaculture has surpassed capture fisheries in many countries.

Aquaculture has been growing and has surpassed capture fisheries as a source of fish production in many countries. Global aquaculture production more than quadrupled between 1990 and 2011. In 2011, it accounted for about 40% of global fish production. This growth occurred more quickly in some regions of the world than in others. OECD countries produced around 9% of world aquaculture production, the largest producers being Korea, Japan, Chile and Norway. In recent years, the rate of growth in global aquaculture production has been slowing down.

Unlike capture fisheries, aquaculture offers opportunities to use farming systems and management practices to enhance food production while alleviating pressures on natural stocks. However, aquaculture also has negative effects on local ecosystems, and its dependence on fishmeal and fish oil products, at least in the case of farming carnivorous species, can add to pressure on some stocks and puts aquaculture in competition with other markets for fish, which could become a constraint on aquaculture development.

The role of fisheries in the economy varies widely among countries.

The share of fisheries and associated industries in the economy varies widely among countries. There are large differences in trends in aquaculture production and in capture fisheries among OECD countries and among fishing areas, with significant increases in the Pacific and Indian Oceans. China remains the largest producer, though fishery statistics for China are under review and still entail uncertainties.

BIODIVERSITY AND ECOSYSTEMS: LAND RESOURCES

POLICY CONTEXT

The issue

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 the 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;
- 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).

Challenges

The main challenge is to ensure sustainable management of land and soil resources so as to reconcile competing demands and conflicting interests (optimal mix of land use and multiple uses), and to preserve the land's essential ecosystem functions. This requires integrated land use and territorial planning, coherence with sectoral policies (mining, agriculture, forestry manufacturing, transport, energy), appropriate governance and the use of a mix of policy instruments, including ownership rights, property and other taxes, and protected area networks.

MONITORING PROGRESS

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.

The indicators presented here relate to **land use changes** since 1990 in the OECD and the world. Information on **land take** by urban and and other artificial land development in Europe is given as a complement.

INTERPRETATION

These indicators should be read in connection with information on wetlands, protected areas, land degradation through erosion and desertification, and soil quality (acidification from acid precipitation, excessive use of fertilisers and pesticides, waste dumping, sludge spreading, carbon content). Their interpretation should consider the levels of economic development and the structure of countries' economies and patterns of trade. Geographic factors and population density also play a role.

MEASURABILITY

Land use data exist for all countries, but at varying degrees of quality. Internationally harmonised data on conversions from one type of land use to another are not yet available. More needs to be done to exploit satellite images to monitor changes in land cover.

See also *Definitions and notes* page 99.

MAIN TRENDS

Biodiversity rich areas have declined in OECD countries
Forest area has remained stable, and agricultural land has decreased

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.

In nearly all OECD countries the agricultural land area has decreased since the early 1990s, with an average annual reduction of -0.5% in recent years. Farmland has mainly been converted to use for forestry and urban development. Despite this overall trend, agriculture remains the major land use for many countries, representing over 40% of the land area in two-thirds of OECD countries. The share of agricultural land under certified organic farming remains very low, below 2% on average for the OECD. The area of transgenic crops has grown rapidly since the mid-1990s, especially in North America, reaching on average some 18% of the OECD area of arable and permanent cropland.

In Europe, infrastructure development has led to fragmentation of natural habitats

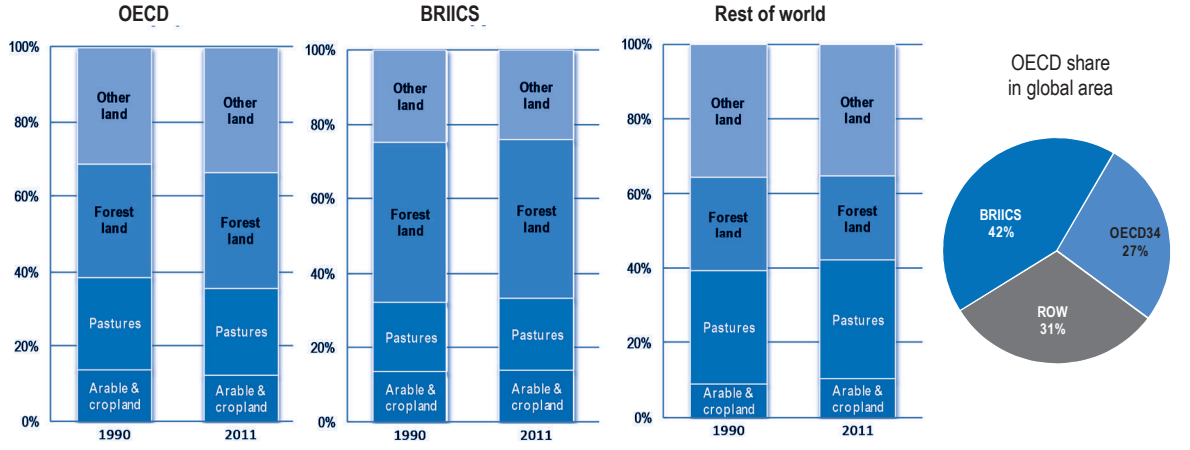
In Europe, where human use of ecosystems is high, data on land-cover change from 2000–06 (from the European Environment Agency's CORINE database) show that:

- The area of natural and semi-natural habitats has declined and is increasingly fragmented by built-up areas and transport infrastructure.
- About 1.8% of the total land area is sealed by urban areas and infrastructure development. Depending on the degree of sealing, it reduces or completely prevents natural soil functions and other ecosystem functions on the area concerned.
- About 1120 km² of natural and semi-natural land is taken every year by urban and other artificial land developments (2000-2006).

These changes affect the amenity value of the landscape, decrease habitats and fragment the landscapes that connect them, and are thus associated with a decline in many species populations and reduced biodiversity.

LAND USE

Figure 5.8. Land use changes
OECD, BRIICS, rest of world, 1990-2011

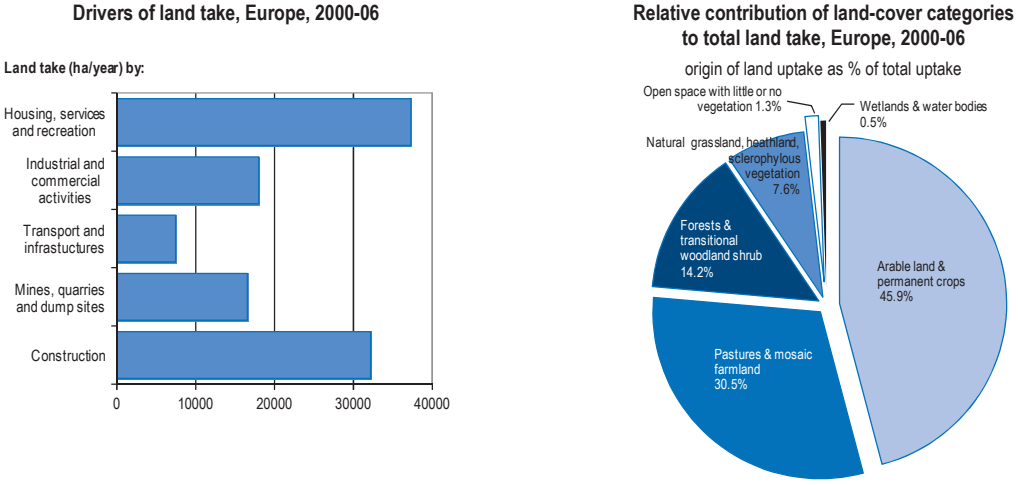


Source: *FAO, FAOSTAT* (database).

StatLink http://dx.doi.org/10.1787/888932925559

LAND TAKE: INDICATOR EXAMPLES

Figure 5.9. Land take by artificial land developments in Europe



Land take by expansion of residential areas and construction sites is the main cause of the increase in artificial areas to the detriment of agricultural areas and, to a lesser extent, forests and semi-natural and natural areas. The annual land take in 36 European countries was about 1 120 km^2 in 2000-06. In the 21 countries for which data are available for both 1990-2000 and 2000-06, the annual land take was 9% higher in the second period. The composition of the land areas taken changed from pasture and mosaic farmland to arable land and permanent crops, and to more forests, grasslands and open spaces.

Source: EEA, Land take indicators, *http://www.eea.europa.eu/data-and-maps/indicators/land-take-2/assessment-2.*

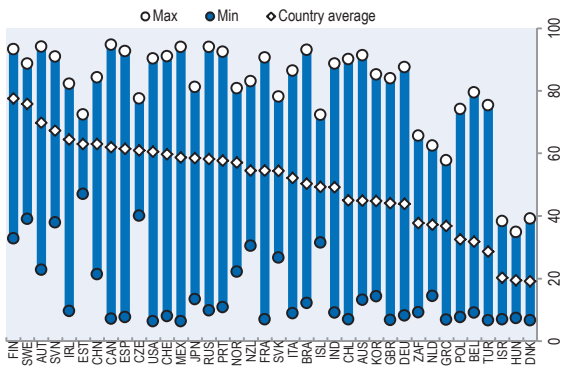
StatLink http://dx.doi.org/10.1787/888932925

Box 5.1. Measuring land cover and changes in land use at different geographical levels

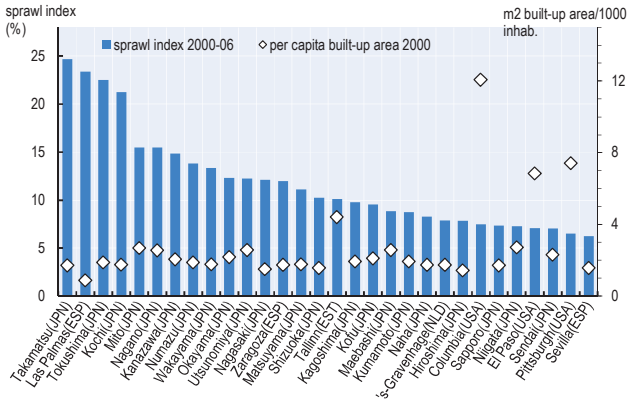
In the recent years, the OECD has been using satellite datasets (global layers) at different resolutions, combined and harmonized with geographic information systems (GIS), to measure land cover and its changes with respect to small portions of territory. The results show that geographic information data are a key and underexploited resource for monitoring the state of local environmental assets in regions and cities of different sizes and for producing internationally comparable indicators with the largest possible coverage of OECD and non-OECD countries.

The share of land covered by natural vegetation varies from around 80% in Finland to 20% in Denmark. However, a more detailed picture of the distribution of natural vegetation within countries, obtained by superimposing the MODIS Land Cover dataset onto boundaries of small regions, shows that inter-regional differences are higher than 60 percentage points in half of the 38 countries considered.

Per cent of regional land covered by vegetation, 2008



Top 30 OECD metropolitan areas for urban sprawl, 2000-2006



Despite recent progress in earth observation, remote sensing and techniques for processing large datasets, there is not a unique global dataset recording changes over time in land cover. By harmonizing the available sources of data for Europe, Japan and the United States, a classification into six typologies is suggested. This classification allows comparisons in the land take by urban development, loss of land for agriculture or forests in regions, share of green areas within cities, *etc.*

Monitoring the form and the quality of urbanisation processes are of concern for policy makers. This is particularly important when the expansion of land for urban uses (residential and commercial buildings, major roads and railways) threatens the quality of the landscape or bio-diversity. In the past decade, one-third of the OECD metropolitan areas in Europe, Japan and the United States have continued increasing their built-up areas, at a pace even faster than population growth. The urban sprawl index measures the percentage change over time in the built-up area "available" per person living in a metropolitan area. Values of the index higher than 1 mean that the growth of built-up area was faster than the growth of population (or in other words the built-up area per person has increased). The Figure above shows some of the metropolitan areas with the highest values of the sprawl index. Several metropolitan areas of Japan, Las Palmas and Zaragoza (Spain) and Tallin (Estonia) show values higher than 10%. However, these metropolitan areas had relatively lower levels of built-up area per person in 2000, compared to metropolitan areas in the United States.

Similar techniques of integrating different sources of data, making use of GIS and combining administrative and statistical data, have been used to obtain estimates of environmental indicators at the desired geographical level (regions and cities). Examples in the *OECD Regional Statistics* (database) include: per capita CO_2 emissions in regions and metropolitan areas (total and by sector); regional population exposed to fine air particulate matter (PM10); regional range of CO2 sequestration and release; percent of urban land converted from agriculture, forest and vegetation.

Source: OECD (2013) *Regions at a Glance*; OECD (2013), "Metropolitan areas", *OECD Regional Statistics* (database)

BIODIVERSITY AND ECOSYSTEMS: WILDLIFE RESOURCES

POLICY CONTEXT

The issue

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.

Challenges

The main challenge is to maintain or restore the diversity and integrity of ecosystems, species and genetic material and to ensure sustainable use of biodiversity. This implies strengthening the degree of protection of habitats and species, eliminating illegal exploitation and trade, integrating biodiversity concerns into economic and sectoral policies and raising public awareness. It requires a mix of instruments that address both demand and supply, including economic and market-based instruments (pricing, removal of environmentally harmful subsidies, and environmentally related taxes, charges and fees, as well as payments for ecosystem services, biodiversity offsets and tradable permits such as fishing quotas), supported with regulations, voluntary approaches and information-based instruments. Benefits are also expected from climate change mitigation and adaptation measures, particularly in developing countries.

MONITORING PROGRESS

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). A target endorsed at the WSSD (Johannesburg, 2002) aimed to significantly reduce the rate of biodiversity loss by 2010. Parties to the CBD further adopted (Nagoya, 2010) the Strategic Plan for Biodiversity 2011-20, including 20 headline targets (the Aichi Biodiversity Targets) and five strategic goals.

The indicators presented here relate to selected aspects of biodiversity:

- The number of **threatened species** compared to the number of known or assessed species. Data cover mammals, birds, and vascular plants.
- The state of **wild bird species** in Europe and the United States.

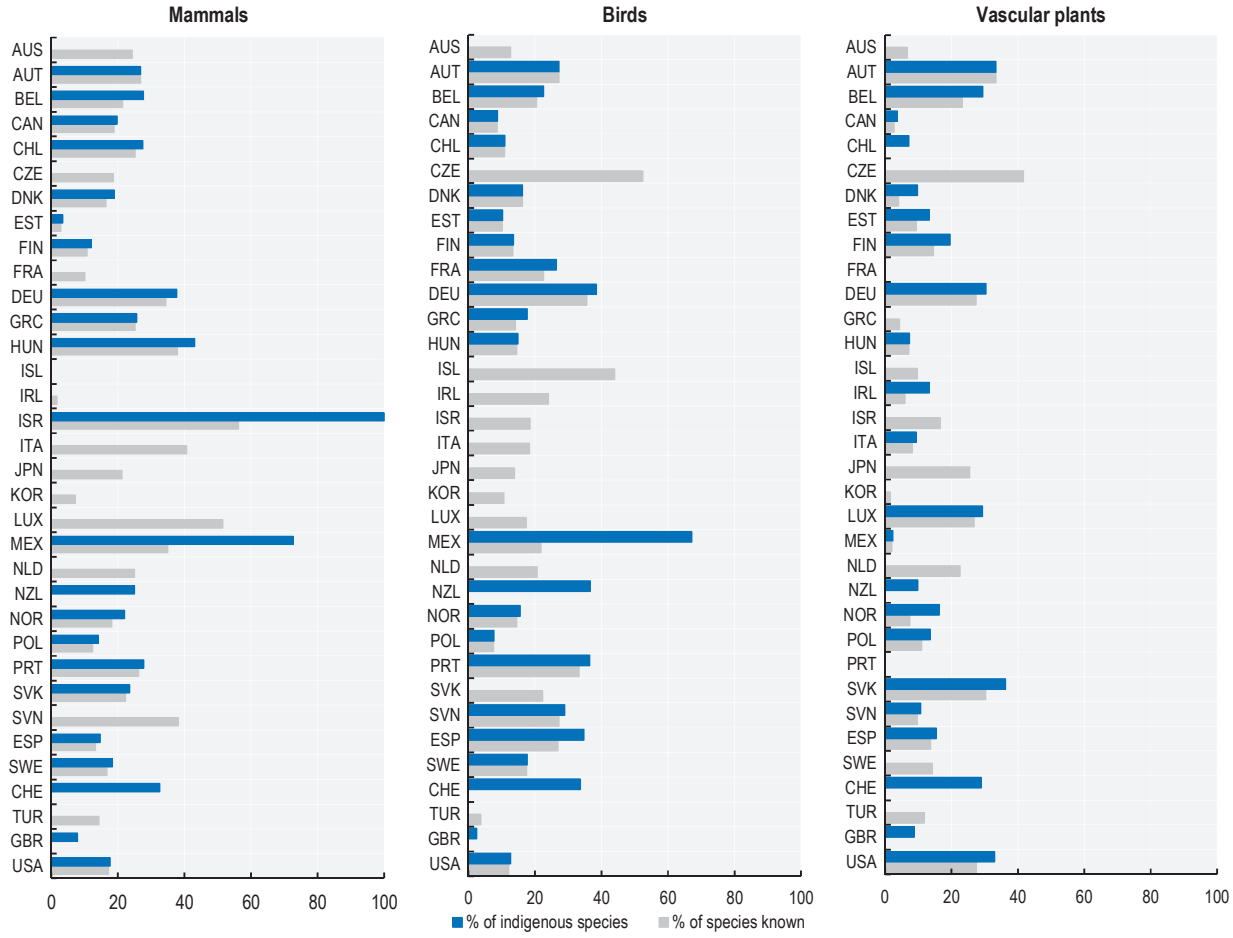
It should be kept in mind that these indicators only provide a partial picture of the status of biodiversity and that they also reflect efforts made to monitor species. They should be read in connection with information on the density of population and of human activities, habitat alteration and the use of biodiversity as a resource (*e.g.* forest, fish).

MEASURABILITY

Data on threatened species are available for all OECD countries with varying degrees of completeness. The number of species known or assessed does not always accurately reflect the number of species in existence, and 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. Bird population indices are available from Europe and North America. More accurate and comparable time-series data on wildlife populations still need to be developed.

See also *Definitions and notes*, page 100.

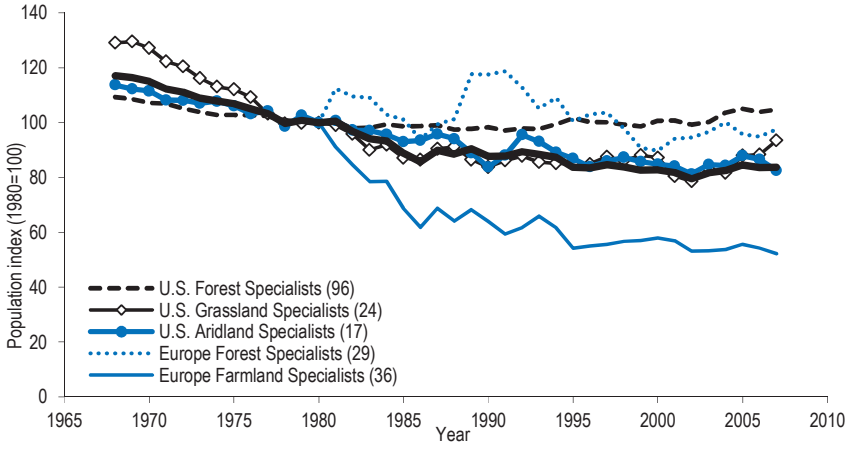
Figure 5.10. Threatened species
OECD countries, latest available year, in % of species known or assessed



Source: OECD Environment Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925597

Figure 5.11. Provisional Wild Bird Indices, for the US and Europe
1968-2007



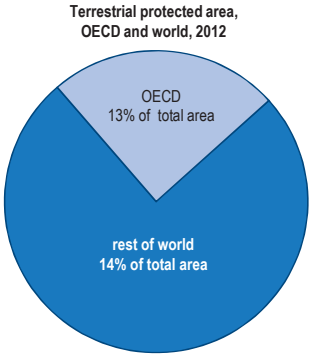
Source: Biodiversity Indicators Partnership (BIP).

StatLink *http://dx.doi.org/10.1787/888932925616*

MAIN TRENDS

Many natural ecosystems have been degraded, limiting the ecosystem services they provide. Animals and plants are increasingly endangered and ...

While protected areas have grown in most OECD countries, pressures on biodiversity and threats to global ecosystems and their species are also increasing. Many natural ecosystems have been degraded, limiting the ecosystem services they provide. 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.



Source: OECD Environment Statistics (database); *UNSD Millenium Development Goals Indicators*

- 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.

... wild bird populations declined in Europe and North America.

Today, one in eight bird species is threatened with global extinction. Sharp declines in many formerly common and widespread species signal wider environmental problems and the erosion of biodiversity as a whole. A wild bird index combining data from Europe and North America shows that specialist birds have declined by nearly 30% in 40 years. The largest declines have occurred in grasslands and arid lands in North America and in farmed lands in Europe, whereas widespread forest specialists show fluctuating but stable trends.

Agriculture is the major land user in most OECD countries and agricultural land is a primary habitat for wildlife, in particular for bird and insect species. Farmland bird populations declined continuously over 1990-2010 in almost all OECD countries. The rate of decline slowed over the 2000s compared to earlier decades; in some OECD countries (*e.g.* the United States) farmland bird populations have even been rising since the early or mid-2000s. This has been partly associated with efforts to introduce agri-environmental programmes and to encourage semi-natural land conservation on farms, changes in farm management practices, reductions in nutrient surpluses and pesticide sales, and changes in land use.

The main causes of declining wild species were changes to habitat quality or loss of natural and semi-natural habitats to other uses; intensification of agriculture and of pesticide and fertiliser use; lowering of groundwater tables and river flows; and clearance of native vegetation, such as forests.

Definitions and notes: Freshwater resources

Total freshwater resources

Total 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.

Water stress

Water stress is defined as the intensity of use of freshwater resources, expressed as gross abstraction in percentage of total available renewable freshwater resources (including inflows from neighbouring countries) or in percentage of internal resources (*i.e.* 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.

Freshwater abstractions

The freshwater abstraction indicators relate to the intensity of use of freshwater resources, expressed as gross abstractions per capita, as % of total available renewable freshwater resources (including inflows from neighbouring countries) and as % of internal resources. Indicators of water resource use intensity show great variations among and within individual countries. For some countries the data refer to water permits and not to actual abstractions.

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- The Water Information System for Europe (WISE). *http://water.europa.eu/*.

Definitions and notes: Forest resources

Forest area

Forest area refers to land of more than 0.5 ha with a canopy cover of more than 10%, or trees able to reach these thresholds in situ.

Growing stock

Volume over bark of living trees more than X cm in diameter at breast height (or above buttress if these are higher). 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.

Sources

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- OECD (2012), *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264122246-en*.

Definitions and notes: Fish resources

Fish stocks within safe biological limits

The proportion of fish stocks exploited within their level of maximum biological productivity, *i.e.* stocks that are underexploited, moderately exploited or fully exploited. Safe biological limits are the precautionary thresholds advocated by the ICES. The stocks assessed are classified on the basis of various phases of fishery development: underexploited, moderately exploited, fully exploited, overexploited, depleted and recovering.

Fish production

The indicators presented here refer to fish production from capture fisheries and aquaculture in fresh, brackish and marine waters. Captures refer to nominal catches (landings converted to a live weight basis) of freshwater, brackish water and marine species of fish, including diadromous species, crustaceans, molluscs and miscellaneous aquatic animals. Excluded are aquatic plants, whales, seals and other aquatic mammals.

OECD totals exclude Luxembourg and contain estimates.

Sources

- FAO (2013), *FISHSTAT* (database), *http://www.fao.org/fishery/statistics/software/fishstat/en*.
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Definitions and notes: Land resources

Land use

- 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 change

This indicator relates to the change over time of the distribution of land uses within a country. 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. The unit of observation is the proportion of each category of land use changed to another land use over a given period. 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.

Sources

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- FAO (2013), *FAOSTAT, Land Use Statistics* (database), *http://faostat.fao.org/site/377/default.aspx#ancor*.
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- OECD (2013), "Metropolitan areas", *OECD Regional Statistics* (database), http://dx.doi.org/10.1787/data-00531-en.

Further reading

- EEA (2010), *The European Environment - State and Outlook 2010: Thematic Assessment on Land Use. www.eea.europa.eu/soer/europe/land-use/key-facts*.

Definitions and notes: Wildlife resources

Threatened species

This refers to critically endangered, endangered, and vulnerable species, i.e. those plants and animals that are in danger of extinction or soon likely to be. See the IUCN Red List Categories and Criteria: Version 3.1 Second edition for further information. Data cover mammals, birds, and vascular plants. Other major groups (e.g. fish, reptiles, amphibians, invertebrates, fungi) are not covered.

The percentage of threatened indigenous mammals of Israel refers to 3 indigenous species that are all threatened.

Protected areas

These are areas under management categories I to VI of the World Conservation Union (IUCN) classification referring to the various levels of protection, as well as protected areas without a specific IUCN category assignment. Categories I and II (wilderness areas, strict nature reserves and national parks) reflect the highest protection level.

Global wild bird index (under development)

Birds are seen as a good indicator of the integrity of ecosystems and biological diversity. Being close to or at the top of the food chain, they reflect changes in ecosystems more rapidly than other species.

The global wild bird index (WBI) is an average trend in a group of species suited to track trends in habitat conditions. A decrease in the WBI means the balance of species' population trends is negative, representing biodiversity loss. If it is constant, there is no overall change. An increase means the balance of species' trends is positive, implying that biodiversity loss has halted. However, an increase may not always indicate an improving environmental situation, as in extreme cases it could result from expansion of some species at the cost of others, or reflect habitat degradation. In all cases, detailed analysis must be conducted to interpret the trends accurately. The composite can hide important trend patterns for individual species. Farmland bird population indices are available only for OECD Europe, Canada and the United States, but efforts are being made under the Biodiversity Indicators Partnership to develop the global WBI, building on national data.

Sources

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- North American Breeding Bird Survey (BBS). U.S. Department of Interior: Washington, D.C. *https://www.pwrc.usgs.gov/BBS/*.
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- IUCN (2013), *The IUCN Red List of Threatened Species*, *http://www.iucnredlist.org/about*.
- OECD (2012a), *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264122246-en*.
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- OECD (2010b), *Paying for Biodiversity: Enhancing the Cost-Effectiveness of Payments for Ecosystem Services*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264090279-en*.
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CHAPTER 6.

THE ENVIRONMENTAL QUALITY OF LIFE

Environmental health and risks: air quality

Environmental services and amenities: access to sewage treatment

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 material 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.

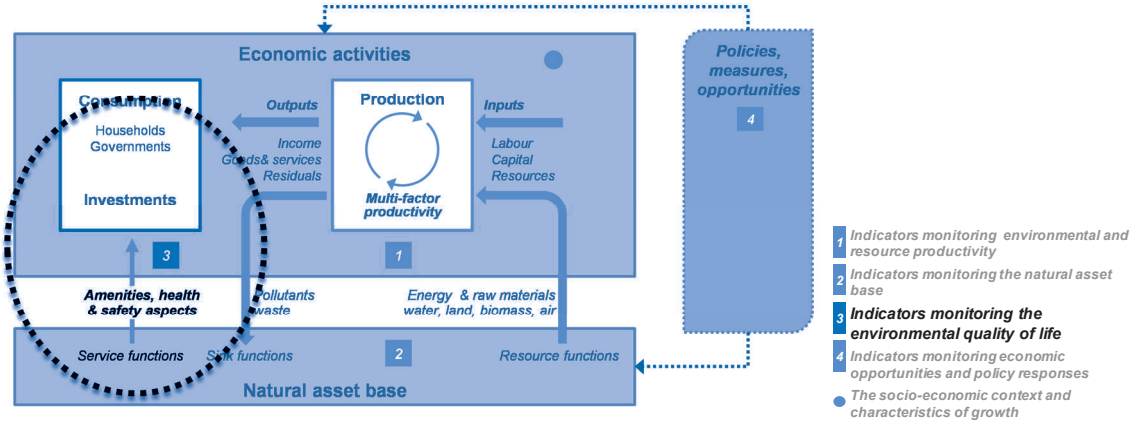
The main aspects of importance to green growth include:

- **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 these aspects can be complemented with information on people's perceptions about the quality of their environment. They should be read together with other quality of life and well-being indicators.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	M	Indicators presented here
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**	M		
	16.1. Population connected to sewage treatment (at least secondary, in relation to optimal connection rate)		S/M	☑
	16.2. 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.

ENVIRONMENTAL HEALTH AND RISKS: AIR QUALITY

POLICY CONTEXT

The issue

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.

Challenges

The main challenges are to further reduce emissions of local and regional air pollutants in order to achieve a strong decoupling of emissions from GDP, and to limit the exposure of the population to air pollution. This implies implementing appropriate pollution control policies and environmentally sustainable transport policies, and achieving technological progress and energy savings.

MONITORING PROGRESS

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.

The indicators presented here relate to **population exposure to air pollution** by small and fine particulates (PM_{10} and $PM_{2.5}$).

- For small particulates, the indicator refers to 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.
- For fine particulates, the indicator refers to estimates of the share of the population exposed to various $PM_{2.5}$ levels, derived from satellite-based measurements.

They are complemented with an indicator on ground-level ozone in selected European cities.

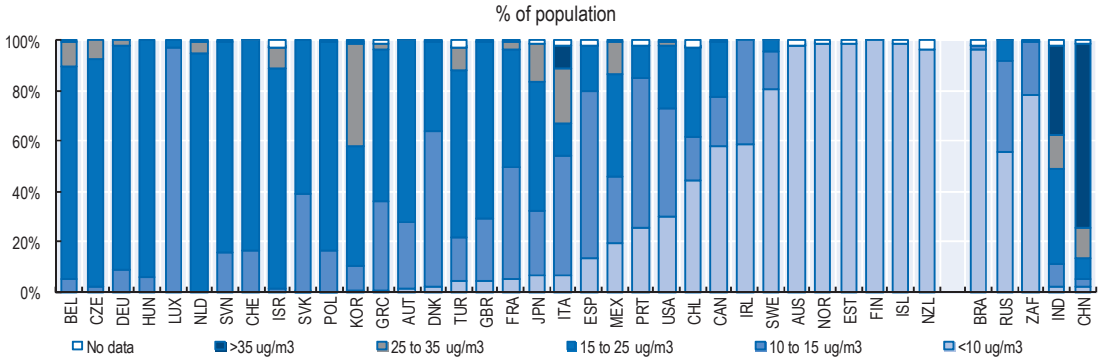
When interpreting these indicators, it should be kept in mind that they provide only a partial view of air pollution problems. They should be read in connection with information on other air pollutants, on urban air emissions, socio-demographic patterns, climatic conditions, and emission and fuel standards.

MEASURABILITY

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. 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.

More needs to be done to better estimate exposure to outdoor air pollution, in particular exposure of sensitive groups, and to explore the impact on human health and the associated distributional and equity issues. See also *Definitions and notes*, page 109.

Figure 6.1. Population exposed to air pollution by fine particulates (PM2.5), by WHO thresholds
OECD and BRIICS countries, 2001-06 average



Source: OECD (2011), *Regions at a Glance 2011.*

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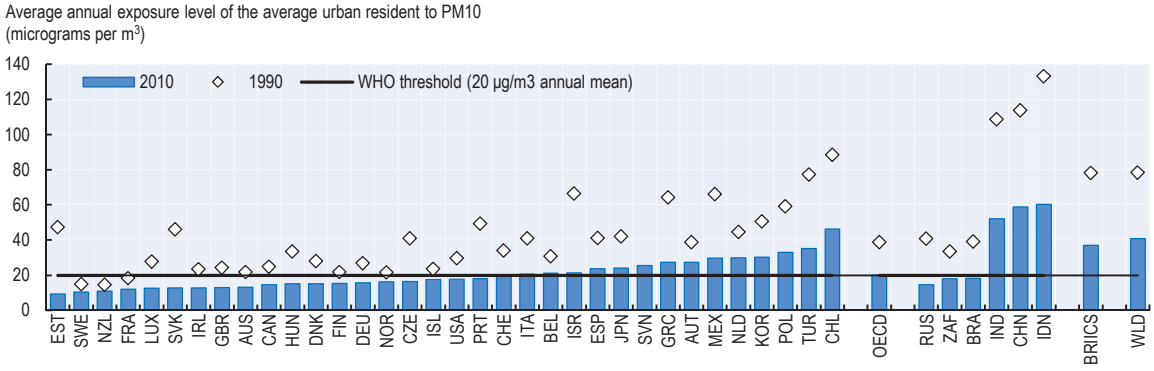
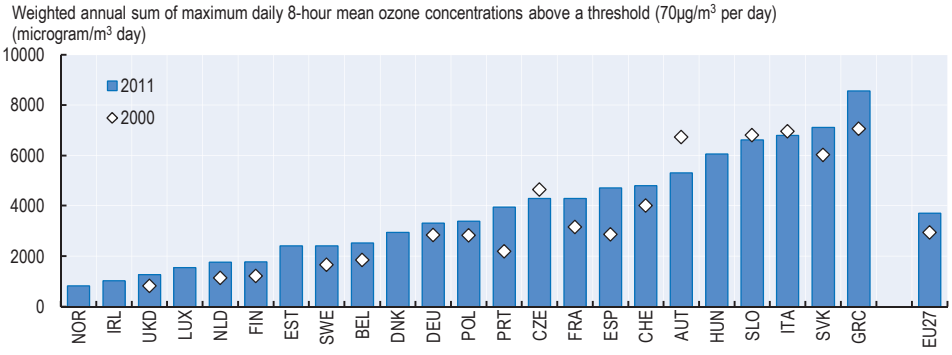
Figure 6.2. Population exposed to air pollution by small particulates (PM_{10})
OECD and BRIICS countries, 1990 and 2010



Source: The World Bank, *World Development Indicators* (database)

StatLink http://dx.doi.org/10.1787/888932925654

Figure 6.3. 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 m3) at urban background stations in agglomerations. Based on EEA calculations.

Source: European Environment Agency; *Eurostat*, *Sustainable Development Indicators* (database).

StatLink http://dx.doi.org/10.1787/888932925673

MAIN TRENDS

Human exposure to PM10 and some other air pollutants is decreasing… …but ozone, NO2 and PM2.5 are causes of growing concern

Over the past two decades, urban air quality has continued to improve slowly with respect to 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.

Ambient air pollution is estimated to cause about 3.7 million premature deaths each year…

Some population groups are especially vulnerable to air pollution. The very young and the very old are the most at risk. The World Health Organization estimates that ambient air pollution in both cities and rural areas caused 3.7 million premature deaths worldwide in 2012. About 88% of those premature deaths occurred in low- and middle-income countries, and the greatest number in the Western Pacific and South-East Asia regions.

Potential benefits of pollution mitigation would be considerable. A recent OECD study estimates the cost of the health impact of air pollution in OECD countries – in terms of what the population at large would be "willing to pay" to avoid the fatalities – to about USD 1.7 trillion. Available evidence suggests that road transport would account for about half of this cost. In the United States, the measurable public health benefits from the Clean Air Act for 2010 were put at 13 million prevented lost work days and USD 2 trillion, outweighing related costs 30 to 1. In Europe, it is estimated that outdoor air pollution takes a toll of up to 20% of disability-adjusted life years, which translates into 100 000 premature deaths and the loss of 725 000 working days annually.

…and could become the top cause of environment-related deaths by 2050

Measurement of $PM_{2.5}$ derived from satellite images, combined with data on population distribution, indicates that large fractions of the world population breathe air that exceeds the World Health Organization recommended level of 10µg of $PM_{2.5}/m^3$. The share of people living in areas with health-damaging levels of pollution is particularly high in some countries, including China and India.

There are virtually no safe limits with respect to human exposure to air pollution. The effects of PM on health occur at levels of exposure currently being experienced by most urban and rural populations in both developed and developing countries. The mortality in cities with high levels of pollution exceeds that observed in relatively cleaner cities by 15–20%. In the EU, average life expectancy is 8.6 months lower due to exposure to $PM_{2.5}$ from human activities. In developing countries, exposure to pollutants also comes from indoor combustion of solid fuels in open fires or traditional stoves, which increases the risk of mortality among young children and the risk of chronic pulmonary disease and lung cancer among adults.

The latest *OECD Environmental Outlook* (OECD, 2012) projects that, if no new policies are implemented, urban air quality will continue to deteriorate globally, and that with increasing urbanisation and population ageing, outdoor air pollution will become the top cause of environment-related deaths by 2050.

ENVIRONMENTAL SERVICES AND AMENITIES: ACCESS TO SEWAGE TREATMENT

POLICY CONTEXT

The issue

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.

Challenges

The main challenge is to protect and restore surface water bodies and groundwater reservoirs to ensure the achievement of water quality objectives as well as public access to sewage treatment and safe drinking water. It implies reducing pollution loads through treatment and investment in water infrastructure, and a more systematic integration of water quality considerations in agricultural and other sectoral policies. Applying the user-pays principle to all types of users and taking an integrated ecosystem-based approach to the management of freshwater resources by river basin are essential. In establishing water tariffs, social aspects, such as affordability of water bills for low income households, also need to be taken into account.

MONITORING PROGRESS

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.

The indicators presented here relate to:

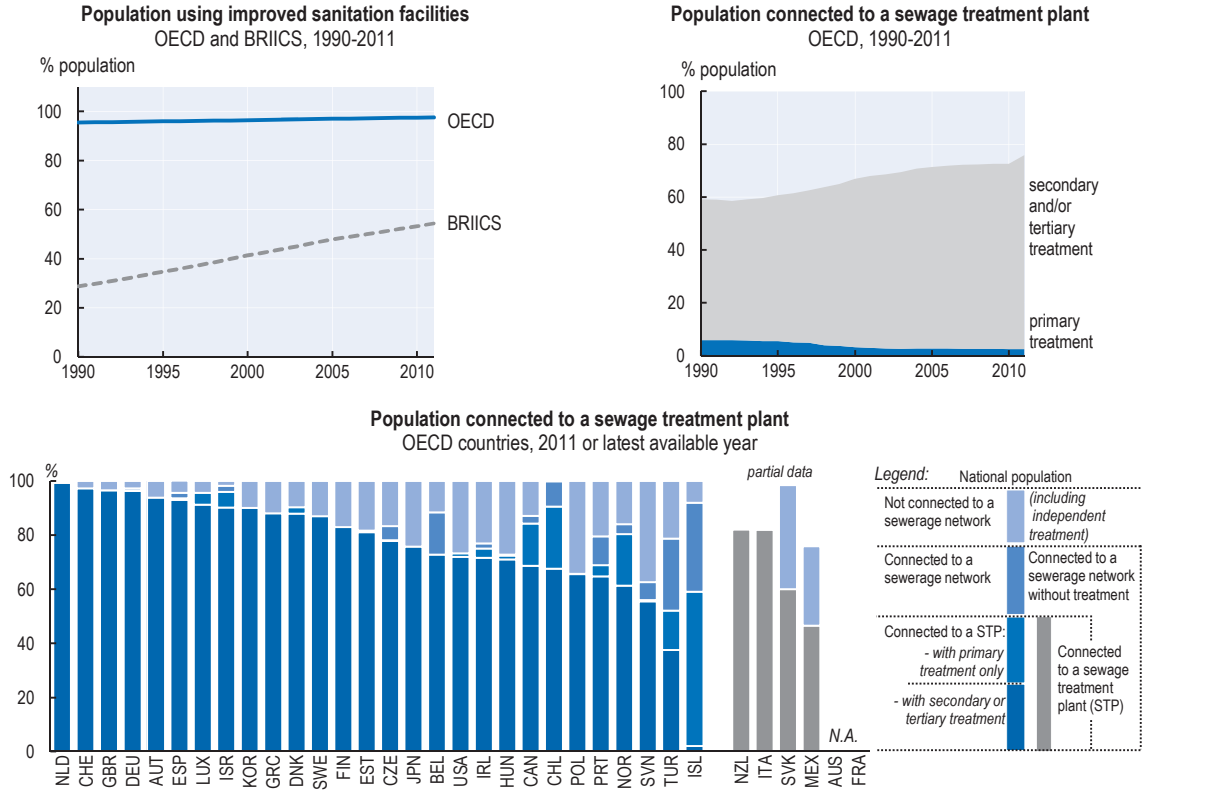
- **Public access to sewage treatment services**, showing the percentage of the national resident population in OECD countries that is connected to a wastewater treatment plant and to sewerage. The extent of secondary (biological) and/or tertiary (chemical) treatment provides an indication of efforts to reduce pollution loads.
- **Public access to basic sanitation** as measured by the Millennium Development Goals (MDG) indicators. This shows the percentage of the national resident population that has access to improved sanitation facilities.

The indicator on public access to wastewater treatment services should be related to an optimal national connection rate taking into account geographical features and the spatial distribution of habitats (the optimal rate is not necessarily 100%). It should be read in connection with information on public wastewater treatment expenditure, water prices for households and the related cost recovery ratios, and the quality of rivers and lakes. When interpreting the indicators on access to improved sanitation facilities, it should be noted that these indicators may not entirely capture whether the water and sanitation systems are being appropriately operated and maintained.

MEASURABILITY

Data on the share of the population connected to sewage treatment plants are available for almost all OECD countries. In some European countries, the data relate to the share of urban wastewater treated expressed in population equivalents and are thus not fully comparable. Information on the level of treatment remains partial. See also *Definitions and notes*, page 110.

Figure 6.4. Population using improved sanitation facilities and connected to a sewage treatment plant



Source: OECD Environment Statistics (database); UN Water, *Key Water Indicators* (database)

StatLink http://dx.doi.org/10.1787/888932925692

MAIN TRENDS

Waste water treatment has progressed, with some variations in treatment levels across 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.

The overall amount spent on sewerage and wastewater treatment (up to 1% of GDP), and the relative shares of investment and operating expenditure within the total, also differ widely among OECD countries. Some countries completed their sewer systems long ago and now face considerable investment to renew pipe networks. Others recently finished expanding wastewater treatment capacity so the weight of expenditure has shifted to operating costs. Yet others must still complete their sewerage networks even as they build sewage treatment stations. While access to sanitation facilities is less of an issue in OECD countries, much progress is needed in developing countries.

Definitions and notes: Human exposure to air pollution

Population exposure to pollution by particulates and ozone

The major components of particulate matter (PM) 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}) that are capable of penetrating deep into the respiratory tract and causing significant health damage. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. Fine particulates smaller than 2.5 microns in diameter ($PM_{2.5}$) cause even more severe health effects because they penetrate deeper into the respiratory tract and because they are potentially more toxic and may include heavy metals and toxic organic substances. There is a close, quantitative relationship between exposure to high concentrations of particulates (PM_{10} and $PM_{2.5}$) and increased mortality or morbidity, both daily and over time.

Air quality measurements are typically reported in terms of daily or annual mean concentrations of particles per cubic meter of air volume (m3), and routinely expressed in terms of micrograms per cubic meter (μg/m3).

Ozone at ground level – 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. As a result, the highest levels of ozone pollution occur during periods of sunny weather.

Excessive ozone in the air can have a marked effect on human health. It can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases.

Exposure to PM2.5

The indicators are derived from satellite-based measurement of $PM_{2.5}$. Population exposure to air pollution is calculated by taking the weighted average value of $PM_{2.5}$ for the grid cells present in each region with the weight given by the estimated population count in each cell. 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.

Exposure to PM10

The indicator shows urban-population weighted PM10 levels in residential areas of cities with more than 100,000 residents. The estimates 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.

Exposure to pollution by ozone.

The indicator 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 (O_3) are 8-hour mean concentrations of 100 micrograms per cubic meter.

Sources

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Definitions and notes: Public access to environmental services and amenities

Population connected to sewage treatment plants

"Connected" means physically connected to a wastewater treatment plant through a public sewerage network. Individual private treatment facilities such as septic tanks are not covered.

Primary treatment refers to a physical and/or chemical process involving settlement of suspended solids, or other process in which the BOD5 (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.*

The OECD totals are estimates and exclude Australia and the Slovak Republic. Data for "Connected to a sewerage network without treatment" and "Not connected to a sewerage network (including independent treatment)" contain estimates for Belgium, Chile, Hungary, Ireland, Poland, Portugal and the United States.

Population using an improved sanitation facility

The indicator 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.

Sources

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CHAPTER 7.

ECONOMIC OPPORTUNITIES AND POLICY RESPONSES

Technology and innovation

Environmental goods and services

International financial flows

Environmentally related taxes and transfers

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 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 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 with in this section are:

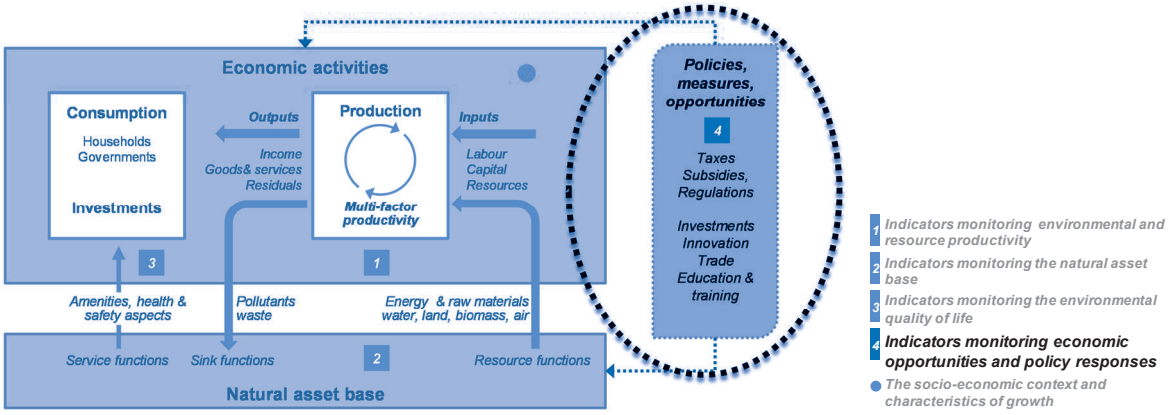
- **Technology and innovation**, which are important drivers of growth and productivity in general, and of green growth in particular. They are important for managing natural resources and raw materials and minimising the pollution burden. Innovation can spur new markets, contribute to job creation, 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.
- **Investment and financing** 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, indicators regarding economic instruments should be complemented by indicators on **regulation**. However, data availability and comparability of regulatory measures across countries hamper the construction of such indicators.

The indicators here can also be complemented with indicators on **international trade** as a source of economic opportunities, including green growth opportunities. Since trade in green products is only a small part of this, however, no specific trade-related indicators are put forward here. General indicators on international trade and competitiveness can be found in the section on the socio-economic context.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	M	Indicators presented here
Technology and innovation	**17. 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	
	18. Patents of importance to green growth	M	S/M	☑
	(% of country applications under the Patent Cooperation Treaty)			
	- Environment-related and all-purpose patents		S/M	
	- Structure of environment-related patents		S/M	
	19. Environment-related innovation in all sectors	M	M	☑ Example
Environmental goods and services	**20. Production of environmental goods and services (EGS)**	M	M	☑ Example
	21. Gross value added in the EGS sector (% of GDP)		M	
	22. Employment in the EGS sector (% of total employment)		M	
International financial flows	**23. International financial flows of importance to green growth**	M	L	
	% of total flows and % of GNI			
	24. Official development assistance		S	☑
	25. Carbon market financing		S	☑
	26. Foreign direct investment		L	–
Prices and transfers	**27. 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	
	28. Energy pricing	M	S	☑
	(share of taxes in end-use prices)			
	29. Water pricing and cost recovery (tbd)	M	S/M	–
	<u>To be complemented with indicators on:</u>			
	Environmentally related subsidies		M/L	
	Environmentally related expenditure: level and structure		L	
Regulations and management approaches	**30.** *Indicators to be developed*		..	
Training and skill development	**31.** *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.

TECHNOLOGY AND INNOVATION

POLICY CONTEXT

The issue

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.

Challenges

The main challenges are to strengthen research, foster innovation and the use of new technology in production, and encourage the creation of markets and the uptake of new technology by consumers. This implies effective and timely support for the commercialisation of "green" technology to reduce future costs associated with environmental issues. It also requires an appropriate mix of policy tools and instruments, such as procurement, financing incentives, economic instruments, intellectual property rights and voluntary initiatives. Support from government R&D budgets is often needed to reduce the cost of new technology and help bring it to market competitiveness.

Further efforts are needed to disseminate good practices, foster entrepreneurship and partnerships, and to support technology transfer and knowledge diffusion at global level.

MONITORING PROGRESS

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.

The indicators presented here relate to:

- **R&D expenditure of importance to green growth**. The data refer to government appropriations or outlays for R&D and to business expenditure on R&D, expressed as percentages of all R&D expenditure.
- **Patents of importance to green growth**. The data refer to patent applications under the Patent Cooperation Treaty (PCT) related to: clean energy generation and efficiency, transport fuel efficiency, environmental management and emission mitigation.

R&D expenditure is an input measure that indicates an economy's relative degree of investment in generating knowledge. It thus reflects an intent towards green growth, not a green growth as an outcome. International comparisons should consider differences among countries in industrial structure and research capability; high R&D spending alone does not mean superior innovation performance.

Patent applications reflect inventive performance, but not all technologies or processes are the subject of applications, and not all enterprises wish to disclose technological advances through patent applications. Also, not all patents lead to innovation. The development and adoption of new technologies with positive green growth implications may come from any sector of the economy. The patent indicators here thus do not measure the full extent of innovative activities and do not distinguish between high-quality and low-quality patents.

Patent applications reflect inventive performance, but not all technologies or processes are the subject of applications, and not all enterprises wish to disclose technological advances through patent applications. Also, not all patents lead to innovation. The development and adoption of new technologies with positive green growth implications may come from any sector of the economy. The patent indicators here thus do not measure the full extent of innovative activities and do not distinguish between high-quality and low-quality patents.

MEASURABILITY

Data on government R&D are available for most OECD countries, though the coverage of national surveys and the sampling and estimation methods used may vary. Significant gaps exist concerning harmonised data on private-sector R&D expenditure, and harmonised micro-data. Design, product engineering and technology service expenditures, which are closely related innovation inputs, are not captured.

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.

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. More work is needed on a whole-economy approach to monitoring green innovation processes and on technology transfer.

See also *Definitions and notes*, page 134.

RESEARCH AND DEVELOPMENT

Figure 7.1. Government R&D budget related to energy and environment
OECD countries, 2008-2012 average

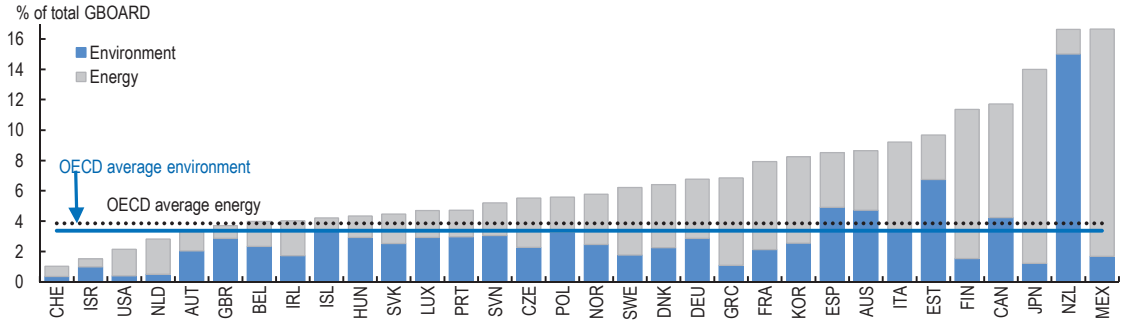


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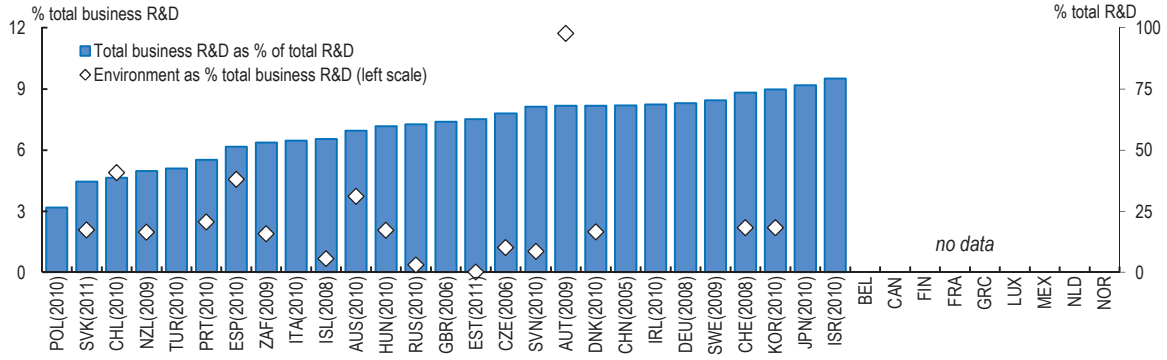
Figure 7.2. Business R&D investment related to environment
selected OECD countries, 2010 or latest available year*



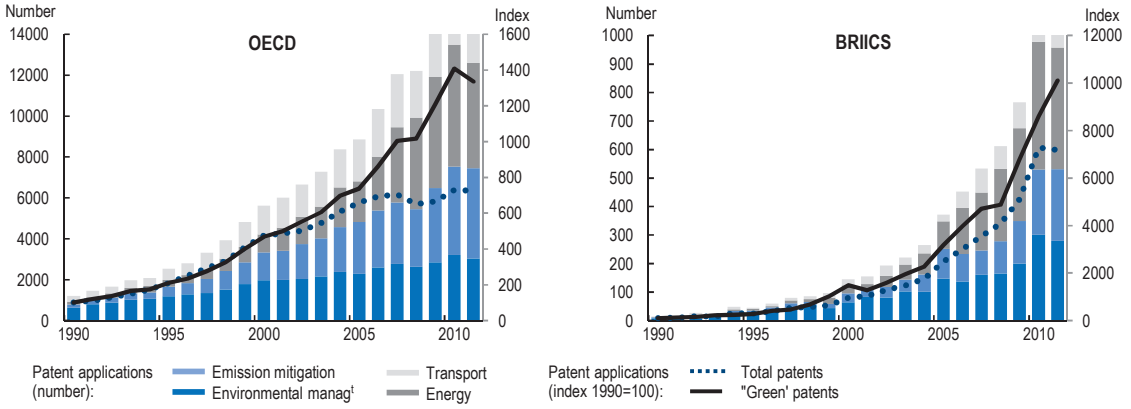
*Data prior to 2005 are not considered.

Source: OECD Science, Technology and R&D Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925730

PATENTS

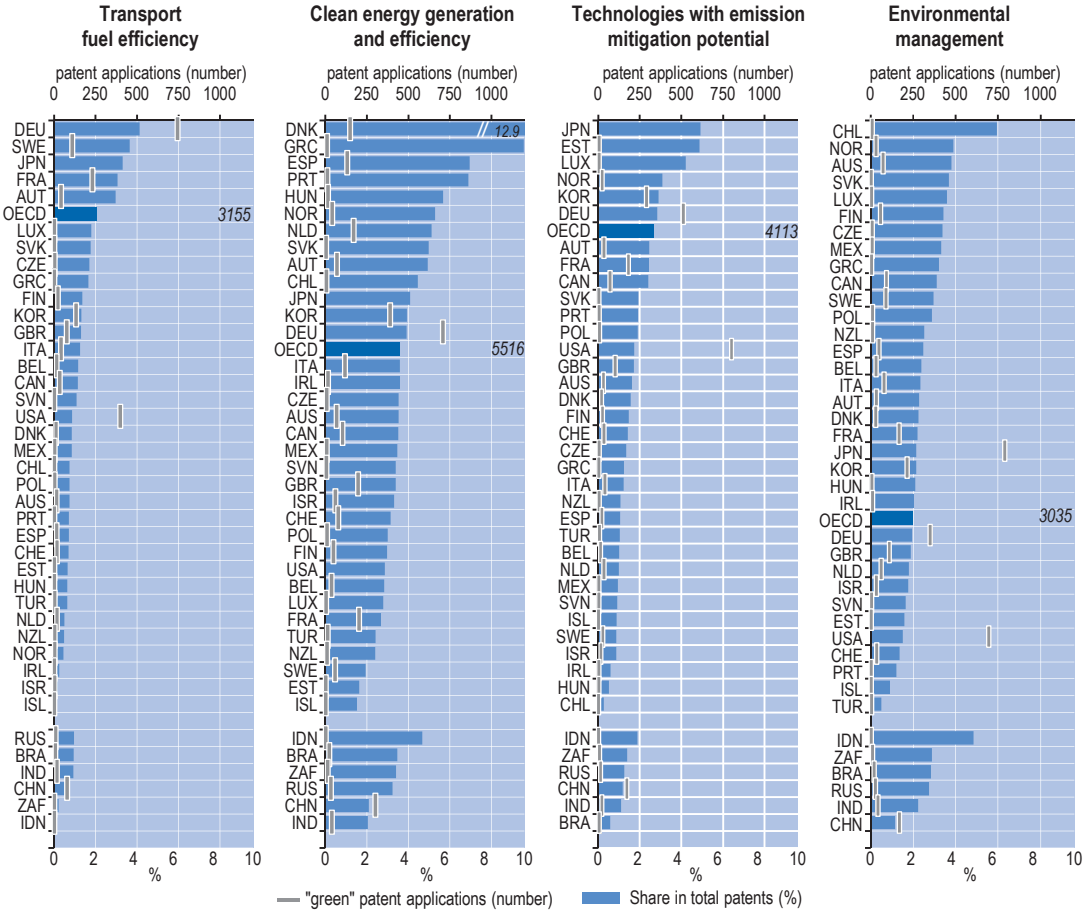
Figure 7.3. Patent applications under PCT of importance to green growth, OECD and BRIICS
1990-2011



Source: OECD Patent Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925749

Figure 7.4. Patent applications under PCT of importance to green growth, by type
OECD and BRIICS countries, 2009-11



Source: OECD Patent Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925768

MAIN TRENDS

Public environment-related R&D is gaining importance…

Public R&D spending has slightly decreased since 1990, but the amount dedicated to environment and energy efficiency has increased. This reflects concerns about climate change, rising energy prices and the scarcity of fossil fuels.

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.

Business expenditure on environment R&D accounts for a small share of total business R&D in all but one of the OECD countries for which data are available. There is no systematic evidence of a positive relationship between public and business environment R&D.

… and the number of green patents is increasing

OECD work indicates that predictability, flexibility and stringency of environmental policies often lead to higher investment in innovation. Green technology development is accelerating in all areas. Since 1990, in most regions and countries, the share of green patents has increased, reaching more than 10% of total patents in 2011. This is partly due to increased applications in cleaner energy generation and energy efficiency. Much development still takes place at the margin, however, and is unlikely to deliver major changes in key environmental domains.

Innovation efforts vary by country, with a high degree of specialisation

Innovation efforts differ greatly among countries. Most technology development is concentrated in relatively few countries and there is considerable specialisation among them. In general, the OECD countries with the highest all-purpose innovation are also among the most innovative in technology relevant to green growth. Differences exist however in the overall size of patent portfolios, in the share of environment-related inventions in total patents, and in the types of technologies countries are specialised in.

- The most important field of innovation relates to technologies and optimisation processes that support cleaner energy generation and increased efficiency. Although the United States, Japan and Germany are the largest innovators in this field in terms of patent numbers, when expressed as a share of total patents, Denmark filed more patent applications than any other OECD country in this area over 2009-11.
- The second most important field relates to emission abatement and fuel efficiency. Key innovators are countries whose economic structures lean towards the motor vehicle and transport industry, notably Japan, Germany, the United States and France.
- Some countries are investing in advanced technologies that hold particular promise of long-term emission abatement, such as hydrogen and fuel cells, carbon capture and storage, and clean fossil fuel use.
- In all economies considered, most patenting occurs in energy generation and environmental management.

Environment-related innovation across the economy is key

Innovation of importance to green growth may occur in any economic sector, industry or type of application. Firm-level innovation data reveal that the most innovating firms introduce system innovation, comprising product and process innovation as well as marketing and process innovation. Green innovation thus extends beyond technological change and applications to societal and organisational improvement.

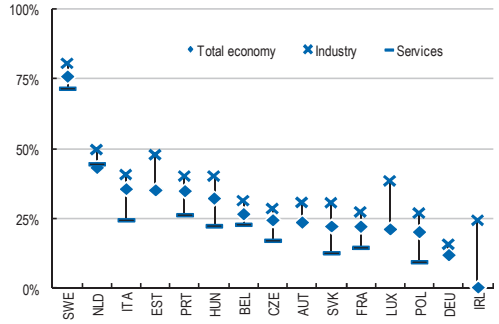
Little information is available on environment-related innovation across sectors. The available data suggest that such system innovation is still rather limited in most countries.

In 2008, on average, less than one-third of the innovators surveyed in the European Union introduced procedures to regularly identify and reduce environmental impacts. Most innovations take place in industry, although services are not far behind. Environmental regulations (and taxes) and market demand appear to be the main drivers of environmental innovation. The figures vary by country, but on average one-quarter of surveyed firms perceived existing regulations and taxes as an incentive to introduce eco-innovation, while 18% cited expected market demand and 7% said government support (Box 7.1).

Box 7.1. System innovation of importance to green growth in the European Union: indicator examples

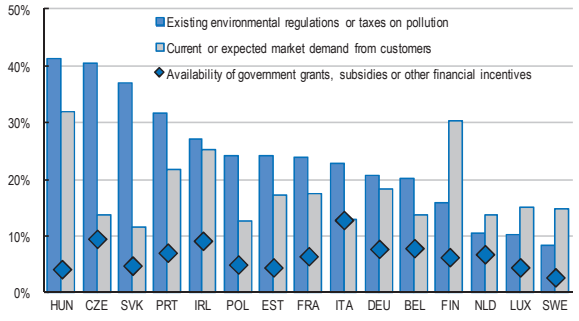
selected EU countries, 2008

Environment-related innovation in all sectors



Notes: Enterprises with procedures to regularly identify and reduce environmental impacts as % of all surveyed enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation). All firm sizes.

Determinants of environment-related innovation



Notes: Innovating enterprises motivated to introduce environmental innovation as % of all enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation).All firm sizes.

Source: European Commission, Eurostat, Community Innovation Statistics.

ENVIRONMENTAL GOODS AND SERVICES

POLICY CONTEXT

The issue

Producing environmental goods and services generates growth and employment while contributing to greener growth. 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. 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.

Challenges

The main challenge is to foster production of EGS in a wide range of sectors and to strengthen the export competitiveness of the EGS sector. This requires market conditions and policy frameworks that support entrepreneurial development and knowledge transfer.

Key factors influencing EGS supply and demand are regulations and environmental policy objectives, technological developments, the emergence of new market segments, and economic instruments and incentives that enable the sector to be competitive. Capacity building, stronger industry-science links, training and development of skills are particularly important in allowing small and medium-sized enterprises to seize green business opportunities.

MONITORING PROGRESS

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.

The indicators presented here relate to:

- **employment in selected environmental protection activities** for selected countries, expressed as a percentage of all employment in recycling (ISIC 37); water collection, purification and distribution (ISIC 41); and sewage and refuse disposal, sanitation and similar activities (ISIC 90).
- **employment and value added in the EGS sector** for the European Union, expressed as full-time equivalents for employment and as a percentage of GDP for value added.

When interpreting these indicators, it should be noted that they provide only a partial picture of activities relevant for green growth, and that not all indicators reflect an internationally agreed classification. It should also 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 (Box 7.2).

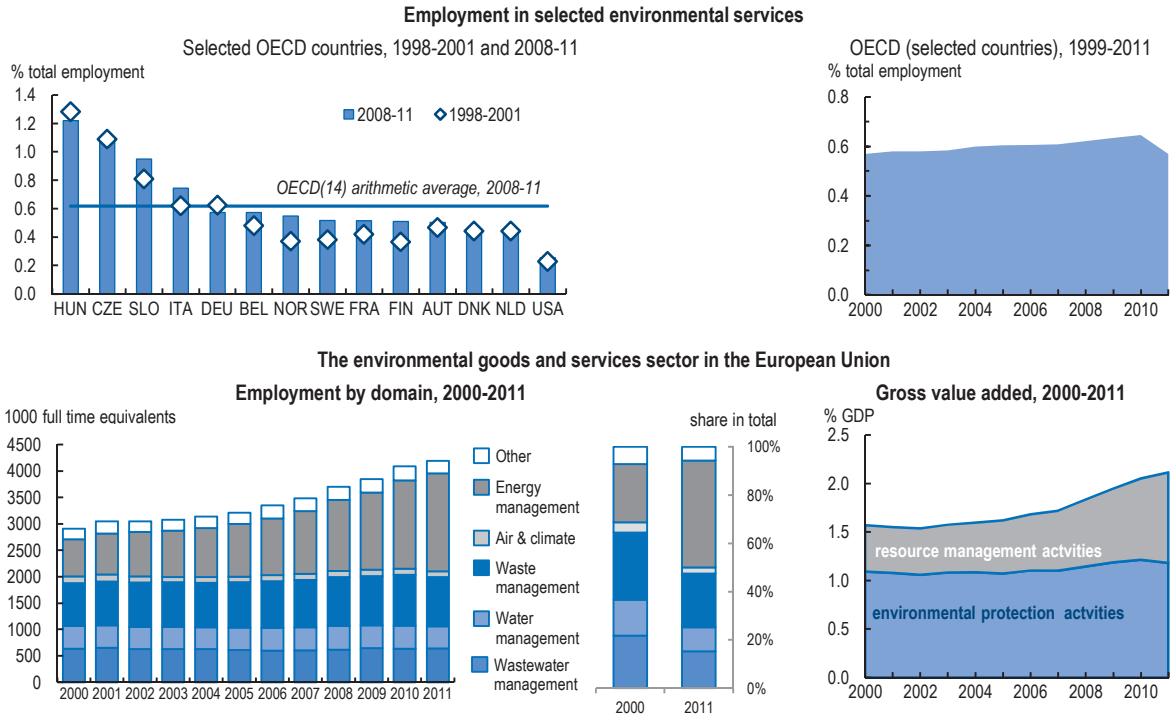
MEASURABILITY

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 Central Framework of the UN System of Environmental Economic Accounting (SEEA).

The scope for monitoring shifts from traditional business activities to greener activities remains limited. Most indicators used to describe entrepreneurial performance are not available at the level of detail required to capture activities characterised as 'green'.

See also *Definitions and notes*, page 135.

Figure 7.5. Employment and value added in sectors producing environmental goods and services



Source: STAN: OECD Structural Analysis Statistics (database); Eurostat.

StatLink http://dx.doi.org/10.1787/888932925787

MAIN TRENDS

"Green" sectors hold a modest but growing share of the economy

The share of green sectors today is rather small. The share of employment in selected green industries represents, on average, only about 0.6% of total employment; the share of firms primarily active in selected green industries out of the total number of firms is even lower. EGS nevertheless account for an increasing share of merchandise exports.

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.

What counts is the "green" transformation of the economy

An important complement to measures of green industries is information on opportunities arising from integration of environmental considerations in activities throughout the economy, independently of whether particular products or services serve environmental purposes. Gathering such information would require, for instance, business surveys akin to information on innovation. General indications about entrepreneurship are helpful, since barriers to entrepreneurship are likely to determine the creation of jobs and growth of firms, regardless of whether they are involved in environment-related activities.

Box 7.2. The EGS sector: measurement and interpretation

In 2009, Eurostat published a handbook to provide guidance to statistical offices in the collection of data on turnover, value added, employment and exports of the EGS sector. It builds on work carried out jointly with the OECD (OECD and Eurostat, 1999) and constitutes a methodological reference that has been integrated in the Central Framework of the SEEA. It 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 resource-efficient technologies, goods and services that minimise natural resource use.

Overall, despite existing definitions, setting the boundaries of the EGS sector remains difficult as does measurement and interpretation.

- The definition above is essentially a product-based definition of "green" – it brings together enterprises producing goods or technologies whose main purpose is environmental. Identifying the main purpose of a technology or product is often difficult, so some arbitrariness cannot be avoided. It is also apparent that the EGS sector is highly diverse and includes government as well as corporate producers . A given production unit may find some of its activities meeting the definition, but not all.
- The definition covers only one aspect of "green" and omits greening of processes, regardless of industrial activity. An economy can "turn green" and realise growth opportunities, without necessarily producing EGS, if production processes become more environmentally efficient.

Thus, 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). The Nordic Council of Ministers recently published a report on measuring green jobs (Nordic Cooperation, 2012) arguing that the issue extends beyond the definition of "green" jobs and businesses, as all economic activities affect the environment one way or another along the supply chain.

Some studies have tried to capture the broader aspect of green activities. For instance, Arvantis, Ley and Wörther (2010) use firm-level data to identify the "Cleantech" sector, defined as firms whose innovation activity falls into at least one of the following categories: (a) development of environment-friendly products (product innovation), (b) reduction of the share of cost of materials (process innovation), (c) reduction of the share of energy cost and (d) reduction of environmental pressure through production (process innovation).

The difficulties described here can result in significant differences among estimates of the size of the EGS sector in an economy. The OECD Environmental Performance Review of Germany (OECD, 2012) describes a case where two assessments based on different measurement approaches led to diverging messages on the size of the sector, leading to public debate on the employment and competitiveness prospects of the country's green growth agenda.

- The German Federal Statistical Office collects information on EGS, defined as goods, construction operations and services aimed at avoiding, reducing or remediating damage to the environment caused by production and consumption. The underlying environmental domains are waste management, water protection, noise abatement, air quality control, nature and landscape conservation, soil decontamination and, since 2006, climate protection, with resource conservation and renewables added even more recently. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) used a broader definition to assess the market size of the environmental technology services sector.
- The size of the estimates differed significantly, with a bearing on policies. While the BMU estimated turnover in a broadly defined sector at 5% of GDP (2008), the statistical office estimate was 2% of GDP (2009). The related employment figures ranged from 180 000 to 1.8 million, depending on the definition used and on whether indirect employment was considered.

Establishing a methodological link between the various national definitions and the international statistical standard integrated in the SEEA would help improve the credibility of indicator-based policy reports.

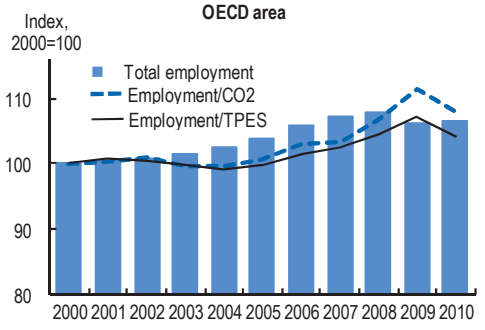
Source: OECD (2012), *OECD Environmental Performance Reviews: Germany 2012,* Nordic Co-operation (2012), *Measuring Green Jobs: An evaluation of definitions and statistics for green activities.*

Box 7.3. Employment and distributional aspects of green growth: Examples

The transition towards greener growth will reshape the labour market and create new employment opportunities. The example below indicates that employment growth has recently outpaced CO_2 emissions and energy trends in OECD countries. Although informative, such an aggregate picture masks the opportunities and challenges associated with relocation of jobs between industries as a result of structural shifts implied by greener growth (OECD, 2012g).

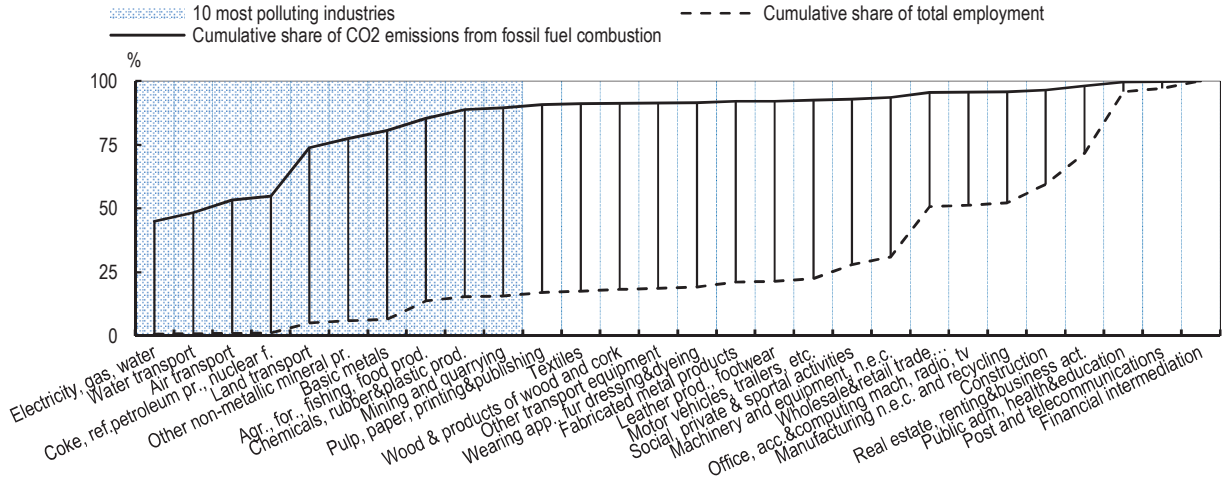
An example from the 2012 *OECD Employment Outlook* (OECD, 2012i) depicts a high concentration of emissions in a relatively small number of industries that account for a limited share of total employment. The 10 most carbon-intensive industries account for nearly 90% of all CO_2 emissions but only 14% of employment, on average, in the EU-25. Employment shares of the 10 most polluting industries differ across EU-25 countries, but are generally higher in countries with lower GDP per capita (OECD-ILO, 2012).

Employment per CO_2 and per total primary energy supply, OECD area



Industries with a very large environmental footprint will need to adapt. A carefully designed framework of labour market and skill policies can support dynamic and socially inclusive labour market adjustments (OECD, 2012j). Recent OECD policy work (OECD, 2012i; OECD, 2012j; OECD-ILO, 2012) highlights good policy practices. On the supply side, a strong skill development system and active labour market programmes, together with a social dialogue, can reinforce the adaptive capacity of labour markets to prevent unemployment from becoming structural. On the demand side, moderate employment protection and strong product market competition can support job creation, along with environmental and innovation policies that create new markets. Adverse distributional effects can be addressed through safety net measures, such as unemployment insurance, and in-work benefits.

CO_2 emissions and employment by industry, EU-25 countries, 2005



Source: OECD (2012), OECD Employment Outlook 2012.

INTERNATIONAL FINANCIAL FLOWS

POLICY CONTEXT

The issue

Public and private sources of international financial flows are key to the uptake and dissemination of technology and good practices. They contribute to cross-country exchange of knowledge, stimulate entrepreneurship and partnerships, and are a key aspect of work to combine development and environmental objectives. Technology transfer and the diffusion of knowledge through investment projects play an important role in fostering resource-efficient progress of societies across the world.

Challenges

The main challenge is to strengthen the use of public financing to leverage private equity in projects supporting the transition to greener growth. In government, there is a need to improve the capacity of environmental staff to interact with their finance ministry colleagues and help steer budget-support towards green growth objectives. Further efforts are also needed to disseminate best practices and foster comprehensive entrepreneurship and partnerships, particularly in large infrastructure projects. On a global level, countries need assistance to transform assessments of sectoral needs into a coherent identification of innovation priorities.

MONITORING PROGRESS

Progress towards green growth can be assessed by monitoring global public and private finance flows. Public financing can be partly measured by the extent to which official development assistance (ODA) has an environment marker. Private financing can be partly measured by trading of carbon allowances and investments in offset projects of importance to green growth.

The indicators presented here relate to:

- **Official Development Assistance**, including total ODA (as a percentage of GNI), the share of ODA to environment and renewable energy (as a percentage of total ODA) and ODA targeting the objectives of the Rio conventions, *i.e.* related to biodiversity, desertification and climate change (as a percentage of total ODA).
- **Private financing**:
  - Carbon market financing, which relates to trading of carbon allowances in terms of value of offset transactions based on known volumes of sales of units and estimates of average offset prices, expressed in US dollars.
  - The structure of supply and demand of certified emission reduction (CER) credits issued through Kyoto Protocol Clean Development Mechanism (CDM) projects in the pipeline, expressed as a percentage of all projects, by countries and regions.

These are complemented with examples of export credit projects with environmental considerations, international investment vehicles for clean energy and stock exchange performance of alternative energy and sustainable industry equity prices.

When interpreting the indicators on ODA, it should be noted that Rio markers indicate donors' policy objectives in relation to each aid activity. There is no internationally agreed methodology for tracking the exact share of aid activity expenditure related to each objective.

Concerning carbon market financing, there may be duplicates in the spot or secondary transactions not accounted for, which could lead to a slightly upward-biased indicator of total carbon market in terms of carbon allowances. The structure of CDM transfers should be interpreted in view of the number of projects that have had credits issued, as opposed to the number of credits issued per project type.

MEASURABILITY

The main statistical challenge is the additivity and the monitoring of financial flows of importance to green growth. Although some standards exist, such as the OECD Development Assistance Committee (DAC) Creditor Reporting System (CRS), it remains difficult to determine the environmental purpose of existing aid commitments and investment projects. ODA donors are requested to screen each aid activity reported to the CRS, but data gaps remain for some donors.

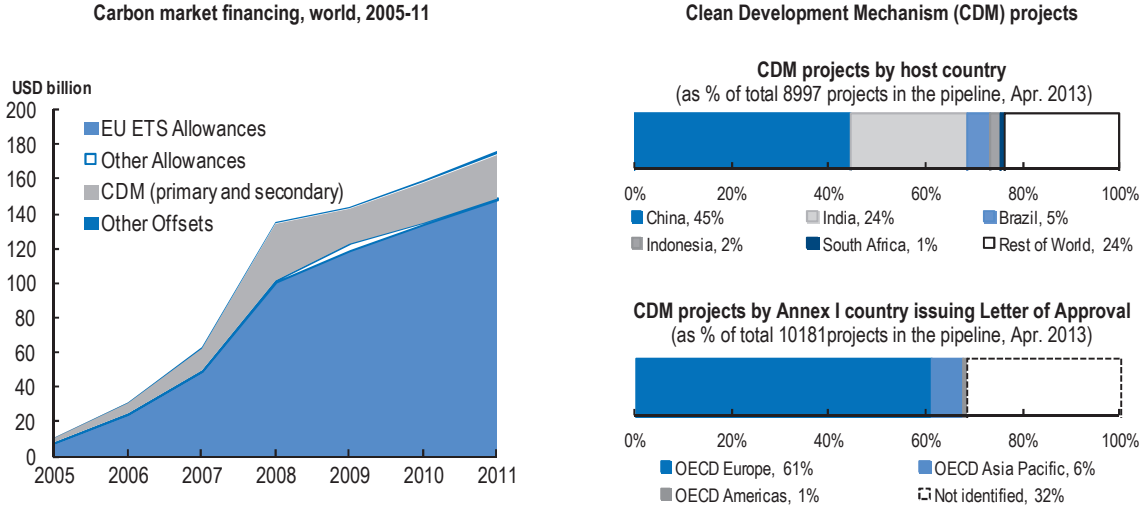
Public financing is also provided through official export credits and through multilateral development banks (MDBs), which can facilitate and leverage private investment. Official export credits relate to direct export credit financing, export credit insurance and export credit guarantees facilitated by government support. MDBs increasingly manage dedicated environmentally related funds. Regarding leveraging of public international finance, MDBs and bilateral donors gather some data and report on leveraging performance of development assistance, but there is no agreed methodology on how to track these flows consistently.

While there are efforts to assess annual investment flows into CDM projects, there is no standard methodology that would provide a comprehensive, measurable indicator without a risk of double-counting private flows.

A limitation of these indicators is that they do not track financial flows between OECD countries directly. A "green" FDI-based indicator could fill this gap, but the lack of an agreed definition and the patchiness of the data render its calculation impossible at this stage. The OECD has started working with its member countries to develop an operational definition of "green" FDI and an agreed measurement method.

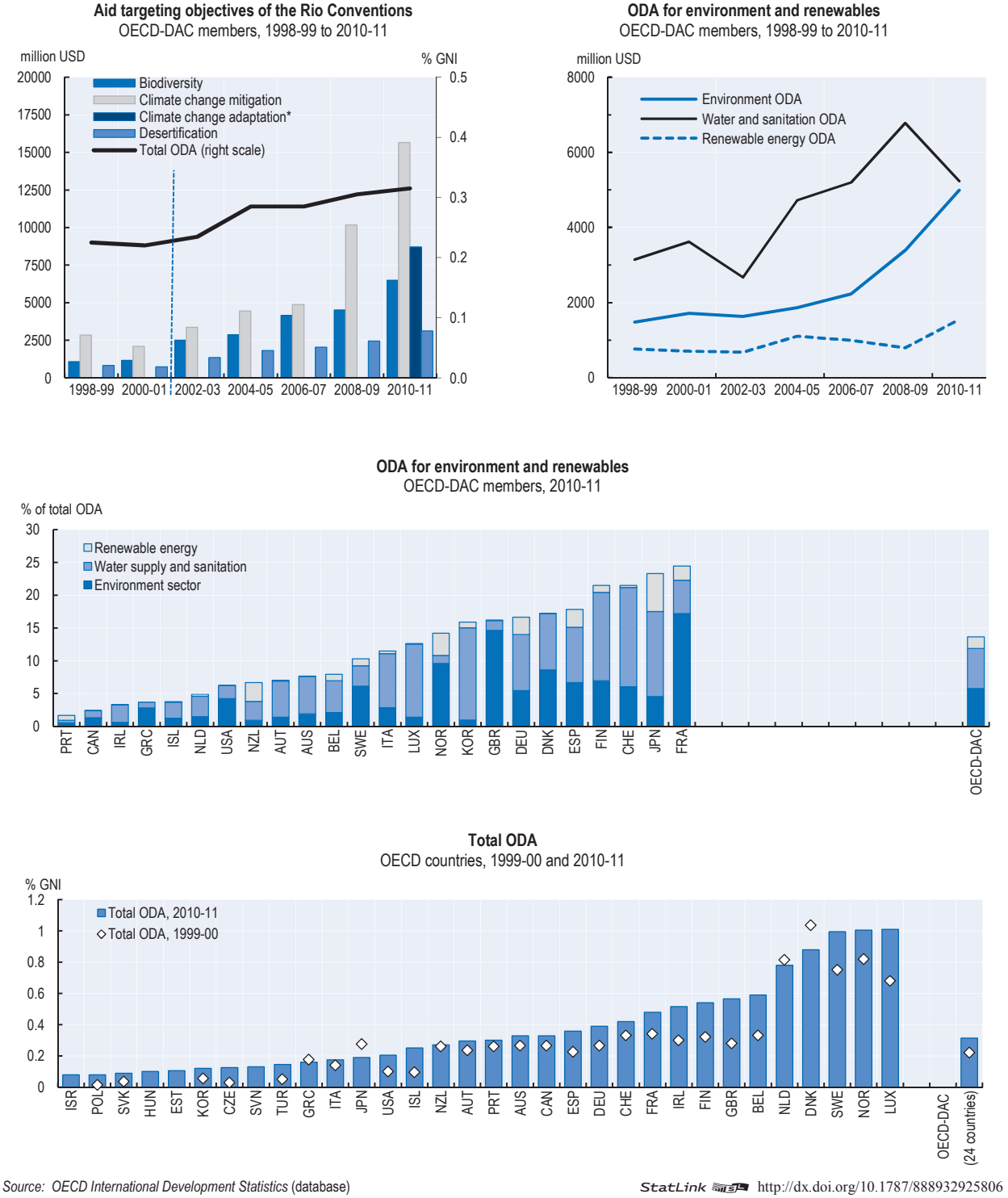
See also *Definitions and notes*, page 136.

Figure 7.6. Carbon market financing



Source: based on UNEP Risoe *CDM/JI Pipeline Analysis and Database; UNFCCC CDM Registry; World Bank.*

Figure 7.7. Official Development Assistance (ODA) of importance to green growth



Source: OECD International Development Statistics (database)

StatLink http://dx.doi.org/10.1787/888932925806

MAIN TRENDS

Carbon markets shrank due to the crisis and to reduced industrial output

Carbon market financing represents an important source of international financial flows related to green growth. Since the launch of the European Union Emission Trading Scheme (EU ETS) the global carbon market thrived and reached a historical high (USD 144 billion) in 2009. In 2010 global carbon financing shrank by 1%, and the share of the EU ETS of total carbon allowances decreased from 96% in 2009 to 84% in 2010. On the demand side, reduced industrial output has decreased demand for carbon allowances thus exerting a downward pressure on carbon prices. On the supply side, investors have responded to the crisis by diversifying portfolio positions towards safer asset markets.

CDM projects account for the lion's share of transactions

Project-based transactions also contracted. The value of CDM projects declined by 59% between 2009 and 2010 in response to the crisis. In 2010, CDM projects represented USD 19.8 billion, i.e. 14% of global carbon financing. China remained the key seller of CER credits issued by CDM projects (accounting for 41% of CDM projects), with other emerging economies scaling up their participation.

CDM projects are vital in facilitating low-carbon investment in projects of importance to green growth. While landfill gas projects have declined, projects related to renewables and industrial energy amount to nearly two-thirds of the market. Since key financial players in the carbon market operate in European exchange markets, OECD Europe countries account for a large share (63%) of total demand for CDM projects.

Environment related ODA has continued to rise.

OECD-DAC Members provide as much as 95% of global development aid. With foreign direct investment (FDI) and other private flows to low-income countries on the decline, development aid has a role to play in countering the development impact of the economic crisis and in fostering the transition to greener growth.

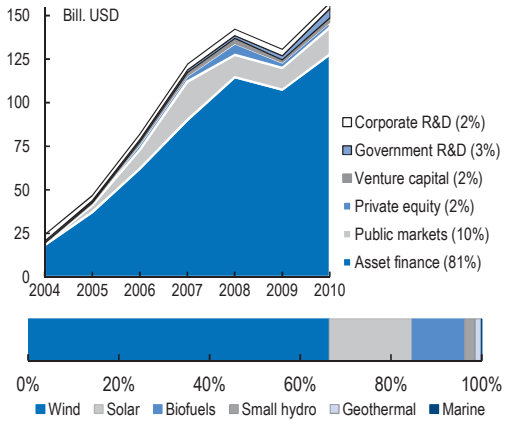
Despite the crisis, total ODA flows continued to rise to 2011, reaching USD 123 billion, but the collective efforts of OECD-DAC members fell short of the international ODA target of 0.7% of GNI.

Aid flows targeting the objectives of the Rio conventions have been increasing since the late 1990s. In 2011, DAC members allocated some USD 6 billion for biodiversity-related aid, USD 22.9 billion for climate change-related aid (mitigation and adaptation) and USD 2.5 billion for desertification-related aid.

Other aid targeted to environmental and renewable energy purposes did not gain much from the increased availability of aid resources and remained stable until the mid-2000s. In 2006, however, the trend started to reverse thanks to stronger support from bilateral donors for water- and climate-change related programmes. ODA targeted to environmental purposes amounted to USD 25 billion in 2011, a 38% increase from 2005. Similarly, aid for renewable energy sources surpassed aid for non-renewables. This was largely due to hydropower-related projects, which represented about 98% of aid for renewables in 1995, 50% in 2005 and 29% in 2011.

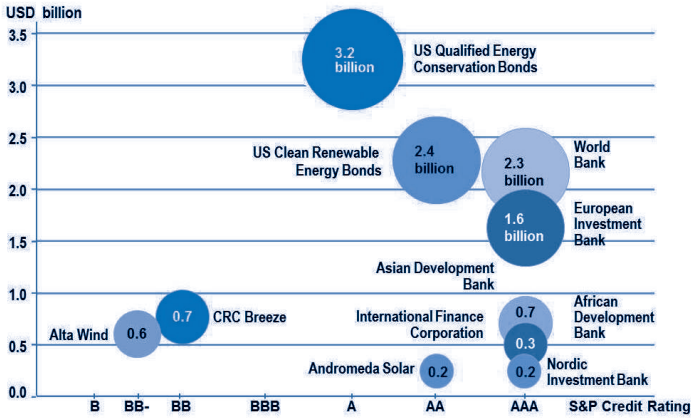
Box 7.4. Export credits and financial markets: examples

Global financial investment in renewable energy, by type and by technology



Source: BNEF-UNEP (2011).

Volume and credit-rating of green bonds



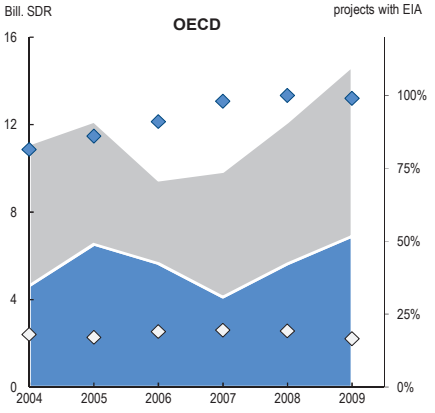
Source: Della Croce, R., C. Kaminker and F. Stewart (2011), "The role of pension funds in financing green growth initiatives".

The emergence of green financial markets

Sizeable opportunities in international financing have appeared in the field of clean energy, where new investment flows have more than quadrupled since 2007. After the 2008 crisis, the market rebounded, with investment in cleaner energy (USD 211 billion in 2010) surpassing investment in fossil fuel technology. The major share of the private sector's finance represented asset finance (over 80%), followed by public equity markets (10%). Venture capital and private equity financing of renewables has been rather cyclical, representing about 4% in 2010. Most of the investment was for projects related to wind (66%), solar (18%) and biofuels (12%).

New opportunities for financing green growth related projects have also emerged with a number of financial institutions issuing green bonds. Although the green bond market is still developing and smaller than global bond markets, it amounted to about USD 16 billion in August 2011. In pension funds of most OECD countries, bonds remain by far the dominant asset class in portfolio allocations, accounting on average for 50% of total assets under management.

Export credit projects relevant to green growth



Source: OECD International Development Statistics (database).

Incentives provided by export credit agencies have facilitated and leveraged private investment through official export credits. The volume of export-crediting projects has been cyclical but reached nearly 15 billion special drawing rights (SDRs) in 2009, partly due to a surging need to leverage large investment projects in the economic downturn. The composition of projects has changed over time, with energy and transport infrastructure projects gaining in importance.

In 2009, nearly all projects benefiting from export credits in Category A (those that could have a significant environmental impact) and Category B (with potentially less environmental impact) complied with international standards and underwent environmental impact assessment (EIA), compared to less than two-thirds in 2004.

ENVIRONMENTALLY RELATED TAXES AND TRANSFERS

POLICY CONTEXT

The issue

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.

Challenges

The main challenge is to provide clear, stable and transparent market signals. This requires policies and instruments to incentivise innovation and new technology adoption by firms and to facilitate environmentally efficient consumption patterns, while demonstrating a clear policy commitment to move towards greener growth. It also requires further progress in reforming inefficient support to environmentally harmful activities and products, such as fossil fuels, as well as a better understanding of policies supporting such activities and products and the financial transfers they generate.

MONITORING PROGRESS

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

The indicators presented here relate to:

- **Environmentally related tax revenue**, expressed as a percentage of GDP and compared to labour tax revenue, also as a percentage of GDP. The structure of the tax base is given as a complement.
- **Road fuel taxes and prices** expressed in USD per litre of diesel or unleaded petrol.
- **Government support in the agriculture and energy sectors** 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.

They should be complemented with indicators reflecting regulatory measures.

The indicators on environmentally related taxes should not be used to judge the "environment friendliness" of the tax systems. For such analysis, additional information, describing the economic and taxation structure of each country, is required. It should also be kept in mind that revenue from fees and charges, and from levies related to resource management, is not included, except for charges whose benefits are in proportion with their payment (*e.g.* wastewater charges).

The indicators on government support measures do not provide sufficient information for the environmental impact of specific measures to be judged, nor do they indicate which measures might be considered for possible reform or removal. Not all support measures for fossil fuel, for example, are unambiguously inefficient and some caution is required in interpreting the support amounts.

MEASURABILITY

Information on environmentally related taxes is available from the OECD database on instruments used for environmental policy and natural resource management. 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 from the IEA, but compilation has become a challenge. 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.

Information on fossil fuel subsidies is available from the OECD inventory of estimated budget support and tax expenditure for fossil fuels. The data are from official sources. Data on tax expenditure, which represent the majority of the support mechanisms, are not readily comparable across countries and need to be interpreted with caution.

See also *Definitions and notes*, page 137.

MAIN TRENDS

The share of environmentally related taxes in overall tax revenue… …and in GDP has been decreasing over the past decade

Compared to other environmental policy instruments, such as regulations on emissions or technology prescriptions, environmentally related taxation encourages both the lowest-cost abatement across polluters and provides incentives for abatement at each unit of pollution. Generated revenue is also used to support fiscal consolidation and improve public finances at a time of fiscal crisis.

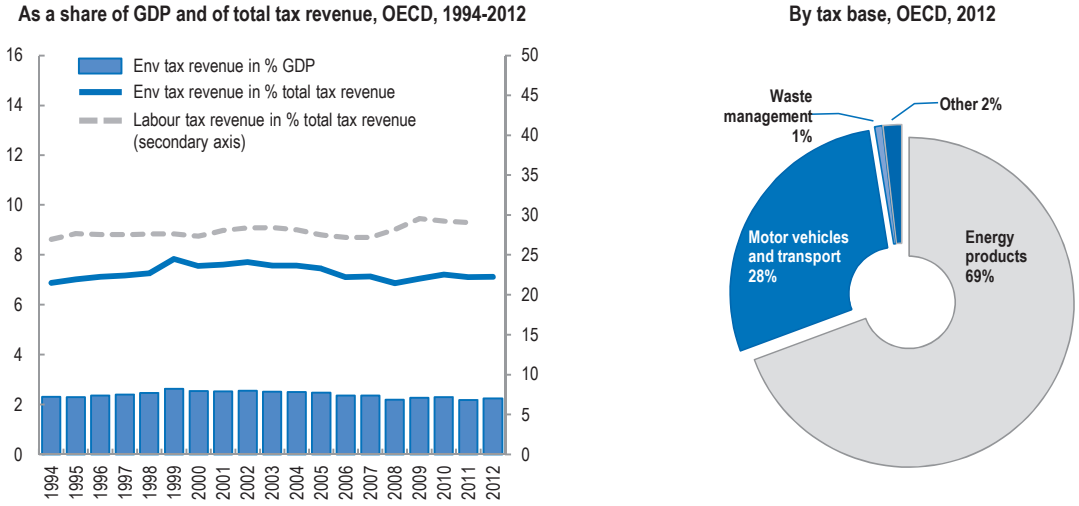
The use of environmentally related taxes is growing but remains limited in many countries. The revenue they raise represents about 2% of GDP. The share has decreased slightly over the past decade, in part due to rising international fuel prices that triggered substitution away from motor vehicle fuels, 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.

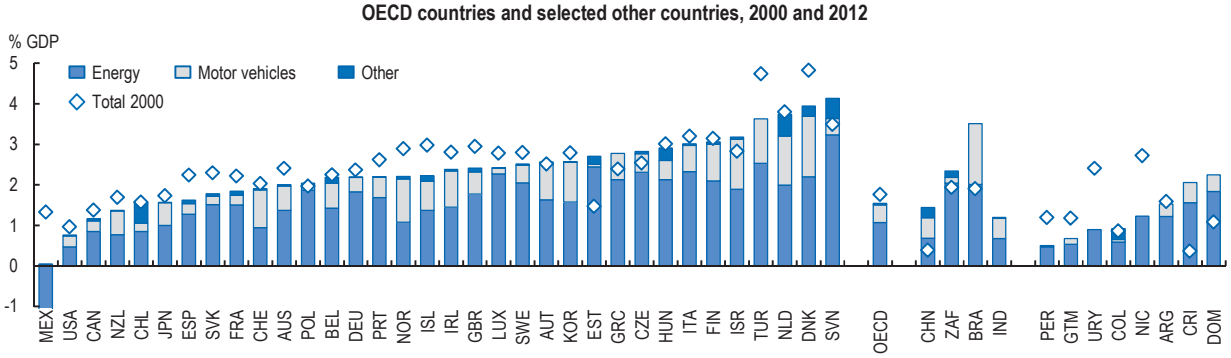
Shifting the overall tax burden away from labour and capital towards consumption and environmentally related taxation is often believed to raise additional revenue. Some OECD countries have introduced new environmentally related taxes as part of fiscal consolidation. Examples include taxes on nuclear fuel and air travel, and vehicle tax rates linked to CO_2 emissions.

The tax base is dominated by transport and energy

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 7.8. Environmentally related tax revenue

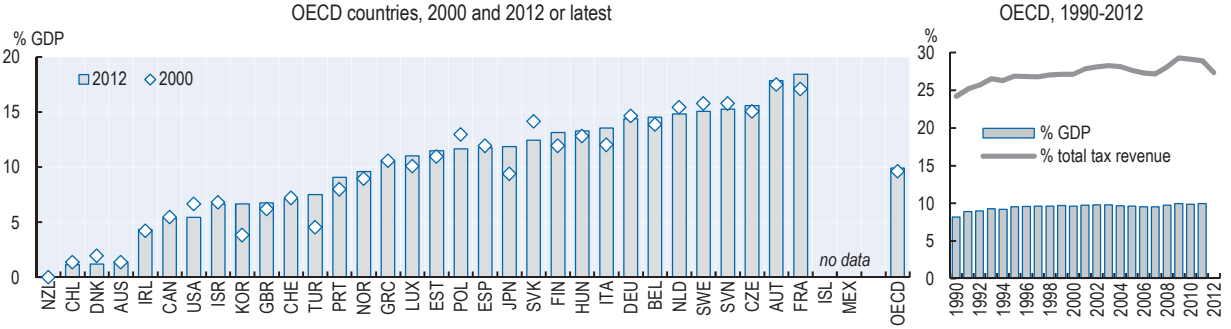




Note: Since 2000 Mexico has applied a price-smoothing mechanism. If petrol and diesel prices are higher than international reference prices, the differential effectively represents an excise duty, known as the Impuesto Especial Sobre Producción y Servicios (IEPS), otherwise the IEPS becomes an implicit subsidy.

Source: OECD Tax Statistics (database); OECD-EEA, *Database on Instruments Used for Environmental Policy*. StatLink http://dx.doi.org/10.1787/888932925825

Figure 7.9. Labour tax revenue



Source: OECD Tax Statistics (database). StatLink http://dx.doi.org/10.1787/888932925844

Figure 7.10. Road fuel prices and taxes
OECD and BRIICS countries, 2011

in current prices and exchange rates.

Source: IEA Energy Prices and Taxes Statistics (database).

StatLink http://dx.doi.org/10.1787/888932925863

Taxes on energy are important environmental and fiscal policy tools…

Real energy end-use prices have increased in most OECD countries, mainly due to a rise in crude oil prices; they rebounded in 2010-11 after a temporary drop in 2008-09 due to the economic crisis.

Given the significant environmental consequences of energy use, taxes on energy are a key environmental and fiscal policy tool that is increasingly used in OECD countries. Tax rates vary by type and use of fuel. An important part of revenue from energy taxes is derived from road fuel taxation, although this part has been decreasing since 2000 due to a decline in the tax base.

Many countries have introduced tax differentials in favour of unleaded gasoline and some have imposed environmental taxes (*e.g.* relating to sulphur content) on energy products. Many apply higher taxes to petrol than to diesel. Diesel-driven motors are more fuel efficient than petrol-driven motors and emit less CO_2 per kilometre driven, but are responsible for more air pollutants like NO_x and fine particulates, and related health impacts, than petrol-driven ones. In countries with little or no tax preference for diesel over gasoline, the share of diesel in transport fuel use is lower than in countries with the preference.

… but their use often lacks coherence.

There are significant differences across and within OECD countries in effective tax rates on energy and carbon that do not reflect relevant externalities.

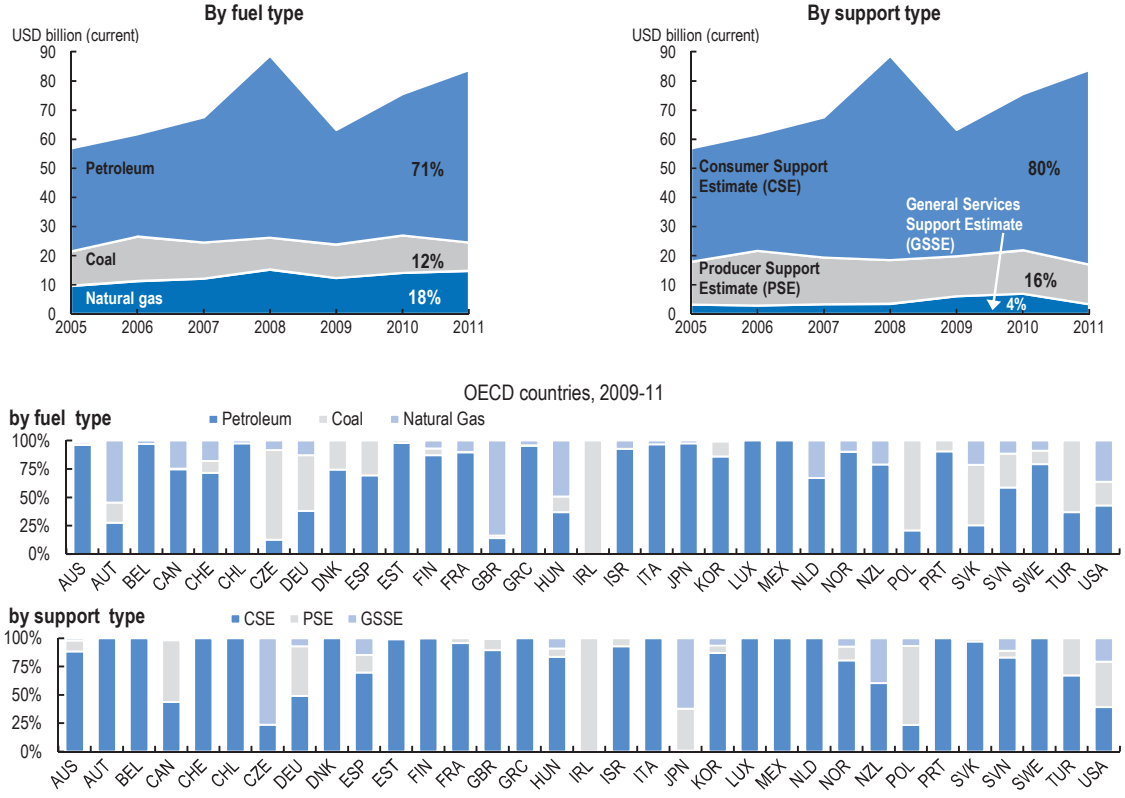
- On average, the effective tax rate in terms of carbon emissions on diesel for road use is 37% lower than the comparable rate on petrol; the rate in terms of energy content is 32% lower.
- In heating and industrial uses, the average effective tax rate in carbon terms on oil products is EUR 24 per tonne of CO_2 compared with EUR 13 per tonne for natural gas; the average rate on coal is only EUR 5 per tonne, despite its significant negative environmental impact.
- Fuel used in agriculture, fishing and forestry is often exempt from tax.

Variations in tax rates and the low levels of taxation on fuels with significant environmental impacts, suggest important opportunities for countries to reform their energy tax systems and achieve environmental goals more cost-effectively.

TRANSFERS TO FOSSIL FUELS

Figure 7.11. Total support estimates for fossil fuels

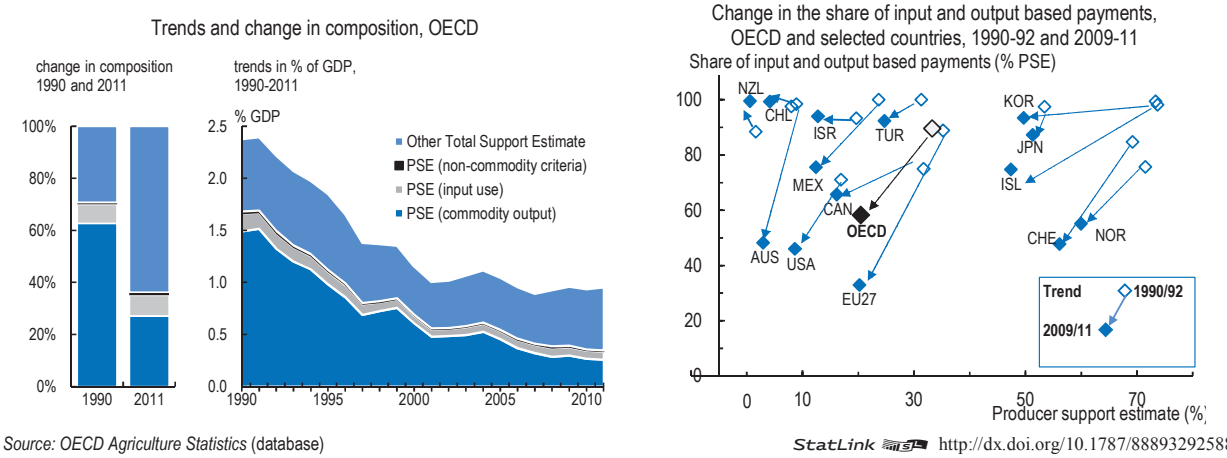
OECD, Trends and change in structure, 2005-2011



Source: OECD (2013), *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels*.

TRANSFERS TO AGRICULTURE

Figure 7.12. Total support estimates in the agriculture sector



Source: OECD Agriculture Statistics (database)

StatLink http://dx.doi.org/10.1787/888932925882

MAIN TRENDS

OECD countries support energy production and consumption in many ways.

Governments support energy production in a number of ways, including by intervening in markets so as to affect costs or prices, transferring funds to recipients directly, assuming part of their risk, selectively reducing the taxes they would otherwise have to pay and undercharging for use of government-supplied goods or assets. Support to energy consumption is also provided through several channels: price controls intended to regulate the cost of energy to consumers, direct financial transfers, rebates on purchases of energy products, and tax relief.

The aggregated value of support amounts to USD 84 billion a year

Over 550 individual producer or consumer support mechanisms for fossil fuels have been identified by the OECD in its inventory of estimated budgetary support and tax expenditure for fossil fuels. The aggregated estimated value of these mechanisms amounted to USD 84 billion in 2011 in OECD countries alone (USD 544 billion in developing and emerging economies) and has increased since 2005 (USD 55 billion). Petroleum received 71% of the support, coal 12% and natural gas 18%. The composition has changed mostly in favour of petroleum, whose share increased from 62% to 71% between 2005 and 2011, while that of coal contracted. About 68% of support was for consumers, 22% for producers and 11% for governments. The relative share of producer support has been reduced by 9% on behalf of increased consumer and government related support to fossil fuels.

Such subsidies undermine the effectiveness of green growth policies, by encouraging carbon emissions. The International Energy Agency (IEA) estimates that, unless market barriers such as support to fossil fuels can be overcome, about 2/3 of the economic potential for energy efficiency will remain untapped in 2035.

The overall level of support to farmers decreased and its composition changed

In 2009-11, annual support to agricultural producers in the OECD area was estimated at USD 250 billion. The share of the producer support estimate (PSE) in GDP decreased from 2.4% in 1990 to 0.9% in 2011, driven by a shrinking share of support going to agricultural production (from 1.5% to 0.3% of GDP). Its share in farmers' total receipts fell from about 33% in 1990-92 to 20% in 2009-11. This overall decrease, in particular of the most distortive components, results in market prices tending to play a bigger role in farmers' choices. Rising agricultural commodity prices may give farmers incentives to increase the scale and intensity of production, with higher use of inputs such as fertilisers, pesticides, energy and water. This potentially affects the opportunity cost of adopting environmentally beneficial farming practices.

The composition of PSE has changed in two respects that affect the environment:

- The share of support based on input use and commodity output, which raises most environmental concerns, has decreased from 90% to 58% since 1990-92.
- The share of non-commodity based payments that include environmental requirements has grown. Support is increasingly tied to environmental conditionality (cross compliance) that links the provision (or withdrawal) of support payments to specified environmental performance requirements.

Definitions and notes: Technology and innovation

R&D expenditure

The data refer to government budget appropriations or outlays for R&D (GBAORD) that measure the funds that governments allocate to R&D to meet various socio-economic objectives. 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 is 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.

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. In addition to R&D, the International Energy Agency collects and publishes related data on government support for energy demonstration projects, typically referred to as RD&D. 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.

Business-sector expenditure for R&D of importance to green growth.

Patent applications

The data refer to patent applications filed under the Patent Cooperation Treaty), 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 data are further refined drawing upon the expertise of patent examiners at the European Patent Office (see OECD, 2011, and Hascic et al., 2012, for details). The following technology fields were considered:

(i) energy generation and efficiency, including renewables-based energy generation, energy generation from fuels of non-fossil origin, insulation, heating and lightning
(ii) transport, including internal combustion engines, electric motors, hybrid propulsion and fuel efficiency
(iii) environmental management, including air pollution abatement, water pollution abatement, waste management, soil remediation and environmental monitoring
(iv) 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.

Innovation

Innovation activity is difficult to capture with measured indicators. The latest information from the EU Community Innovation Survey is used to give a snapshot of possible indicators of environmentally related innovation in all sectors, which is 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. The latest survey was carried out in 27 EU countries and candidate countries, plus Norway and Iceland; it was launched in 2009, the reference period was 2008 and the observation period was 2006-08. Total economy includes all core NACE activities related to innovation activity (B, C, D, E, G46, H, J58, J61, J62, J63, K and M71). Industry includes manufacturing, mining and quarrying, and energy industries, but excludes construction.

Sources

- European Commission (2010), Eurostat, Community Innovation Statistics, *http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis*.
- OECD (2013a), *Green Growth Indicators* (database), *http://www.oecd.org/greengrowth/greengrowthindicators.htm*.
- OECD (2013b), "Research and Development Statistics", *OECD Science, Technology and R&D Statistics* (database), *http://dx.doi.org/10.1787/1996305x*.
- OECD (2013c), *OECD Patent Statistics* (database), *http://dx.doi.org/10.1787/patent-data-en*.

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Definitions and notes: environmental goods and services

Environmental goods and services sector

Employment in the environmental products sector, for selected countries and selected sectors, is expressed as a percentage of total employment. The sectors covered include water supply; sewerage, waste management and remediation activities (ISIC rev.4, 36-39).

Data on the environmental goods and services sector in the European Union result from a data collection carried out by Eurostat in 2009, 2011 and 2013, and include estimates. EU totals have been compiled using a standardised data integration approach that combines existing data at country level from various Eurostat data collections and other international and national sources. The scope of EGSS is defined according to the classification of environmental protection activities (CEPA) and the classification of resource management activities (CReMA). It is to be noted that the figures presented in this report do not cover all resource management activities; the management of forest resources and of wildlife, and research and development for resource management for example are not included. 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.

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Definitions and notes: international financial flows

Environmentally related official development assistance

The OECD Development Assistance Committee has established a comprehensive system for measuring aid targeting the objectives of the Rio conventions, environment and renewable energy. The data on private flows at market terms, such as bank lending and direct investment, are subject to confidentiality restrictions at the level of individual transactions.

Total ODA refers to annual average disbursements as a share of total sector-allocable aid. Environment sector refers to general environmental protection activities, *i.e.* environmental policy and administrative management, biosphere protection, biodiversity, site preservation, flood prevention/control, environmental education/training and environmental research. In addition, an activity can target environment as a "principal objective" – if environment is an explicit objective of the activity and fundamental in its design – or "significant objective" if the environment is an important but secondary objective of the activity. Water and sanitation sector refers to water sector policy and administrative management, water resource conservation, water supply and sanitation, basic drinking water supply and basic sanitation, river basin development, waste management/disposal, education and training in water supply and sanitation. Renewable energy resources includes power generation from renewable sources: hydroelectric power plants, geothermal energy, solar energy, wind power, ocean power and biomass.

ODA targeting the objectives of the Rio conventions is identified using the so-called "Rio Markers" (principal + significant objective), which screen for policy objectives of a cross-sectoral nature, including climate change, biodiversity and desertification. Data cover OECD-DAC members and refer to commitments expressed in constant 2010 US dollars, averaged over two years.

(i) ***Biodiversity-related aid*** is defined as activities that promote conservation of biodiversity, sustainable use of its components, or fair and equitable sharing of the benefits of the use of genetic resources.

(ii) ***Desertification-related aid*** is defined as activities that tackle desertification or mitigate the effects of drought.

(iii) ***Climate change mitigation-related aid*** is defined as activities that strengthen the resilience of countries to climate change and that contribute to stabilisation of GHG concentrations by promoting reduction of emissions or enhancement of GHG sequestration.

(iv) ***Climate change adaptation-related aid*** is a new marker, approved by OECD-DAC members in December 2009. It is defined as aid in support of climate change adaptation and complements the climate change mitigation marker, thus allowing presentation of a more complete picture of aid in support of developing countries' efforts to address climate change.

Carbon market financing

This indicator relates to trading of carbon allowances in terms of value of offset transactions based on known volumes of sales of units and estimates of average offset prices, expressed in US dollars. The structure of supply and demand of certified emissions reduction credits issued by Kyoto Protocol Clean Development Mechanism projects in the pipeline is expressed in percentage of all projects by country and region. Allowance markets include the EU ETS, Assigned Amount Units, the Regional Greenhouse Gas Initiative, the New South Wales Greenhouse Gas Reduction Scheme and the Chicago Climate Exchange. Project-based primary transactions include CDM, Joint Implementation and, where data are available, Voluntary Market transactions. CDM projects in the pipeline refers to the total number of CDM-registered projects and those at validation and requested registration. Rejected projects are excluded, as are projects where validation has been terminated.

Complementary information on financing and investment (Box 7.4)

Export credit projects with environmental considerations: In 2003, OECD countries agreed on a Council Recommendation on Common Approaches on Environment and Officially Supported Export Credits, followed by the 2007 revision reinforcing the EIA requirements for projects that benefit from credit guarantees. Among other issues, it is recommended that countries encourage disclosure of relevant environmental information, encourage prevention and mitigation of environmental impacts and enhance financial risk assessment by taking environmental aspects into account. Category A projects are projects that could lead to significant adverse environmental impacts; Category B projects are projects that could lead to less adverse environmental effects than Category A. The impacts of Category B projects are typically site-specific, few if any are irreversible and mitigation measures are more readily available.

Green bonds are an innovative financial vehicle that raises funds from fixed income investors to support lending for eligible projects that seek to mitigate/adapt to climate change or otherwise comply with environmental criteria set by the issuing organisation. For example, the World Bank Green Bond Project involves projects that permit significant

reductions in GHG emissions, rehabilitation of power plants, carbon reduction through reforestation and avoided deforestation (http://treasury.worldbank.org/cmd/htm/WorldBankGreenBonds.html). Statistics were adapted from OECD (2011d).

New financial investment in clean energy is supported by Bloomberg New Energy Finance (www.bnef.com), which monitors investment in renewables from R&D funding and venture capital for technology and early-stage companies to public market financing for projects and mature companies. Venture capital and private equity relates to all money invested by venture capital and private equity funds in the equity of companies developing renewables technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure. Public markets relates to all money invested in the equity of publicly quoted companies developing renewables technology and clean power generation. Investment in companies setting up generating capacity is included in the asset financing figure. Asset financing relates to all money invested in renewable energy generation projects, whether from internal company balance sheets, debt finance or equity finance, but excluding refinancing. The types of renewable projects included are all biomass, geothermal and wind generation projects of more than 1MW, all hydro projects of between 0.5 and 50MW, all solar projects of more than 0.3MW, all marine energy projects and all biofuel projects with annual capacity of at least 1m litres. Data are from Bloomberg New Energy Finance.

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Definitions and notes: environmentally related taxes and transfers

Environmentally related taxes

Environmentally related tax revenue is expressed in percentage of GDP and percentage of total tax revenue, and is 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.

Road fuel taxes and prices for diesel and unleaded petrol are reported at USD at current prices and exchange rates. BRIICS data are for 2010. Unleaded petrol: data refer to unleaded premium, except for Japan (unleaded regular).

Producer support in agriculture

The indicator of theoretically more environmentally harmful agricultural 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. 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.

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

Budgetary support and tax expenditure for fossil fuel use

The OECD inventory takes stock of the broad set of measures identified by governments that effectively support fossil-fuel use or production, as defined using the PSE-CSE framework, which has already been used extensively to measure other support, most notably in agriculture. The scope of "support" is deliberately broad – broader than some conceptions of subsidy. It covers a wide range of measures that provide a benefit or preference for a particular activity or product, either in absolute terms or relative to other activities or products. The PSE-CSE framework distinguishes among measures that benefit producers (PSE) or consumers (CSE), and those that benefit producers or consumers collectively, or that do not support current production, such as industry-specific R&D (the general services support estimate or GSSE). The data in the inventory were sourced from official government documents and websites, complemented by information provided directly by government agencies. The valuations are generally those estimated by governments, though the OECD has allocated support among various fuels based on production and consumption volumes where such information is not available from government sources.

The charts presented are based on an arithmetic sum of the individual support measures identified for 34 OECD countries. They include the value of tax relief measured under each jurisdiction's benchmark tax treatment. The estimates do not take into account interactions that might occur if multiple measures were to be removed at the same time.

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

The list of indicators presented below has been kept flexible so that countries can adapt it to different national contexts. A balance has also been kept between the desire to be exhaustive and the need for simplicity. The set is thought to be neither exhaustive nor final, and is to be seen in the context of other OECD indicators to acquire its full meaning. The list has been subjected to review by member countries. The indicators specified constitute a starting point and the list may be modified as the discussion evolves and as new data becomes available.

It has also to be noted that not all issues of importance to green growth can be measured in quantitative terms, and that not all indicators proposed here are equally relevant to all countries.

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
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

Group/theme	Proposed indicators	Type	Measurability
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) • Population exposure to air pollution	M P	L 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
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 (tbd)	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*	..	..

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

Measurability S = short term, M = medium term, L = long term

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OECD Green Growth Studies

Green Growth Indicators 2014

The OECD Green Growth Strategy supports countries in fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which well-being relies. Policies that promote green growth need to be founded on a good understanding of the determinants of green growth and need to be supported with appropriate indicators to monitor progress and gauge results.

This book updates the 2011 Towards Green Growth: Monitoring progress. It presents the OECD framework for monitoring progress towards green growth and a selection of updated indicators that illustrate the progress that OECD countries have made since the 1990s.

Contents

Part I. Monitoring progress towards green growth

Chapter 1. The OECD green growth measurement framework and indicators

Chapter 2. Green growth indicators in practice

Part II. The indicators

Chapter 3. The socio-economic context and characteristics of growth

Chapter 4. The environmental and resource productivity of the economy

Chapter 5. The natural asset base

Chapter 6. Environmental quality of life

Chapter 7. Economic opportunities and policy responses

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