Towards Green Growth: Monitoring Progress

OECD INDICATORS

Towards Green Growth: Monitoring Progress

OECD INDICATORS

OECD

This work is published on the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries.

Please cite this publication as:
OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD Publishing.
http://dx.doi.org/10.1787/9789264111356-en

ISBN 978-92-64-11134-9 (print)
ISBN 978-92-64-11135-6 (PDF)

This report was prepared for the OECD Meeting of the Council at Ministerial Level, 25-26 May 2011, Paris

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.

Cover design by advitam for the OECD.

Corrigenda to OECD publications may be found on line at: *www.oecd.org/publishing/corrigenda*.

Revised version, January 2012
Details of revisions available at: http://www.oecd.org/dataoecd/37/54/49304206.pdf

Introduction by the Secretary-General

The OECD Green Growth Strategy: A lens for examining growth

The world economy is slowly, and unevenly, coming out of the worst crisis most of us have ever known. While dealing with immediate problems such as high unemployment, inflationary pressures or fiscal deficits, we have to look to the future and devise new ways of ensuring that the growth and progress we have come to take for granted are assured in the years to come.

A return to "business as usual" would indeed be unwise and ultimately unsustainable, involving risks that could impose human costs and constraints on economic growth and development. It could result in increased water scarcity, resource bottlenecks, air and water pollution, climate change and biodiversity loss which would be irreversible.

Strategies to achieve greener growth are needed. If we want to make sure that the progress in living standards we have seen these past fifty years does not grind to a halt, we have to find new ways of producing and consuming things. And even redefine what we mean by progress and how we measure it. And we have to make sure to take our citizens with us on this journey, in particular to prepare the people with the right skills to reap the employment benefits from the structural change.

But we cannot just start from scratch. Changing current patterns of growth, consumer habits, technology, and infrastructure is a long-term project, and we will have to live with the consequences of past decisions for a long time. This "path dependency" is likely to intensify systemic environmental risks even if we were to get policy settings right relatively swiftly.

The modern economy was created thanks to innovation and thrives on it, and in turn the economy encourages new ways of doing things and the invention of new products. That will continue to be the case. Non-technological changes and innovation such as new business models, work patterns, city planning or transportation arrangements will also be instrumental in driving green growth.

No government has all the technological, scientific, financial and other resources needed to implement green growth alone. The challenges are global, and recently we have seen encouraging international efforts to tackle environmental issues collectively, including the path-breaking Cancun agreements to address climate change.

At the OECD Ministerial Council Meeting in June 2009, Ministers acknowledged that green and growth can go hand-in-hand, and asked the OECD to develop a Green Growth Strategy. Since then, we have been working with a wide range of partners from across government and civil society to provide a framework for how countries can achieve economic growth and development while at the same time combating climate change and preventing costly environmental degradation and the inefficient use of natural resources.

This publication summarises the work done so far. As a lens through which to examine growth, the analysis presented here is an important first step to designing green growth strategies while at the same time providing an actionable policy framework for policy makers in advanced, emerging and developing economies.

The OECD will continue to support global efforts to promote green growth, especially in view of the Rio+20 Conference. The next step will see green growth reflected in OECD country reviews and the output of future OECD work on green growth indicators, toolkits and sectoral studies, to support countries' implementation efforts towards green growth.

We have set ourselves ambitious targets, but I am confident that by working together we will reach them.

Angel Gurría
OECD Secretary-General

Preface

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 also need to be supported with appropriate information to monitor progress and gauge results.

Monitoring progress towards green growth requires indicators based on internationally comparable data. These need to be embedded in a conceptual framework and selected according to well specified criteria. Ultimately, they need to be capable of sending clear messages which speak to policy makers and the public at large.

This report responds to these needs and accompanies the OECD Green Growth Strategy. It presents a conceptual framework, a proposal for developing green growth indicators and results for selected indicators derived from OECD databases.

The indicators presented in this report are a starting point: they will be further elaborated as new data become available and concepts evolve. They are accompanied with a measurement agenda that will help addressing the most pressing data development needs.

The elaboration of this report, which is published on the responsibility of the Secretary-General of the OECD, has been drawing on the OECD's expertise with statistics, indicators and measures of progress**. It has benefitted from the expert advice of many stakeholders, including other OECD Directorates, ministries and statistical offices in countries and other international organisations.

** This report was developed by a Task Force led by the OECD Statistics Directorate and involving experts from several OECD Directorates, including the Economics Department, the Environment Directorate, the Directorate for Science, Technology and Industry, and the International Energy Agency. It draws on work undertaken across the OECD, including by the Development Co-operation Directorate, the Directorate for Financial and Enterprise Affairs, and the Trade and Agriculture Directorate. Paul Schreyer, Myriam Linster and Ziga Zarnic were responsible for drafting the report with the statistical support of Sylvie Foucher-Hantala, Mauro Migotto and Sarah Sentier.

Towards green growth - Monitoring progress OECD Indicators

Executive Summary

Developing and implementing framework conditions that promote green growth requires a good understanding of the determinants of green growth and of related trade-offs or synergies. It also requires appropriate information to support policy analysis and to monitor progress.

For convenience, the ***definition*** used in this report is repeated here:

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.

Green growth has thus several dimensions, 'greening growth' and harnessing new growth possibilities from environmental considerations. By its very nature, such a process is not easily captured by a single indicator, and a ***small set*** of measures will be needed. The ambition is ***pragmatic***: green growth indicators are seen as markers or milestones on a path of greening growth and of seizing new economic opportunities.

The set of green growth indicators listed below is a starting point rather than a final list and will be further elaborated as new data become available and as concepts evolve. Indeed, a central conclusion from the work on indicators is the measurement agenda that is drawn up at the end of the section. It provides the way forward towards addressing the most pressing data ***development needs*** in the area.

Measurement framework

A natural starting point for defining green growth indicators is the ***sphere of production*** where economic inputs are transformed into economic outputs (goods and services). A direct source of economic growth is therefore the growth of ***inputs***, in particular labour, produced capital such as machines, and intermediate inputs that are used up in production such as steel in the automobile industry. But production also uses ***services from natural assets***, either in the form of natural resource inputs into production (these may be non-renewable such as minerals extracted from the ground or renewable such as fish stocks) or in the form of disposal services where the natural environment provides services as a sink for pollutants and residuals emitted during production. Services from natural assets are rarely quantified in economic models and accounting frameworks and yet they are central to examining the greening of growth.

A ***first group*** of indicators is therefore ***environmental and resource productivity***, representing the volume of output per unit of services from natural assets. Rising environmental and resource productivity would appear to be a necessary condition for green growth.

Changes in environmental and resource productivity can reflect several effects, including substitution processes between natural assets and other inputs, shifts in industry composition or overall, 'multi-factor' productivity change. In a first instance, it will not be able to empirically distinguish between these effects but such work figures prominently on the measurement agenda. Some care must therefore be taken when interpreting partial productivity measures although the caveats relating to environmental productivity are not different from those relating for instance to labour productivity. But environmental and resource productivity indicators would appear useful nonetheless. The choice of specific indicators in this area was governed by the idea of capturing ***key aspects of a low-carbon, resource-efficient economy***. As these indicators deal with the production side of the economy, growth has been captured by GDP.

It is also of interest to introduce the notion of ***demand-based environmental services***, i.e., those flows of environmental services or emissions that are induced by domestic final demand but not necessarily by domestic production. In the case of emissions, this 'footprint' approach tracks the emissions embodied in imports, adds them to direct emissions from domestic production and subtracts the emission contents of exports. The resulting figure informs about the direct and indirect contents of environmental services in domestic final demand – essentially consumption of households, governments and investment.

The production perspective outlined above is not sufficient to monitor the transition towards green growth. For sustained growth, the asset base has to be kept intact. One reason is that ***a declining asset base constitutes a risk to growth*** and such risks should be avoided. 'Asset base' should be understood in a comprehensive way, encompassing produced as well as non-produced assets, and including in particular environmental assets and natural resources. Broader concepts such as sustainable development would also include human capital or social capital. For purposes of the green growth strategy, however, the focus will remain on ***economic and natural assets***. Loosely speaking, 'keeping the asset base intact' implies that net investment is positive – more needs to be added to the asset base in the form of investment or natural regeneration than is subtracted though depreciation or depletion. Whether a particular growth path of consumption or income can be sustained depends also on expected rates of multi-factor productivity change, thus adding to the central role that innovation and technical change play in considerations about green growth.

A major question is how easily one type of asset can be substituted for another asset, i.e., if the decline in one type of asset can be made up for by an increase in another type of asset. In a world of perfect measurement and perfect markets, this information should be contained in asset prices, reflecting society's preferences and vision of the future. Absent such prices for most assets, measurement has to start with ***monitoring the physical evolution of natural assets*** and this constitutes the ***second group*** of indicators. Over time, measurement efforts should be undertaken to advance on the valuation of (net investment) in at least some important natural assets. This has been reflected in the measurement agenda.

Considerations about keeping society's asset base intact relate directly to one dimension of the quality of life that is relevant for the work at hand, namely the direct impact of the environment on people. Environmental outcomes are important determinants of health status and wellbeing more generally. They provide an example where production and income growth may not be accompanied by a rise in overall well-being. For instance, air pollution, in particular exposure to particulate matter, is much higher in some of the emerging economies than across the OECD countries. In addition, a larger share of the population lives under medium to severe water stress, while low levels of wastewater treatment and pollution contribute to the incidence of waterborne and preventable diseases. The ***third group*** of indicators thus deals with the ***environmental quality of life***.

A ***fourth*** aspect is the ***opportunities arising from environmental considerations.*** One way of framing relevant indicators is by examining the role of 'green industries', trade in 'green products' and creation of 'green jobs'. While widely discussed, closer inspection of these concepts shows that they are often difficult to pin down statistically. There is a more basic question whether the potential for green growth is adequately captured by measuring the output and jobs of those companies that produce environmentally related goods, services and technologies. For instance, an economy could move towards a low carbon growth path if traditional industries (say mining or steel production) increase their energy efficiency through new modes of organisation – process innovation – or if there is product innovation that leads to products that are less energy intensive in their use, triggered by cost or competitiveness considerations rather than environmental concerns. Thus, the production of environmental goods, services and technologies is only *one* aspect of the potential for green growth.

Another central aspect in the context of economic opportunities is ***innovation and technology***. These are drivers of multi factor productivity change through new products, entrepreneurship and business models, and new consumption patterns. General innovation has to be distinguished from green innovation. The latter mainly relates to environmentally-related research and development and technologies. Thus, akin to 'green industries', looking at 'green innovation' will only tell part of the story that innovation at large plays in the transition to green growth. A trade-off arises from the perspective of constructing green growth indicators. Focusing on green innovation indicators does not do justice to the full importance of innovation, but general indicators of innovation are not very helpful in monitoring society's responses to the green growth challenge. The work at hand covers both aspects.

Clear and stable ***market signals*** are key to affecting the behaviour of producers and consumers. 'Getting the prices right' has to be one of the major policy concerns when producers and consumers cause negative externalities to the environment through their economic activity. Several of the policy response indicators relate to ***environmental taxes and transfers***.

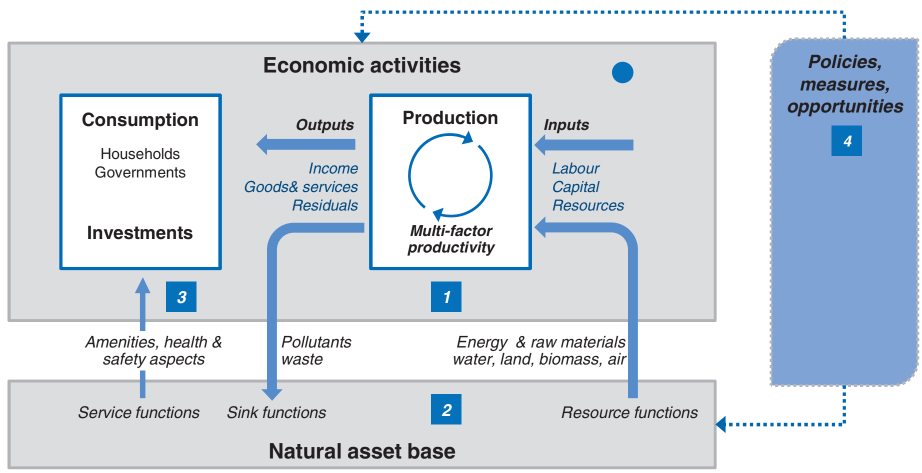
Regulatory instruments should not be forgotten as a tool to reduce negative effects on the environment. Constructing indicators of regulation is tricky, however, as the information is often of a qualitative nature and hard to compare across countries. No results are shown here but the point has been marked in the measurement agenda.

Proposed indicators

The measurement framework thus explores four inter-related groups of indicators:

1. indicators monitoring the environmental and resource productivity of production and consumption;
2. indicators describing the natural asset base;
3. indicators monitoring the environmental dimension of quality of life, and
4. indicators describing policy responses and economic opportunities.

They are complemented with generic indicators describing the socio-economic context and characteristics of growth.



A preliminary selection of indicators was made on the basis of existing work in the OECD, other international organisations, and in member and partner countries. The indicators were selected according to their policy relevance, analytical soundness, and measurability, and structured in line with the measurement framework. The proposed set is thought to be neither exhaustive nor final. It has been kept flexible enough so that countries can adapt it to different national contexts.

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

Measurement agenda

Measurement issues constrain the full and timely production of green growth indicators. While there is a substantive amount of economic and also environmental data, it is often difficult to combine them due to differences in classifications, terminology or timeliness. A first and crucial ingredient of the measurement agenda is thus to develop and populate a ***consistent environment-economy accounting framework***. The System of Environmental and Economic Accounting (SEEA) will provide such a framework. Measurement efforts should be placed within this framework so as to maximise consistency and international comparability.

Apart from the general usefulness of integrated statistics, the preliminary set of green growth indicators reveals important gaps in the information base. These areas should form part of a green growth measurement agenda, to be implemented over the coming years. In particular:

- There are significant gaps in environmental-economic data at the ***industry level***.
- There is a need to develop and improve the physical data for key stocks and flows of natural assets. Prominent examples are information on land and ***land use*** changes and ***non-energy mineral resources*** that often constitute critical inputs into production.
- Better physical data also helps improving ***material flow analyses***.
- Improved information on ***biodiversity***.
- Efforts should also be directed at developing ***monetary values*** reflecting prices and quantities for (changes in) key stocks and flows of natural assets. Such valuations, even if incomplete and imperfect are required for ***extended growth accounting*** models, more comprehensive balance sheets and for adjusted measures of real income.
- Periodic information to inform on how environmental concerns trigger ***innovation*** in companies should be developed.
- Thought should be given how indicators on economic instruments can be complemented by indicators on ***environmental regulation***.
- Improved measures are needed on both the objective and the subjective dimensions of ***quality of life***, in particular measures of environmentally induced health problems and related costs; and public perceptions.

The proposed set of indicators comprises about twenty-five indicators, not all of them are measurable today. The multi-dimensional nature of green growth requires a sufficient number of indicators to do justice to the various aspects of the issue at hand. But a large dashboard also carries the danger of losing a clear message that speaks to policy makers and helps communicating with the media and with citizens. It is proposed that ***a small set of 'headline' indicators*** be selected that are able to track central elements of the green growth concept and that are representative of a broader set of green growth issues. This is a task that still lies ahead and requires broad consultation and discussion because, inevitably, opinions on the most salient set of indicators will vary among stakeholders. The OECD stands ready to take this task forward.

Part one: Monitoring progress towards green growth

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 to monitor progress and gauge results.

Monitoring progress towards green growth requires indicators based on internationally comparable data. These need to be embedded in a conceptual framework and selected according to well specified criteria. Ultimately, they need to be capable of sending clear messages which speak to policy makers and the public at large.

Four areas have been chosen to 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**, to reflect the fact that a declining asset base presents risks to growth and because sustained growth requires the asset base to be maintained.
- **Environmental quality of life**, capturing the direct impacts of the environment on people's lives, through e.g. access to water or the damaging effects of air pollution.
- **Economic opportunities and policy responses**, which can be used to help discern the effectiveness of policy in delivering green growth and where the effects are most marked.

An important measurement agenda remains, including the selection of a small set of headline indicators. The set proposed here comprises about 25 indicators, not all of them measurable today.

1. The OECD approach

Developing and implementing framework conditions that promote green growth requires a good understanding of the determinants of green growth and of related trade-offs or synergies. It also requires appropriate information to support policy analysis and to monitor progress. Progress can be measured through indicators that monitor trends and structural changes, and that attract attention to issues that require further analysis and possible policy action. Indicators also help raise the profile of green growth issues in the public debate and gauge how well policies are performing with respect to green growth.

By its very nature, progress towards green growth is not easily captured by a single indicator. Indeed, *green growth indicators*[1] are best seen as markers that identify necessary conditions for green growth, for instance in the form of rising environmental and natural resource productivity. The principles applied in drawing up a first set of green growth indicators were:

- A ***balanced coverage*** of the two dimensions of green growth – "green" and "growth"- and of their main elements. Particular attention is given to indicators that are of significance for the two dimensions.
- The identification of ***key issues*** for which indicators are needed, i.e. those that are of common relevance to green growth in OECD countries and in partner countries. This draws upon the OECD's accumulated experience in policy analysis and evaluation, as reflected in the Green Growth Strategy.
- The use of a ***conceptual framework*** that reflects the integrated nature of GG while organising the indicators in a way useful to decision-makers and the public. This needs to be supported with a ***statistical accounting framework*** to help structure and combine underlying statistics and ensure coherence among data sets.
- The careful ***selection*** of indicators that best reflect major trends related to these issues. As indicators can serve different purposes and uses, the number of potentially useful indicators is fairly large. It is therefore necessary to apply commonly agreed upon ***criteria*** that guide and validate their choice (Box 1).

Box 1 Key principles in selecting indicators to monitor progress with green growth*

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

** These principles and criteria describe the "ideal" indicator; not all of them will be met in practice.*

1 The term "green growth indicators" used hereafter refers to indicators that monitor progress towards a green growth.

2. The measurement framework

A practical and pragmatic way of integrating economic and environmental policies requires a matching framework, definitions and comparable data to measure progress towards green growth.

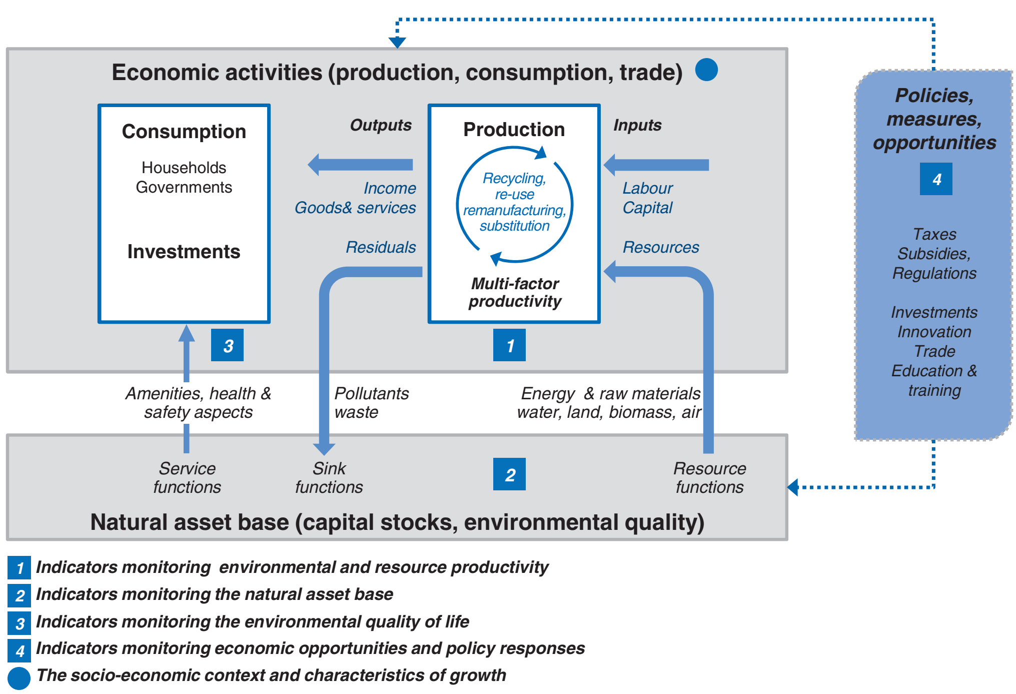
The main purpose of the ***conceptual framework*** is to organise thinking about indicators and to identify relevant, succinct and measurable statistics. The framework is not an alternative to international guidelines on which the underlying data series should be based, in particular the System of Integrated Environmental and Economic Accounting (SEEA). Rather the conceptual framework has to build on definitions and accounting conventions such as those provided by the SEEA. The SEEA is currently being revised. When finalised and implemented, many indicators described in the present document such as environmental productivity are best derived from the SEEA accounting framework.

Measurement has to start with a definition of the object of measurement, green growth in the case at hand. The ***working definition*** used here is that:

> 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.

Thus, a central idea is that 'green' can promote growth. This can be achieved by getting the framework conditions right, by setting the price signals and regulatory actions that provide incentives towards substituting away from scarce environmental resources and by fostering innovation, productivity and human capital, as demonstrated in the Green Growth Strategy Synthesis Report.

Figure 1. Framework for Green Growth Indicators



The following sections will explore four inter-related groups of indicators: (i) indicators monitoring environmental and resource productivity; (ii) indicators describing the natural asset base; (iii) indicators monitoring the environmental quality of life, and (iv) indicators describing policy responses and economic opportunities (Figure 1).

What is true for most indicators also holds for green growth indicators: they are always limited in some respect and, in particular in international comparisons, they need to be interpreted in a country-specific context. Such context will be provided in the discussion accompanying the presentation of green growth indicators (Box 1).

The set of green growth indicators discussed below is of a preliminary nature and will be further elaborated as new data become available and as concepts evolve. Indeed, a central conclusion from the work on indicators is the measurement agenda that is drawn up at the end of the section. It should provide the way forward towards the most pressing data development needs in the near future.

Indicators of environmental and resource productivity

Concepts

A natural starting point for defining green growth indicators is the sphere of production where economic inputs are transformed into economic outputs (goods and services). A direct source of economic growth is therefore the growth of inputs, in particular labour, produced capital such as machines, and intermediate inputs that are used up in production such as steel in the automobile industry. But production also uses services from natural assets, either in the form of natural resource inputs into production (these may be non-renewable such as minerals extracted from the ground or renewable such as fish stocks) or in the form of regulating services where the natural environment provides services as a sink for pollutants and residuals emitted during production[2]. Services from natural assets are rarely quantified in economic models and accounting frameworks. Green growth indicators should therefore strive and identify the most important environmental services, and if possible quantify their role in economic growth.

A useful way of examining the role of inputs in economic growth is by way of partial productivity measures. For instance, one of the most widely used partial productivity measure is labour productivity, the volume of output per hour worked. Rising labour productivity is generally considered an important ingredient for economic growth and rising income per capita. Broadly speaking, labour productivity may be rising for two reasons. First, more of other inputs are used per unit of labour. In other words, there has been a process of substitution. For instance, production may have become more capital intensive – in this case, labour productivity may have risen because more machines are used per worker. Second, overall efficiency of the production process is rising through improved organisation, or technical change. It can also be said that overall or multi-factor productivity has increased.

The same reasoning as for labour productivity can be applied to natural assets that are used in production. Here, the partial productivity measure is environmental and resource productivity or the volume of output per unit of services from natural assets. Rising environmental and resource productivity would appear to be a necessary condition for green growth. Akin to labour productivity, a change in environmental productivity can be due to a substitution effect or due to a change in multi-factor productivity. Substitution effects could relate to the substitution of natural assets for labour or for produced capital. For instance, better insulation of buildings implies that the environmental service 'absorption of CO_2' is substituted by more services from produced capital associated with a refurbished and better-insulated roof. Such a substitution process is likely to be desirable from a green growth perspective because it combines economic activity with environmental efficiency. A similar point could be made for substitution between labour and environmental services. But in some cases the green growth qualities of substitution may be less obvious. For instance, if environmental services in one

2 Alternatively, emissions could be treated as undesirable or negative output rather than as environmental inputs. This is a matter of convenience and labelling but has no implication for measurement.

industry or country are replaced by more intermediate inputs from other industries or from abroad, this shows up as a rise in environmental productivity. In fact, environmental effects may simply have been displaced to other industries or abroad.

Several forces drive multi-factor productivity change. One is technology diffusion, i.e., the increasing adoption of the most efficient production technologies. For instance, broad-based adoption of energy-efficient housing can be a way of moving closer to an economy's efficiency frontier. Another driving force is sectoral reallocation. If an economy's resources move towards more productive activities, this will increase economy-wide efficiency. The third driver of overall productivity change is innovation: here, production possibilities are increased, by means of new processes or by my means of new products.

Caveats

A first conclusion from the above discussion is that a set of green growth indicators should include the productivity of those natural assets that matter in production. The set of assets may differ between countries or regions although some will be relevant everywhere, when the environmental asset is of a global nature. A case in point is climate change: in the face of a global asset (the atmosphere's capacity to absorb greenhouse gases), the environmental efficiency of greenhouse gas emissions has relevance independently of a particular location. Other natural assets, for example water will be of critical importance in some countries (where there is scarcity) and less so in others (where there is abundance). Several caveats have to be kept in mind when constructing indicators of environmental and resource productivity:

- Changes in environmental and resource productivity are not necessarily indications of changes in technology or efficiency narrowly defined as they can be driven by effects of substitution between inputs or they can be a consequence of overall productivity change. Quantifying substitution and productivity effects is not a matter of course and requires an extended productivity measurement framework along with the relevant data on environmental services. It is unrealistic to expect a full quantification of the various effects for all types of environmental services today. But it will be possible to make some progress with an extended accounting framework for selected environmental services (see below).
- International comparisons of environmental and resource productivity across countries have to be interpreted carefully. Differences in industry and geographical structures account for some of the cross-country differences in environmental productivity. This does not invalidate productivity measures but alerts to the need for careful interpretation and for complementing with other indicators. One way of controlling for differences in economic structures is to carry out cross-country comparisons using a common industry structure. This is a useful approach when the rates of change of environmental and resource productivity are compared. However, to date, absent a set of integrated environmental-economic accounts in most countries, it is difficult to measure rates of change of environmental productivity for individual industries. Comparisons of *levels* of environmental productivity by industry pose further conceptual and empirical issues as discussed in the box below.
- A rise in environmental and resource productivity indicates that on average environmental inputs are used more efficiently but gives no indication whether environmental pressures are decreasing in absolute terms. Nor does it indicate if environmental pressures are below a desired or critical level. For such assessments, it is useful to separately identify the environmental and the growth components of productivity indicators or to accompany them by indicators of absolute environmental pressures[3].

[3] The 2008 *OECD Guide on Material Flows and Resource Productivity* describes decoupling as "…breaking the link between 'environmental bads' and 'economic goods'. Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force over a given period. Decoupling can be either absolute or relative. Absolute decoupling is said to occur when the environmentally relevant (pressure) variable is stable or decreasing while the variable reflecting the economic driving force is growing. Decoupling is said to be relative when the growth rate of the environmentally relevant

Production versus demand-based measures

It was mentioned earlier that one reason for changes in a country's environmental or resource productivity can be a change in the international structure of production. For instance, more intermediate products are purchased from abroad. If the production of these intermediate products has a low environmental efficiency, its displacement abroad will raise domestic environmental productivity but not necessarily global environmental efficiency. Apparently 'positive' national results may then merely be a reflection of the substitution of domestic impacts for impacts overseas (i.e. through imports).

It is thus of interest to introduce a notion that has not been present in production-related indicators, namely *demand-based environmental services*, i.e., those flows of environmental services or emissions that are induced by domestic final demand. This 'footprint' approach tracks the environmental services embodied in imports that have been delivered by natural assets in production processes abroad. These are added to direct emissions from domestic production. Conversely, the environmental contents of exports of domestic products are deducted. The resulting figure informs about the direct and indirect contents of environmental services in domestic final demand – essentially consumption of households, governments and investment.

Earlier work by the OECD sought to inform this debate by producing estimates of direct and indirect CO_2 emissions that were emitted to satisfy domestic final demand (Ahmad and Wyckoff 2003). The authors pointed out that "...changes in emissions at the national level can occur for many reasons: including the relocation of production abroad, and/or by import substitution. This may have a negligible impact on global emissions but, if the imports use more GHG intensive production processes than the domestically produced goods that they displace, global emissions could well be higher." This work has now been brought up to date and should be the subject of a regular update (Ahmad and Yamano, forthcoming). Use was made of the OECD Input-output database that covers 47 countries including large non-OECD economies such as Brazil, China, India and Indonesia. At the core of the matter lies a model that permits estimating the carbon contents of each countries imports and exports, including 2nd order effects when goods are exported and re-imported, for instance.

One of the key findings, confirming and updating earlier estimates is that total emissions generated to satisfy domestic demand in OECD countries rose quicker than emissions related to production only. The converse holds in particular for large emerging economies. This reflects a host of factors, including trends in the international specialisation in production and relative comparative advantages of different countries. It should be emphasised here that the estimates obtained are not "leakage" estimates obtained from a model (replete with assumptions about how actors may react to a price change); these are estimates based on observed trends in production, consumption and trade patterns.

Measuring demand-based emissions or environmental services is analytically appealing but not a universally relevant answer to questions of green growth. For once, the appeal of the method rises with the degree to which environmental issues are of a global nature. Greenhouse gas emissions are the most prominent case in point: no matter where they are emitted, they equally contribute to the deterioration of the environmental asset 'climate system'. This provides a justification for adding up direct and indirect emissions when judging the environmental friendliness of a good or service. Things are less clear when it comes to environmental services that are associated with local rather than global environmental assets. Take the case of measuring the direct and indirect contents of water in a consumption good. Water use in a water-rich environment has very different effects on nature than water use in a water-poor environment. Adding up the direct and indirect use of water means putting equal weights on wherever water-use occurs which may provide a biased message about the environmental impact of consumption[4]. Thus, 'footprint' type calculations are best used for issues associated with global environmental assets. Indeed, the computations to follow focus on the global

variable is positive but less than the growth rate of the variable reflecting the economic driving force." Measurement of relative decoupling is therefore equivalent to a rise in environmental and resource productivity. See Glossary at the end of this report.

4 With renewable resources such as water, there is also an issue how to deal with replenishment and recycling of water, all of which complicates demand-based analysis.

asset 'stable climate' and relate to CO_2 emissions. Other possibilities for demand-based computations include material flows.

A second caveat with indicators that reflect the direct and indirect contents of environmental services in final demand is that the link to policy is more complex than with direct, production-related measures. Suppose a country improves on its production-related environmental pressure but worsens on its consumption-related measures because domestic production has been substituted by imports. Policy conclusions are likely to be complex, multi-dimensional and difficult to assess in their effects as they involve trade issues, issues of international investment, and consumer and industry policy. Thus, in general, measures of embodied environmental services would appear to be less directly related to a particular policy implication than some of the direct measures.

GDP, production and material well-being

While most people would agree that the measurement of 'green' is multi-dimensional – clean air, water, stable climate etc. – they would immediately turn to the single most widely used measure of economic growth, Gross domestic product (GDP), to track the 'growth' dimension of 'green growth'.

For the measurement of environmental and resource productivity, GDP is an appropriate concept of output. It reflects, figuratively speaking, 'what comes out of the factory door' and monitoring this flow along with what goes into the 'delivery entrance' in terms of environmental services is relevant. GDP is incomplete as a measure of production insofar as some of the non-market production undertaken by households is outside its boundary and there may be a need to expand these boundaries but this does not take away the conclusion that *for the analysis of a country's production,* and the interaction of this production with the environment, GDP is a useful vehicle. GDP is also the entry point for discussing employment-related issues of green growth, labour being the single most important factor in producing goods and services and employment being closely linked to market production.

At the same time, there are some important shortcomings of GDP. One is that a number of environmental inputs or unwanted outputs are not recognised as such (Box 2). Also, GDP is largely based on market valuations of economic goods and services, and society's valuation may be different in the presence of environmental externalities. And as a gross measure, GDP takes no account of depreciation, depletion or degradation of assets, whether produced or natural.

In a context of measuring societal progress and well-being[5], GDP generally overlooks the contribution of natural assets to well-being, for instance through human health. Also, as a measure of living standards or material well-being, GDP is a less-than-perfect indicator. For these purposes, household consumption or real net income measures are preferred: while, of course, consumption or real income and GDP are related they need not grow at the same rate, even over longer periods. One reason is that the relative prices of imports and exports may develop differently, creating favourable or unfavourable real income effects for residents of a country, independently of the evolution of GDP. Another reason is international income flows for instance remittances paid – these are part of a country's GDP but not of its national income. A third reason is that distributional information can be attached to measures of consumption or income. Average growth rates of GDP or national income may not be representative for the majority of households of the distribution of income changes over time. A green growth strategy therefore has to target several measures of economic growth: GDP for production, consumption or real net income and possibly their distribution among households for material well-being. Ultimately, a complete measure of real net income would also account for the depletion and degradation of natural assets (see discussion on the asset base below).

5 See Stiglitz, Sen and Fitoussi (2009) or Jackson (2009).

Box 2 Comparing the environmental productivity of industries across countries

The amount of environmental services consumed by a particular industry during production (such as the emission of greenhouse gases) is typically measured on a relative basis both domestically and internationally by comparing the ratios of output to emissions. As outlined in the main text, such ratios reflect not only the overall efficiency of production processes but also different degrees of substitution between labour, capital, and environmental inputs. The first step towards comparing pollution intensities of a particular industry across countries is to measure emissions per unit of monetary value of output (gross output or value-added). Monetary measures, expressed in domestic currency units per unit of pollutant are not yet ready for international comparison: they are expressed in different currencies and they reflect both the prices and quantities of output in the industries considered. One additional piece of information is therefore needed for comparison: industry-specific purchasing power parities or price ratios that help converting values into volumes. This is best explained below.

Suppose we want to compare the environmental productivity of the car industries in country A and country B. Let Y^A and Y^B be the monetary value of car output in country A and country B, respectively. Let R^A and R^B the emissions or environmental services consumed in the car industries of the two countries. The ratios Y^A/R^A and Y^B/R^B are not only incomparable, they are by themselves not meaningful. To render them meaningful, one notes that the values Y^A and Y^B have a price and a quantity component: $Y^A=P^AQ^A$ and $Y^B=P^BQ^B$. Industry-specific purchasing power parities (call them PPP) are measures of the ratio of the prices of output of the car industry in country A and country B, that is PPP= P^A/P^B. With PPPs in hand, the comparison of environmental productivity is – at least in principle – possible:

$$\text{Relative environmental productivity} = \frac{Y^A/R^A}{Y^B/R^B}/PPP = \frac{Q^A/R^A}{Q^B/R^B}$$

Industry-specific PPPs are hard to come by, however, and substituting industry-specific PPPs by economy-wide PPPs or by exchange rates risks introducing significant biases into the analysis: relative price levels for the entire economies of countries A and B or bilateral exchange rates may be quite different from relative price levels in a particular industry. The more products are country-specific, or not traded internationally, the harder it is to produce accurate measures of industry-level PPPs. Often, industry-level information is not detailed enough and like cannot be compared with like. For example Australia produces proportionally more aluminium as a percentage of the total “metal” industry output than the United Kingdom, say. Higher emission intensities in Australia compared to the UK in this industry would then be reflective of the differences in structural composition of the metal industry as well as of true differences in emission intensity in the production of aluminium and other metal products. Industry-level PPPs are scarce although some recent studies have made progress in this direction. (e.g. EU KLEMS).

The multiple measurement and conceptual issues associated with the international comparison of the levels of environmental productivity explain why very little use has been made of this approach in the present document. Some of the measurement issues on the production side are absent when productivity is compared on the consumption side of the economy – consumption PPPs are easier to measure and international specialisation in production does not prevent comparing pollution intensities of consumption, provided the latter reflect the environmental services used up both in domestic production and embodied in imports. More of which will be explained under the second type of indicators described below.

Composition of growth and demand

Supply interacts with demand from households, governments, and firms and the structure of demand shapes the structure of supply, domestically or abroad. Patterns of demand and their changes matter for the composition of growth. Many policy instruments, for instance price signals through taxes and subsidies or regulations, are directed at consumers, and changing demand structures will affect the supply structure of economies. By the same token, the size and structure of government consumption can be instrumental in greening the economy, for instance through environmentally sensitive procurement policies.

Therefore, indicators of patterns of household and government consumption are useful to shed light on consumer behaviour and consumption patterns, for example in the field of transport services – have travel distances increased? Has there been substitution between means of transport? Has household demand for organic food products risen – and how have relative prices for such goods evolved? As in other areas, data constraints in particular at the international level, limit the availability of comparable indicators. However, it will be possible to provide some relevant indications of energy efficiency of homes, and of travel distances.

Closely associated with measuring consumption patterns is the policy question of how to facilitate behavioural change towards more environmentally-friendly consumption patterns. For example, consumers can support markets for products that exhibit desirable environmental properties (e.g., with respect to recyclability). The ability to do so depends on consumer awareness, education, the availability and quality of information. These are matters of consumer policy and relevant indicators can help monitoring their uptake.

Despite the important role of the public sector in today's societies with many possibilities for levering green growth, empirical evidence remains sketchy and hard to compare across countries or over time.

Looking ahead: two steps towards an enhanced growth accounting framework

For several years, one of the OECD's main publications **Going for Growth** has analysed the sources of economic growth and linked them with policy recommendations and policy assessment. At the core of this and other work at the OECD (such as the OECD Growth Study 2003), lies a growth accounting approach that starts from a comparison of GDP per capita in OECD countries and then systematically attributes differences between countries to several factors, one of them being the degree to which labour is used in the economy (a labour market effect) and the other being the degree to which labour that is employed produces output (a labour productivity effect). Differences in labour productivity can then be further analysed to reveal differences in capital equipment per worker and differences in multi-factor productivity. Each of these factors relates back to policies – labour market and social policies, investment policies, innovation policies and so forth and these links constitute a useful framework for analysis that has stood the test of time. However, the standard growth accounting framework misses out on two aspects that are central to the Green Growth Strategy: the role of **environmental services** and the role of **material well-being**. At least conceptually, there is no reason not to enhance the standard framework to integrate these two aspects. Two steps would need to be taken.

Recognising the role of environmental services

First, a recognition of relevant environmental services as an input into production. Emitting CO2 is using an environmental service, the absorptive capacity of the atmosphere. Alternatively, rather than as unmeasured inputs, emissions could be treated as unmeasured negative output. Extracting minerals from a mine is using an environmental service from a natural resource. The System of National Accounts (SNA) only recognises those environmental services that relate to the use of land, mineral and energy resources, certain biological and water resources as long as there is a (monetary) benefit to their owner. Even so, more often than not, these inputs are not measured in empirical work. Other services, in particular regulatory services and sink functions are not even recognised on conceptual grounds in the SNA.

Because multifactor productivity (MFP) growth is measured as the difference between the change in outputs and the change in inputs, a rise in unmeasured environmental service input will show up as a rise in multifactor productivity. Explicitly introducing some of the key environmental services into growth accounting computations is thus a first step towards reviewing measures of the sources of economic growth without fundamentally altering the basic growth accounting methodology. Two complications have to be overcome, however.

- One is the choice of the relevant environmental services. Our definition of green growth suggests that only those environmental services that have a bearing on sustainable use of natural capital should qualify as a relevant measure. For instance, an increase in the use of solar energy per unit of output would probably be a welcome development even if it involves more environmental (solar) services per unit of output than before. But there is no issue of unsustainable resource use. On the other hand, the carbon intensity of production is likely to be a relevant indicator of green growth as there is an issue of sustainability of current rates of carbon emissions. A different way of putting it is that for environmental services to be relevant for inclusion in growth accounts, there has to be a social cost associated with them. Such an extension would be of particular interest for certain industries. For instance, Gollop and Swinand (2001) introduce environmental services into a growth accounting approach for U.S. agriculture. Their measure focuses on pesticides and their effect on ground water, along with an estimate for a modified measure of productivity growth.
- The second major challenge is to produce a reasonable estimate for the value of the environmental service. At a minimum, this requires an estimate of marginal abatement costs, at best an estimate of society's marginal valuation of the environmental service. In some cases, such as the environmental services from biodiversity chances are slim to derive a robust valuation. In other areas such as nature's sink services for carbon or nutrients there may be a better scientific basis to value environmental inputs. The UN Handbook on Integrated Environmental and Economic Accounting (SEEA 2003) and its forthcoming updated version provide detailed indications about the possibilities and techniques for such valuations.

Establishing links with measures of material well-being

Second, building the bridge between environmental services and alternative measures of material well-being. The extended growth accounting model does not have to stop with extending the set of inputs and its contribution to GDP growth. A second extension is to examine how measures of material well-being such as real net income would be modified if additions and subtractions to the natural asset base could be valued.

With the two steps combined, it would be possible to track changes in material well-being (real income) back to the effects of changing uses of traditional inputs such as labour and capital, selected environmental services, and a modified rate of multi-factor productivity growth. Note that this extended growth accounting only deals with environmental services that enter domestic production. Measurement of embodied environmental services (as in the example of CO_2 in the present report) complements but does not replace the extended growth accounting exercise, nor does it dispense from broader analysis of well-being.

The natural asset base and the environmental quality of life

The production perspective outlined above – essentially about the 'greening of growth' – is necessary but not sufficient to monitor the transition towards green growth. For sustained growth it is necessary to introduce a dynamic criterion: ***keeping the asset base intact***[6]. One reason is that a declining asset base constitutes a risk to growth and such risks should be avoided. 'Asset base' should be understood in a comprehensive way, encompassing produced as well as non-produced assets, and including in particular environmental assets and natural resources. Broader concepts[7] such as sustainable development would also include human capital or social capital. For purposes of the green growth strategy, however, the focus will remain on ***economic and natural assets***. Loosely speaking, 'keeping the asset base intact' implies that net investment is positive – more needs to be added to the asset base in the form of investment or natural regeneration than is subtracted though

6 In 2001, OECD Environment Ministers identified four criteria for environmental sustainability: regeneration, substitutability, assimilation avoiding irreversibility.

7 See in particular the work by UN-ECE/OECD/Eurostat (2009). The World Bank's Genuine Savings Indicator rests on the same foundations: a necessary condition for sustainability is that net savings are non-negative.

depreciation or depletion[8]. Whether a particular growth path of consumption or income can be sustained depends also on expected rates of multi-factor productivity change[9], thus adding to the central role that innovation and technical change play in considerations about green growth. A major question is how easily one type of asset can be substituted for another asset, i.e., if the decline in one type of asset can be made up for by an increase in another type of asset. In a world of perfect measurement and perfect markets, this information should be contained in asset prices, reflecting society's preferences and vision of the future. Absent such prices for most assets, measurement has to start with ***monitoring the physical evolution of natural assets***. Over time, measurement efforts should be undertaken to advance on the valuation of (net investment) in at least some important natural assets. This has been reflected in the measurement agenda.

Ideally, such indicators relate to critical levels although in practice few such benchmarks exist or are easily applicable in an international context. One reason is that critical levels of the quality of environmental assets or non-sustainable use of natural resources may vary locally, making national averages not very meaningful. Another reason is that often, there is not always broad-based consensus on where exactly critical limits lie from a scientific viewpoint[10]. From a green growth perspective, it is also important that indicators of the natural asset base relate to assets are critical for economic growth and development.

The present set of indicators of natural assets reflects these criteria. In addition to a stable climate (captured by carbon-related indicators), the indicators of the natural asset base relate to freshwater resources, forest resources, fish resources, mineral resources, land resources, soil resources and wildlife resources.

We note in passing that in order to complete the picture of a country's asset base, and to arrive at a 'green growth balance sheet', at least two types of economic assets would need to be added to the set of natural assets: ***produced assets***[11] and ***net financial assets*** vis-à-vis the rest of the world. The System of National Accounts (SNA) provides the concepts for measuring these, complemented by the forthcoming SEEA with regard to the measurement of natural assets (Box 3). Human capital lies outside the asset boundaries of the SNA and SEEA but is a key asset and driver of innovation and productivity.

Considerations about keeping society's asset base intact relate directly to a concept that has attracted much attention recently, namely well-being. This is a multi-dimensional concept that encompasses material well-being as well as various dimensions of the ***quality of life*** such as health, education, social contacts or security. Conceptual and empirical work to better measure the quality of life is underway in many places, including at the OECD[12] and no attempt is made to fully integrate these efforts into the present considerations. For green growth, one dimension of the quality of life stands out, the direct impact of the environment on people's quality of life.

---

8 For a rigorous formulation of this condition and an overview of the academic literature see Heal and Kriström (2005).

9 The discounted cumulative flow of expected rates of multi-factor productivity change can be considered an intangible asset. See Nordhaus (1995), Weitzman (1997) and Hulten and Schreyer (2010) for theoretical discussions and some back-of-the envelope estimates.

10 However, there have been recent research efforts to identify the critical global 'boundaries'. For instance, Rockström et al. (2009) nominate nine potential 'boundaries': carbon/climate, ocean acidification; stratospheric ozone, global nitrogen and phosphorous (N and P) cycles; atmospheric aerosol loading; freshwater use, land use change; biodiversity loss; and chemical pollution. From a perspective of identifying a concise set of indicators, several of these can be coalesced under the carbon /climate heading – carbon emissions, ocean acidification, stratospheric ozone and aerosols. This leaves a second cluster of boundaries, likely to be related, namely the global N and P cycles, water use, land use change and biodiversity loss.

11 To be precise, there are also several non-produced assets other than natural assets but they shall be ignored here for simplicity.

12 OECD Project on Measuring the Progress of Societies and the forthcoming publication 'How's Life?'.

Box 3 Environmental-economic accounts – The example of Australia*

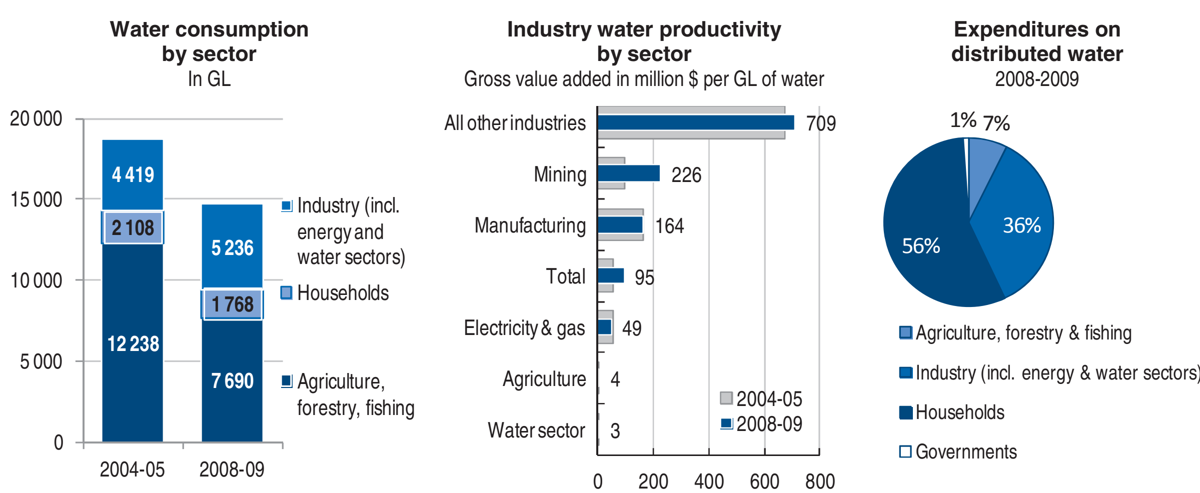
Australian environmental-economic accounts for water are a good example of a consistent environment-economic framework, which facilitates the management of natural resources and helps the decision-making process. A system of environmental-economic accounts can show the inter-relationships, and the potential impact of particular policy positions going beyond physical measures, to provide an insight into impacts on particular industries, communities and businesses, including the impact of regulation, charges and incentives.

Water is a particularly scarce resource in many parts of Australia; hence its management is critical and attracts public attention. An enormous amount of money and effort has been invested over many years to manage this resource, but determining the outcomes of these investments often proved difficult as robust measurement frameworks did not exist. In general, water data has suffered from a range of problems including:

- Inconsistent definitions and standards;
- Independence from any framework which facilities data linkage or interconnectivity;
- Inconsistent frequency and timing;
- Poor spatial representation;
- Low levels of visibility, discoverability and accessibility;
- Lack of time series and therefore lack of stability over time;
- Poor capacity to support modelling and forecasting.

The Australian Bureau of Statistics has made progress in this direction by producing a range of individual environmental-economic accounts, which integrate bio-physical and socio-economic information. The accounts for water provide high quality information on physical flows of water supplied to and used by industries and households, how much they pay, the value added per unit of water for each industry, and water returns to the environment.

For example, water consumption by sector is a useful tool for policy makers to evaluate productivity and behaviour in water consumption by key sectors over time. The figure below shows for instance that water consumption by households fell by 16% between 2004–05 and 2008–09. Another example is the net physical use of distributed (both urban and rural) water and related expenditures. Household expenditures accounted for the largest share of 56%, with an average household paying $1.93/10^{3}L (agriculture $0.12/10^{3}L, industry $1.03/10^{3}L) in 2008-2009. Together with the water intensity, this information has specific policy interest for regulators reviewing pricing structures. For instance, the gross value added for agriculture increased by 16% to $4 million of gross value added for every Gigaliter (GL) of water consumed in 2008-2009, while water consumption decreased by 41% since 2004–05.



* The conceptual model adopted by the Australian Bureau of Statistics for environmental accounts is the United Nations System of Integrated Environmental and Economic Accounting (SEEA).

Source: Australian Bureau of Statistics (ABS).

Environmental outcomes are important determinants of health status and wellbeing more generally. They provide an example where production and income growth may not be accompanied by a rise in overall well-being[13]. For instance, air pollution, in particular exposure to particulate matter, is much higher in some of the emerging economies than across the OECD countries. In addition, a larger share of the population lives under medium to severe water stress, while low levels of wastewater treatment and pollution contribute to the incidence of waterborne and preventable diseases. Economic and health challenges are expected if global warming continues, including the fall of agriculture yields, increased water stress, and loss of biodiversity. As the greenhouse gas emission trends in emerging economies as a whole will have a considerable impact on global climate, these challenges make "green growth" a high priority (OECD 2010a).

The group of indicators on the environmental quality of life includes measures covering (i) people's exposure to various pollutants and the associated health effects, (ii) people's exposure to environmental risks; and (iii) the access to basic environmental services, in particular clean water and connection to sewage treatment. As contextual information, objective measures are complemented by subjective measures such as people's perceptions about the quality of the environment they live in.

Economic opportunities and policy responses

Opportunities arising from greening growth

Although green growth can be framed in a well-established environment-economic growth model, there is a dynamic aspect to green growth that is difficult to capture in such a model. This is the Schumpeterian nature of economic growth through entrepreneurship and innovation. In other words, it is about the economic opportunities arising from the incentives triggered by the right policies and the right framework conditions. In particular, prices signals provide incentives to innovate. And the issue of prices is directly linked to natural asset valuation.

A starting point for examining economic opportunities from environmental considerations is by examining the role of 'green industries', trade in 'green products' and creation of 'green jobs'. While widely discussed, closer inspection of these concepts shows that they are often difficult to pin down statistically. That said, some progress has been made in this respect since the first publication of a manual on measuring the environmental goods and services industry (OECD and Eurostat 1999). More recently, Eurostat developed detailed guidelines and in 2010, a first set of data for several European countries has become available (Box 4).

Statistical issues apart, there is a more basic question whether the potential for green growth is adequately captured by measuring the output and jobs of those companies that produce environmentally related goods, services and technologies. For instance, an economy could move towards a low carbon growth path if traditional industries (say mining or steel production) increase their energy efficiency through new modes of organisation – process innovation – or if there is product innovation that leads to products that are less energy intensive in their use, triggered by cost or competitiveness considerations rather than environmental concerns. Thus, the production of environmental goods, services and technologies is only *one* aspect of the potential for green growth and only a partial representation of the Schumpeterian dynamics alluded to earlier.

Examining the dynamics of firm creation and entrepreneurship in relation to environmental goods, services and technologies goes one step further: green entrepreneurship is both a source of innovation and a source of opportunities for economic growth. Yet, indicators of environmentally-related entrepreneurship still tell only part of the story. But moving further into the area of general indicators of entrepreneurship implies losing any explicit link to environmental considerations. This issue also arises with indicators of R&D and innovation.

13 Conceptually, and in terms of a model of economic growth, this implies that society's utility is driven not only by consumption possibilities but also by the state of natural assets.

Box 4 The Environmental Goods and Services Sector

In 2009, Eurostat published a handbook (Eurostat 2009) to provide conceptual and practical guidance to statistical offices in the collection of data on the turnover, value-added, employment, and exports of the environmental goods and services sector (EGSS). The handbook builds on earlier work carried our jointly with the OECD (OECD and Eurostat 1999) and constitutes the methodological reference for the relevant work in the European Union. The draft *System on Integrated Environmental and Economic Accounting* (SEEA) contains a consistent definition of the EGSS, as activities to measure, control, restore, prevent, treat, minimise, research and sensitise environmental damages to air, water and soil, resource depletion as well as problems related to waste, noise, biodiversity and landscapes. This includes 'cleaner' technologies, goods and services that prevent or minimise pollution and results mainly in resource-efficient technologies, goods and services that minimise the use of natural resources.

The definition of the EGSS delineates environmental activities from others by only including those products that are produced with an environmental purpose as the main purpose. This is identified mainly on the basis of the technical nature of the activity or the producer's intention, i.e. regardless of the intention of the users. For instance, producers of renewable energy technologies, clean cars or eco-efficient devices would be part of the EGSS. On the other hand, the electronic delivery of documents is an example of a service that would be excluded from the EGSS. While it substitutes printing and physical delivery and may thereby provide savings in paper and energy for transport, it has not been provided mainly for environmental purposes. Needless to say, identifying the main purpose of a technology or product is often difficult so that a certain arbitrariness cannot be avoided. Another borderline case is activities related to natural hazards and natural risk management, intended mainly to prevent or reduce the impact of natural disasters on human health. These are excluded from the European definition of the EGSS but had been included in the earlier OECD/Eurostat definition.

It is also apparent that the EGSS is highly diverse and includes government producers as well as producers in the corporation sector. Even for a given producing unit, some of its activities may be falling under the definition of the EGSS and not others. The unit will be part of EGSS if its primary activity is of an environmental nature. For example, in-house waste collection and treatment or internal wastewater treatment plants are ancillary activities with a primary environmental purpose and would thus not fall under the concept of the EGSS.

Another issue to deal with is double-counting when some environmental technologies, goods or services are used in the production of another environmental output. Considering both activities could lead to an overestimation of the size of the environmental sector. In order to avoid such double counting, intermediate consumption has to be distinguished from final products – a task that is not always easy to accomplish.

A first set of data on value-added and employment in the EGSS has been collected for several European countries and provides some indication of the relative magnitude of the activities so defined. The relevant figures for recent years do not normally exceed 2 to 3 percent of GDP, depending on the country. Data collection will be successively expanded by Eurostat, across countries but also to include consistent measures of exports.

The EGSS as defined above is essentially a product-based definition of 'green' – it brings together enterprises that are mainly engaged in producing environmental products or technologies. Clearly, this is only one aspect of 'green' that leaves out greening of processes, independently of the industrial activity where this arises. Put differently, an economy can turn green and realise growth opportunities without necessarily being engaged in the production of green goods and services because processes of production become more environmentally efficient. Some studies have tried to capture this important aspect of green growth. For instance, Arvantis, Ley and Wörther (2010) use firm-level data to identify the '*Cleantech*' sector, defined as those firms whose innovation activity fall under *at least* one of the following categories: (a) development of environmentally friendly products (product innovation); (b) reduction of the share of costs of materials (process innovation); (c) reduction of the share of energy costs; (d) reduction of environmental pressure through production (process innovation).

Overall, and despite existing definitions, setting the boundaries for the set of environmental goods and services remains difficult as do their measurement and interpretation.

R&D and innovation

Innovation is clearly central to the idea of green growth and its role is described in a recent OECD (2010b) report on *Fostering Innovation for Green Growth*. It was mentioned earlier that innovation drives multi factor productivity change, and so helps the decoupling of outputs from inputs in general. But innovation is more than technical improvements. Innovation and the related process of creative destruction should lead to new ideas, new products, entrepreneurs and business models, and new consumption patterns. General innovation has to be distinguished from *green innovation*. The latter mainly relates to environmentally-related research and development and technologies. Thus, akin to 'green industries' or 'green jobs', looking at green innovation will only tell part of the story that innovation at large plays in the transition to green growth. A trade-off arises from the perspective of constructing green growth indicators. Focusing on green innovation indicators does not do justice to the full importance of innovation. On the other hand general indicators of innovation are not very helpful in monitoring society's responses to the green growth challenge. The work at hand therefore covers both aspects.

International trade

International trade is a source of economic opportunities in general. In conjunction with green growth, there has also been a stream of work on the importance of trade in environmental goods and services (Kennet and Steenblik 2005). The liberalisation of trade in environmental goods and services can help green growth. For importing countries, fewer and lower barriers to trade in environmental goods and services translate into greater access to the most efficient, diverse and least expensive goods and services on the global market. For exporters, liberalisation can create new market opportunities and spur development of globally competitive industries dedicated to environmental improvements, for instance via technology development or diffusion. In terms of measurement, however, the scope of environmental goods and services as defined in the context of trade negotiations is not the same as the scope defined to analyse the domestic environmental goods and services industry. The implication is that data from trade-related analyses of environmental goods and services are not compatible with data from domestic studies. More work will be needed before a match can be made between the activities of the environmental goods and services sector and trade in environmental goods and services.

International financial flows

This group of response indicators relates to the environmental aspects of development aid, to emerging carbon markets as well as to the environmental aspects of green foreign direct investment (FDI). Determining the environmental purpose of an aid flow or an FDI flow is not always easy but some standards exist, in particular for OECD's data on Official Development Assistance. By contrast, while the potential of FDI to contribute to financing and transferring green technology and processes is undoubtedly large, it remains largely unexplored so far. One explanation for this limited attention to FDI is the lack of an operational definition of green FDI and of available data[14].

Prices and taxes

Clear and stable market signals are key to affecting the behaviour of producers and consumers. 'Getting the prices right' has to be one of the major policy concerns when producers and consumers cause negative externalities to the environment through their economic activity. Government can address such market failures through economic instruments such as taxes or through the suppression

14 In this context, the OECD Investment Committee and its subsidiary bodies have started working on issues related to the definition and measurement of green FDI. In the short term, countries agreed to contribute to draw up an inventory of national initiatives and efforts to define and measure "green" FDI. This inventory provides some preliminary evidence to support the analysis in the Green Growth Strategy Synthesis Report but does not constitute a set of internationally comparable measures of green FDI. In the longer-run, countries will investigate the possibility of developing comprehensive and meaningful indicators of green FDI.

of environmentally harmful subsidies. At first glance, the measurement of environmentally-related taxes and the prices of a number of natural assets would appear relatively straightforward. Closer inspection, however, raises several questions. For instance, should the stated purpose of a tax determine its recognition as an environmental tax or the likely effect that a tax has with regard to the environment? To take the example of a rise in a petrol tax: should this be considered an act of environmental taxation? The definition matters for international comparability and interpretation[15]. Another issue concerns prices of natural resources, such as water pricing. A higher or lower price of water in itself tells nothing about whether the price is right. On the other hand, the pricing structure of water, or the extent to which the costs of supply and sanitation are recovered, can be meaningful indicators for the efficiency of price signals. By the same token, a rising share of environmental taxes in overall revenues is at least a signal for rising political importance attached to environmental issues by policy-makers. Overall, the decision was made to retain several indicators relative to the water and energy pricing as well as environmentally related taxes. Environmentally motivated and environmentally harmful subsidies could also be considered in the longer term, though their definition does not yet benefit from an international consensus.

Regulations and management approaches

Over economic instruments used to get prices right, regulatory instruments should not be forgotten as a tool to reduce negative effects on the environment. Constructing indicators of regulation is tricky, however, as the information is often of a qualitative nature. For example, it might be possible to assess whether or not there is an obligation to equip new cars with catalytic converters or to screen environmental legislation for obligations to carry out environmental impact assessments. And what may be a tough standard in country may be lenient in another one if there are large differences in the environmental asset base and its quality. For the purpose at hand, no attempt has been made to capture the breadth of relevant regulations in place. The focus with the available indicators has been on capturing the management activity of some natural resources and biodiversity. For instance, the share of protected areas in the total territory of a country provides a meaningful measure for government efforts to preserve biodiversity through a regulatory measure.

Another aspect of "management" relates to the business sector. For instance industry associations, governments or NGOs may grant environmental certificates to firms to acknowledge the adoption of environmental management practices.

Training and skills development

Education, training and skills development are closely linked to the capacity to innovate. Public policy plays a role by institutionalising environmentally-related lines of education in particular in higher education. Vocational Education and Training is equally important in raising awareness about environmental issues, in fostering innovation on the workplace and in facilitating the transition and development of firms and the workforce into a low-carbon economy (OECD 2010b). These areas have often been under-represented in scoreboards of indicators, one reason being the difficulty of compiling the relevant data in particular for international comparisons. In the short run it will not be possible to show internationally comparable measures in this area, except for indicators on environmental science literacy published by the OECD (OECD 2009).

---

15 The forthcoming revised SEEA provides guidance to the definition and measurement of environmentally-related taxes and subsidies.

3. Towards an OECD set of "Green Growth" indicators

The proposed set of indicators

While it may be premature to identify a final set of OECD indicators, a preliminary selection can be made on the basis of existing work and experience in the OECD, the IEA, other international organisations, and in member and partner countries (Box 5). Such a set will serve as a start for further discussions and will provide a useful tool for current OECD work on country reviews and policy analysis.

The list of indicators proposed here has been kept flexible enough 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 proposed set is thought to be neither exhaustive nor final, and is to be seen in the context of other OECD indicator sets to acquire its full meaning. 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 indicators have been selected according to their policy relevance, analytical soundness, and measurability (Box 1). It is however recognised that the indicators shown in the list are derived from sets developed independently from each other and whose original purpose has not been the measurement of progress towards green growth. More work is required to further refine and link the indicators and to fill remaining gaps.

The list below singles out the main indicator groups and the topics covered in line with the measurement framework described above (Table 1). A complete list of indicators proposed for inclusion in an OECD Set of indicators is presented in the Annex. The list has been subjected to review by member countries. The indicators specified and measured constitute a starting point and the list may be modified as the discussion evolves and as new data becomes available. A selection of indicators that are measurable in the short run is presented in Part Two of this report.

Links to other international initiatives

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.

Several other national and international bodies have embarked on work on green growth, with somewhat different emphases and objectives than the work undertaken by the OECD.

- A major ***Green Economy Initiative*** has been undertaken by the United Nations Environment Program (UNEP) and work on related indicators is under way. UNEP and the OECD are cooperating to identify synergies and commonalities (Box 6).
- Eurostat has launched its ***IGrowGreen*** initiative, an assessment framework to identify country-specific challenges to promote a more resource efficient Europe. Many of the indicators proposed there, in particular the ones relating to the environmental efficiency of production and consumption, are similar to the ones listed in the present report. However, the *IGrowGreen* initiative aims at constructing a single aggregate index of green growth – an objective not followed here.

Wherever possible and meaningful, indicators proposed by the various agencies have been harmonised although this effort is imperfect given the differences in focus and membership of the organisations. In future, efforts will also be made to coordinate this work with the result of Eurostat's Streamlining Indicators Project[16].

[16] In an agreement between the European Environment Agency, the European Commission's Joint Research Centre, the Directorate General for the Environment and Eurostat, the latter was mandated to carry out a 'streamlining' exercise of the environmental indicator sets maintained by the four bodies. Completion of the project is planned for end 2011.

Table 1 Overview of proposed indicator groups and topics covered

Main indicator groups	Topics covered	Related OECD work
The socio-economic context and characteristics of growth		
Economic growth, productivity and competitiveness	**Economic growth and structure** **Productivity and trade** **Inflation and commodity prices**	Economic outlook, Economic surveys Going for growth National accounts, Productivity database Employment outlook Education at a glance Health at a glance Society at a glance
Labour markets, education and income	**Labour markets** (employment / unemployment) **Socio-demographic patterns** **Income and education**	
Environmental and resource productivity		
Carbon and energy productivity	**1. CO_2 productivity** (demand-based, production-based) **2. Energy productivity**	IEA scoreboard CO_2 emissions database OECD input-output tables Environmental indicators Environmental reviews Environmental outlook Material flows & resource productivity Agri-environmental indicators Productivity database
Resource productivity	**3. Material productivity** (demand-based, production-based) Non-energy materials, waste materials, nutrients **4. Water productivity**	
Multi-factor productivity	**5. Multi-factor productivity** reflecting environmental services	
Natural asset base		
Renewable stocks	**6. Freshwater resources** **7. Forest resources** **8. Fish resources**	Environmental indicators Environmental reviews Measuring progress Material flows & resource productivity Environmental outlook Agri-environmental indicators
Non-renewable stocks	**9. Mineral resources**	
Biodiversity and ecosystems	**10. Land resources** **11. Soil resources** **12. Wildlife resources**	
Environmental quality of life		
Environmental health and risks	**13. Environmentally induced health problems and related costs** **14. Exposure to natural or industrial risks and related economic losses**	Measuring progress -How's Life? Environmental indicators Environmental reviews Environmental outlook
Environmental services and amenities	**15. Access to sewage treatment and drinking water**	
Economic opportunities and policy responses		
Technology and innovation	**16. R&D of importance to GG** **17. Patents of importance to GG** **18. Environment related innovation**	Innovation strategy Science, technology & industry scoreboard Patent database R&D database Aid activity database Database on environmental policy instruments Agri-environmental indicators
Environmental goods and services	**19. Production of environmental goods and services**	
International financial flows	**20. International financial flows of importance to GG**	
Prices and transfers	**21. Environmentally related taxation** **22. Energy pricing** **23. Water pricing and cost recovery**	
Regulations & management approaches **Training & skill development**	*Indicators to be developed*	

Box 5 Relevant OECD work for monitoring progress towards green growth

The indicators needed to measure progress with green growth are founded on existing OECD work that is being refined to suit the Green Growth Strategy. Continued co-operation is taking place with other international organisations, such as UNEP, the European Commission, and international institutes.

Measuring environmental performance and resource productivity	The OECD has developed several sets of **environmental indicators** to support policy analysis and country reviews: key and core environmental indicators to track environmental progress; sectoral environmental indicators to monitor policy integration; and indicators to measure the decoupling of environmental pressures from economic growth. The indicators are supplemented with environmental data, including on environmentally related **taxes** and **expenditure**. Recent work has been focusing on the measurement of **material flows and resource productivity** in support of an OECD Council recommendation and of the G8 Kobe 3R Action Plan.
Monitoring trends in energy use and efficiency	The IEA maintains several databases, including energy balances, energy statistics, energy prices and taxes, and publishes various types of **energy indicators**. Recent work has been focusing on the measurement of **energy efficiency** in support of the G8 Gleneagles Plan of Action for Climate Change, Clean Energy and Sustainable Development and on improving mandatory reporting of energy efficiency-related data.
Monitoring technology developments and innovation	The OECD maintains several databases and indicator sets keeping track of developments in technology and industrial performance: main science and technology indicators; indicators on the information economy, globalisation, and entrepreneurship; international patent database, input-output tables and estimates of carbon embedded in trade. Recent work has been focusing on indicators in support of the OECD **Innovation Strategy**, and on an indicator toolkit to promote and monitor **sustainable manufacturing** at corporate level.
Measuring the environmental performance of agriculture	The economic and environmental performance of agriculture is monitored through a set of **agri-environmental indicators**, supported with the measurement of agricultural producer support.
Monitoring international transfers	The OECD maintains two major databases monitoring international monetary transfers: international **investment** flows and official **development assistance**. Recent work aims at developing indicators of "green" foreign direct investment flows and at mapping relevant international investment flows by country and sector of destination.
Measuring sustainable development	The OECD has been promoting the development of indicators and coherent approaches to measure sustainable development. Recent work has been focusing on improving the measurement of different types of capital with emphasis on **human and social capital**.
Measuring well-being and progress	The OECD promotes the development of better measures and indicators of people's well-being and societal progress, to be used alongside standard economic measures such as GDP. Recent work aims at implementing the recommendations of the Stiglitz-Sen-Fitoussi Commission with emphasis on **well-being and sustainability**.
Other relevant work	To underpin its socio-economic analysis, the OECD further maintains databases on a wide range of other topics that are important to characterise economic growth and its outcomes. Examples include: national accounts, international trade, balance of payments, prices and taxes, productivity, government debt, employment, education, health, etc.

Box 6 UNEP's Green Economy Initiative

The UNEP-led Green Economy Initiative, launched in late 2008, provides analysis and guidance to countries on policy reforms and investments to achieve a green transformation of key sectors of the economy. The main output of the initiative is the Green Economy Report, released at UNEP's Governing Council in February 2011 (UNEP 2011). As part of the Initiative, a framework for assessing progress in moving towards a green economy is being developed. This framework on indicators and metrics, which will present options to governments and other stakeholders, will form part of the advisory services on green economy offered to governments by UNEP. This publication on Green Economy Indicators is being prepared in 2011.

The framework for green economy indicators, which will be presented in a separate report in 2011, comprises three principal areas, building on existing frameworks and efforts:

- ***"Green transformation of key sectors and the economy"*** focusing on investments in a green transformation of various sectors of the economy, and their associated share in output and employment.
- ***"Decoupling and Efficiency"*** assessing resource efficiency and productivity, and the decoupling of economic activity from resource use and related environmental impacts, at both sector and economy-wide levels, building on the work of the International Resource Panel.
- ***"Aggregate indicators of progress and well-being"*** referring to various initiatives on overall measures of economic progress and well-being, including poverty alleviation and natural capital depreciation (such as in the "Beyond GDP" initiative).

Depending on level of economic development and natural resource use, countries may choose to prioritise different sets of indicators.

UNEP is also working with other international organisations, including among others the United Nations Statistics Division (UNSD), other UN agencies, the Organisation for Economic Co-operation and Development (OECD), the World Bank, the European Commission, and the European Environment Agency (EEA), to develop a common set of core, or headline, indicators for green economy. Concerning potential headline indicators for decoupling and efficiency, the International Resource Panel has identified impacts related to fossil fuel use and agriculture and food consumption as priority products and materials to focus on for indicator development (UNEP, 2010) UNEP and OECD are seeking to establish a particular cooperation to indicate commonalities and synergies between UNEP's green economy indicators and the OECD's indicators for monitoring progress towards green growth.

Reference: UNEP (2010): Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management. Hertwich, E., van der Voet, E., Suh, S., Tukker, A., Huijbregts M., Kazmierczyk, P., Lenzen, M., McNeely, J., Moriguchi, Y.

4. The measurement agenda

Measurement issues constrain the full and timely production of green growth indicators. Some issues are located at the conceptual level and many issues are of an empirical nature.

A consistent accounting framework

By their very nature, green growth indicators have to combine in a consistent way economic and environmental information. While there is a substantive amount of economic and environmental data, it is often difficult to combine them due to differences in classifications, terminology or timeliness. A first and crucial ingredient of the measurement agenda is thus to develop and populate a consistent environment-economy accounting framework. The new and forthcoming ***System of Environmental and Economic Accounting*** (SEEA) provides such a framework. Placing measurement efforts within this framework will maximise consistency and international comparability.

Specific areas for progress

Apart from the general usefulness of integrated statistics, the present preliminary set of green growth indicators revealed several important gaps in the information base. These areas should form part of a green growth measurement agenda, to be implemented over the coming years. In particular:

- There are significant gaps in environmental-economic ***data at the industry level***. Improving the data situation would for example help in quantifying the effects of industry structures in international comparisons of economy-wide indicators. More sectoral information is also useful from a policy perspective if policy tools are industry-specific;
- There is a need to develop and improve the physical data for key stocks and flows of natural assets. A prominent example is information on land and ***land use*** changes. Land is not only a major asset in a country's balance sheet. Land use change is also a meaningful indicator for the interaction between economic activity and biodiversity. Another example is ***non-energy mineral resources*** that often constitute critical inputs into production.
- Better physical data also helps improving ***material flow analyses*** that could be undertaken at a more granular level and be extended to demand-based measures, akin to the methodology used to assess the CO_2 contents of domestic final demand. Such work would fit with the measurement agenda on material flows and resource productivity spelled out by OECD Ministers in 2004 and 2008.
- Information on ***biodiversity*** remains scarce. Further efforts are needed in particular with regards to species and ecosystem diversity, and species abundance.
- Efforts should also be directed at developing ***monetary values*** for (changes in) key stocks and flows of natural assets by determining prices. In particular, valuation of investment and depreciation (in the case of produced assets) and natural growth and depletion or degradation (in the case of non-produced natural assets) should be advanced. Guidance on measurement approaches is being provided by the forthcoming SEEA and by UNECE/OECD/Eurostat (2009). Such valuations, even if incomplete and imperfect are required to:
  - extend traditional ***growth accounting*** to include natural assets, thereby deriving new measures of multi-factor productivity growth;

- develop more comprehensive ***balance sheets***;
- take first steps towards measures of real ***income adjusted*** for natural growth and depletion of natural assets

- The information base on how environmental concerns trigger ***innovation*** in companies remains limited. Regular innovation surveys and exploitation of other microdata sets could help advancing relevant knowledge about the drivers and impediments to innovation in conjunction with businesses' environmental and resource efficiency.
- Environmentally related policy tools are more easily framed in indicators when they are economic instruments such as taxes or subsidies. The construction of indicators is more complicated when it comes to ***regulatory instruments***. Thought should be given to how indicators on economic instruments can be complemented by indicators on environmental regulation so as to balance the picture of international comparisons of policy responses.
- Measuring the effects of environmental conditions on ***quality of life*** and on life satisfaction is not an easy task. It requires improvements in both objective and subjective measures of the quality of life, in particular:
  - Environmentally induced ***health*** problems and risks and related costs.
  - Public ***perceptions*** of the environmental quality of life that provide insight into citizens' preferences and sense of well-being.

Headline indicators

The proposed set comprises about twenty-five indicators, not all of them are measurable today. The multi-dimensional nature of green growth requires a sufficient number of indicators to do justice to the various aspects of the issue at hand. But a large dashboard also carries the danger of losing a clear message that speaks to policy makers and that helps ***communicating*** with the media and with citizens.

One way of addressing this issue is to construct a composite indicator. The advantages of ease of communication and concise presentation of a composite number must, however be weighed against the problem of choosing units and weights required for aggregation across very different elements. Although there are ways to accommodate some of the issues involved in aggregation (Nardo et al. 2005), the present work does not pursue this avenue. Rather, it is proposed that a ***small set of 'headline' indicators*** be selected that are able to track central elements of the green growth concept and that are representative of a broader set of green growth issues. This is a task that still lies ahead and requires broad consultation and discussion because, inevitably, opinions on the most salient set of indicators will vary among stakeholders. The OECD stands ready to take this task forward.

References

Ahmad, Nadim and Andrew Wyckoff (2003); "Carbon Dioxide Emissions Embodied in International Trade of Goods"; OECD Science, Technology and Industry Working Papers 2003/15, OECD, Directorate for Science, Technology and Industry; available under http://www.oecd-ilibrary.org/oecd/content/workingpaper/421482436815 .

Ahmad, Nadim and Norihiko Yamano (2011 forthcoming); "Carbon dioxide emissions embodied in final consumption", OECD Working Paper.

Arvanitis Spyros, Marius Ley and Martin Wörter (2010); 'Cleantech"-Sektor: Abgrenzungen, Innovationsaktivitäten, Humankapitaleinsatz'; Studie im Auftrag des Bundesamtes für Bildung und Technologie; KOF Studien Nr. 15, October.

de Serres, Alain, F. Murtin and Giuseppe Nicoletti (2010), "A Framework for Assessing Green Growth Policies", OECD Economics Department Working Papers, No. 774, OECD Publishing.

European Commission (2010); iGrow Green: Setting up an indicator-based assessment framework to identify country-specific challenges to promote a more resource efficient Europe; Draft paper unpublished.

Eurostat (2009); The Environmental Goods and Services Sector: A data collection handbook; Luxembourg.

Gollop, Frank and Gregory P. Swinand (2001); "Total Resource Productivity. Accounting for Changing Environmental Quality"; in: Charles R. Hulten, Edwin R. Dean and Michael J.Harper, (eds.); New Developments in Productivity Analysis; University of Chicago Press.

Heal, Geoffrey M and Bengt Kriström (2005); "National Income and the Environment"; in Karl-Göran Mäler and Jeffrey R. Vincent (eds.); Handbook of Environmental Economics; 1105-1618.

Hulten, Charles R. And Paul Schreyer (2010); "GDP, Technical Change, and the Measurement of Net Income: the Weitzman Model Revisited"; NBER Working Paper No. 16010, May.

Jackson, Tim (2009); Prosperity Without Growth?; Report of the Sustainable Development Commission.

Kennett, Maxine and Steenblik, Ronald (2005); "Environmental Goods and Services A Synthesis of Country Studies"; OECD Trade and Environment Working Paper 2005-03.

Nardo, Michela, Michaela Saisana, Andrea Saltelli, Stefano Tarantola, Anders Hoffman and Enrico Giovannini (2005), "Handbook on Constructing Composite Indicators: Methodology and User Guide", OECD Statistics Working Papers, 2005/3, OECD Publishing.

New Zealand Ministry of the Environment (2010); "Green Economy: Some Facts and Figures for New Zealand"; Ministry for the Environment Information Directorate 11/2010.

Nordhaus, W. (1995) "How Should We Measure Sustainable Income?", Cowles Foundation Discussion Papers 1101.

O'Connor, Martin and Karl Schoer (2009); "Environmental-Economic Accounting: Environmental Degradation in the new SEEA"; Statistisches Bundesamt Wiesbaden, available under http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Content/Publikationen/SpecializedPublications/EnvironmentEconomicAccounting/EnvironmentalEconomicAccounting__EEA,property=file.pdf .

OECD (1998); The Global Environmental Goods and Services Industry; OECD Publications, Paris.

OECD and Eurostat (1999); The environmental goods and services industry: manual for data collection and analysis; Luxembourg.

OECD (2001); Measuring Productivity – OECD Manual, Paris.

OECD (2003); The Sources of Economic Growth in OECD Countries, Paris.

OECD (2008); Measuring Material Flows and Resource Productivity ; Volume I (The OECD Guide) and Volume II (The Accounting Framework); Paris.

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

OECD (2009); Green at fifteen? How 15-year-olds perform in environmental science and geosciences in PISA 2006; Paris

OECD (2010a); Going for Growth; Paris.

OECD (2010b); Fostering Innovation for Green Growth, Draft report to the OECD Committees for Scientific and Technological Policies and the OECD Committee on Industry, Innovation and Entrepreneurship; DSTI/IND/STP/ICCP(2010)4.

Rockström Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart III Chapin, Eric Lambin,Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, Björn Nykvist, Cynthia A. De Wit, Terry Hughes, Sander van der Leeuw, Henning Rodhe, Sverker Sörlin, Peter K. Snyder, Robert Costanza, Uno Svedin, Malin Falkenmark, Louise Karlberg, Robert W. Corell, Victoria J. Fabry, James Hansen, Brian Walker, Diana Liverman, Katherine Richardson, Paul Crutzen, and Jonathan Foley (2009); "Planetary boundaries: exploring the safe operating space for humanity"; Ecology and Society 14(2): 32. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art32/

Steenblik, Ron (2005); "Liberalising Trade in Environmental Goods – Some Practical Considerations" ; OECD Trade and Environment Working Paper 2005-05.

Stiglitz, Joseph ; Armartya Sen and Jean-Paul Fitoussi (2009) ; Performances économiques et progrès social : Vers de nouveaux systèmes de mesure ; Odile Jacob, Paris.

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

UN, EC, IMF, World Bank, OECD, (2003) Integrated Environmental and Economic Accounting (SEEA2003), UN Statistical Division, New York; available under http://unstats.un.org/UNSD/envAccounting/seea2003.pdf

UNECE, OECD, Eurostat (2009); Measuring Sustainable Development; available at http://www.unece.org/stats/archive/03.03f.e.htm

UNEP (2010): *Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials*. A Report of the Working Group on the Environmental Impacts of Products and Materials to the International Panel for Sustainable Resource Management. Hertwich, E., van der Voet, E., Suh, S., Tukker, A., Huijbregts M., Kazmierczyk, P., Lenzen, M., McNeely, J., Moriguchi, Y.

UNEP (2011); "Towards a Green Economy – Pathways to Sustainable Development and Poverty Eradication"; under www.unep.org/greeneconomy

U.S. Department of Commerce (2010); Measuring the Green Economy; Washington D.C.

Weitzman, M. L. (1997); "Sustainability and Technological Progress", Scandinavian Journal of Economics, 99, 1-13.

World Bank (2002); Adjusted Net Savings; A Manual; World Bank, available (along with recent data) under web.worldbank.org.

Part two: The indicators

Cut-off date

This part is based on information and data available up to the beginning of March 2011.

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

THE SOCIO-ECONOMIC CONTEXT AND CHARACTERISTICS OF GROWTH

Many green growth indicators bear directly on the interaction between economic growth and the environment. In so doing, they provide information on this nexus but for a considered interpretation they should be assessed against countries' socio-economic context. Also, the available detail for indicators is sometimes limited and contextual information then becomes an imperfect yet important substitute. For example, data on environmental pressure is 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.

Employment and developments on labour markets are at the heart of the Green Growth Strategy. The report ***Towards Green Growth*** explores at some detail the links between environmental considerations, the labour market, education, training and skills and provides quantification using an economic model. While such modelling is in the area of research and outside the remit of green growth indicators, the contextual data remains important.

The section at hand provides such context with regard to **economic growth, productivity and competitiveness**, the industry structure of economies, along with key features of the **labour market** that are important to sustain the creation of jobs and facilitate adjustment processes, and some information on demography, health, education and inequality.

ECONOMIC GROWTH, PRODUCTIVITY AND COMPETITIVENESS

PROVIDING CONTEXT THROUGH INDICATORS

The indicators presented here relate to:

Economic growth

- **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, no account is taken of the depreciation of produced asset nor of the depletion of natural assets. However, GDP is the most widely-used measure of economic growth and remains a central variable for macro-economic 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 given value of exports, thereby increasing the purchasing power of nominal income.

Productivity and trade

- Long-term competitiveness, a driver of sustained material living standards and captured by a measure of countries' relative **unit labour costs**. Unit labour costs reflect the combined effects of wage developments and labour productivity. An important source of **labour productivity** is multi-factor 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. **Multi-factor productivity** is often associated with technological change and innovation. One notes that 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.
- **Inflation and commodity prices**: commodity prices are directly related to important natural resources such as minerals or fossil fuels. Prices are powerful signals, in particular 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 environmentally-friendly growth.
- A proxy measure of international price competitiveness in the form of **trade-weighted unit labour costs**. Changes in unit labour costs approximate output price developments as labour accounts for an important share of final output.
- The relative importance of **international trade** in countries' economies. This measure indicates exposure to international competition abroad and domestically.

Measurability and data quality

Data on economic indicators used here are available across 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 robust.

See also *Notes and definitions*.

ECONOMIC GROWTH, PRODUCTIVITY AND COMPETITIVENESS

MAIN TRENDS

Marked differences in growth rates…

Global economic growth has been marked by large differences between countries. The growth in output of BRIICS has by far exceeded the average growth in the OECD area (6% compared to 2% average annual growth, 1990-2009). Strong growth in emerging markets has raised demand for energy, raw materials and intermediate products.

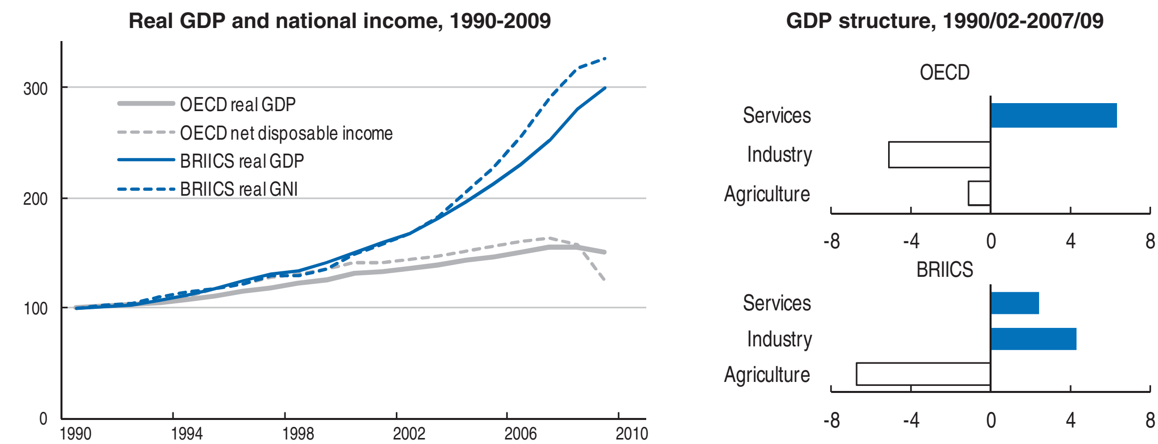
… with changes in the structure of output…

Since 1990, the services sector in the OECD has expanded by more than 6% mainly due to an output contraction of the industrial sector (-5%). Agriculture has accounted for a stable share over the past years.

In contrast to OECD countries, the industrial sector in BRIICS has expanded by more than 4% largely on account of shrinking agriculture sector (-7%) over the same period. This trend is accompanied by a rising importance of the service sector in the Russian Federation, China and India, following income growth and increased participation of countries in global trade.

ECONOMIC GROWTH AND STRUCTURE

GDP and national income, OECD, BRIICS, 1990-2009

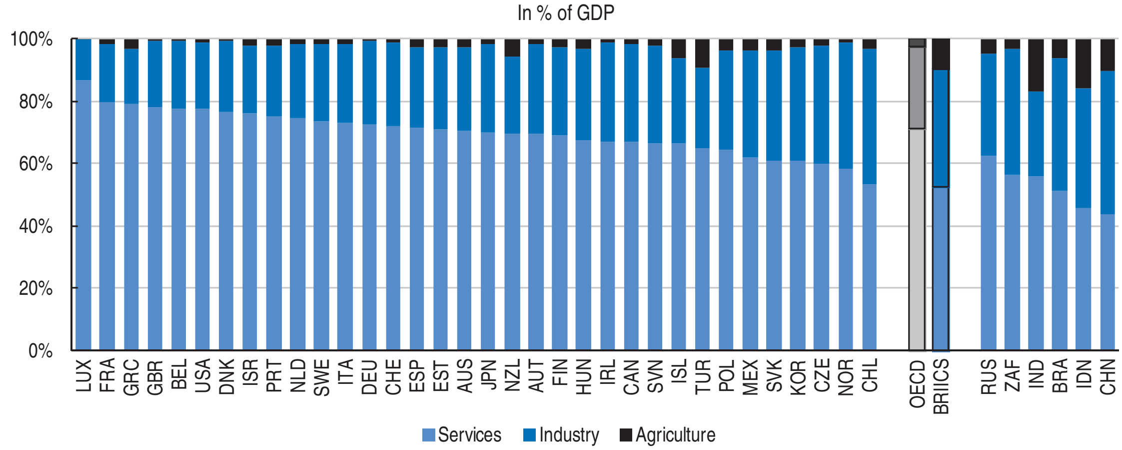


Source: OECD National Accounts; The World Bank World Development Indicators.

StatLink http://dx.doi.org/10.1787/888932425080

GDP structure, OECD countries, BRIICS, 2009

In % of GDP



Source: OECD National Accounts; The World Bank World Development Indicators.

StatLink http://dx.doi.org/10.1787/888932425099

ECONOMIC GROWTH, PRODUCTIVITY AND COMPETITIVENESS

…volatility of commodity prices…

Prices for commodities showed increased volatility and an upward trend since 2000. Volatility of aggregate output is much related to the composition of output. Manufacturing, mining and agriculture are typically 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 orientated towards energy-intensive manufacturing and resource-intensive primary sectors.

… potential displacement effects to BRIICS

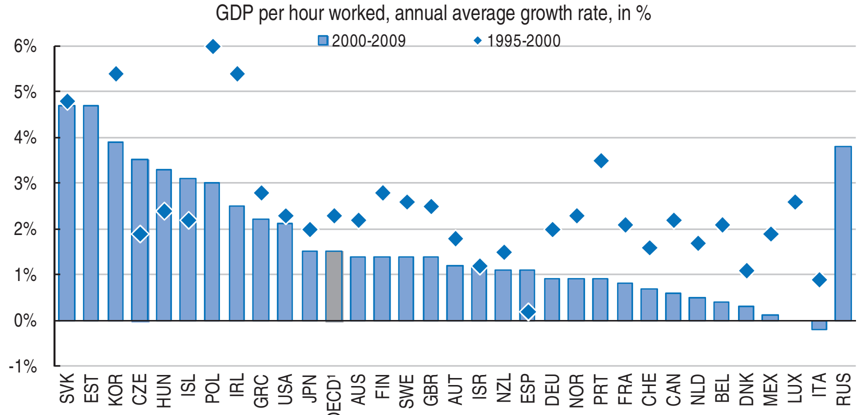
Trade is one of the key contributors to economic growth. The relative importance of trade for countries is correlated with their economic size. Associated with trade and foreign investment are changes in the international chain of value-added and a trend towards greater specialisation. When tasks that are environmentally intensive are picked up by emerging economies, displacement effects may occur showing up in lower environmental productivity in emerging economies than in OECD countries (see the discussion on production and demand-based emissions).

Price competitiveness in international trade (approximated by trade-weighted unit labour costs) has seen significant changes in many countries when the last decade is compared with the 1990s. One factor in the development of unit labour costs is productivity. Multi-factor productivity growth in the past decade tended to be lower than in the period 1995-2000, albeit with large differences between countries.

PRODUCTIVITY

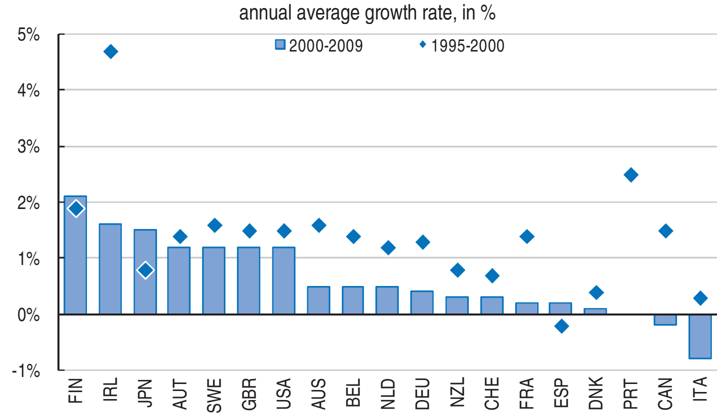
Labour productivity, selected countries, 1995/2000 and 2000/2009

GDP per hour worked, annual average growth rate, in %



Multi-factor productivity, selected countries, 1995/2000 and 2000/2009

annual average growth rate, in %



Source: OECD Productivity Database.

StatLink http://dx.doi.org/10.1787/888932425118

ECONOMIC GROWTH, PRODUCTIVITY AND COMPETITIVENESS

PRICES

Inflation and commodity prices, OECD, world, 1990-2009

Index 1990-100

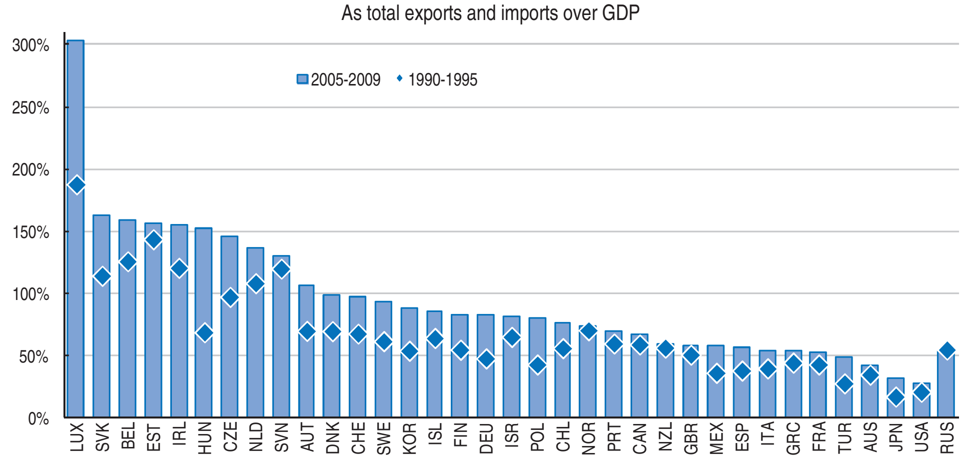
Source: OECD Main Economic Indicators

StatLink http://dx.doi.org/10.1787/888932425137

TRADE

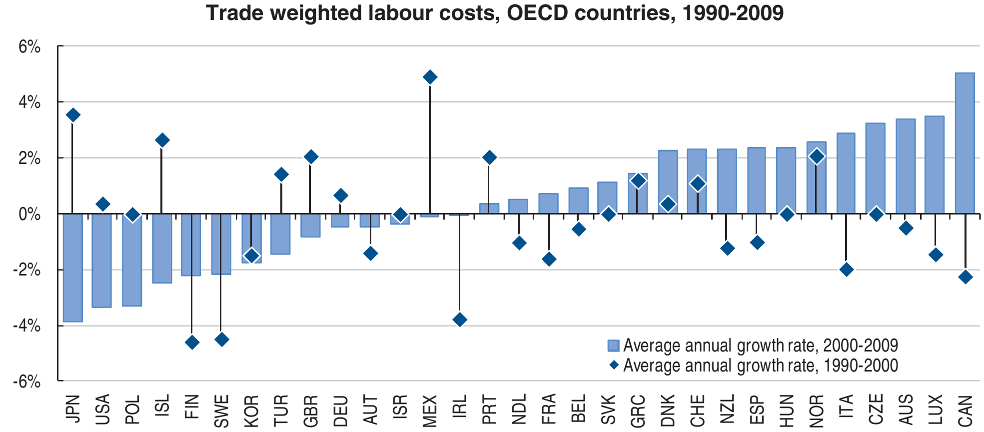
Importance of international trade, OECD countries, 1990/95 and 2005/09

As total exports and imports over GDP



Source: OECD Macro Trade Indicators Database.

Trade weighted labour costs, OECD countries, 1990-2009



Source: OECD Economic Outlook.

StatLink http://dx.doi.org/10.1787/888932425156

LABOUR MARKETS, EDUCATION AND INCOME INEQUALITY

PROVIDING CONTEXT THROUGH INDICATORS

The indicators presented here relate to:

Labour market dynamics

- **Labour force participation** rates, measuring 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.
- **Unemployment** rates which represent the share of people unemployed relative to the persons in the labour force. High and persistent unemployment rates signal an underutilisation of an economy's single most important resource, labour and human capital. By implication, there is an un-exploited growth potential.

Socio-demographic patterns

- **Population density**, the number of inhabitants per square kilometre. While average economy-wide density rates give a first impression of developments, they cannot account for concentration and population density inside a country, in particular the differences between rural and urban areas.
- **Old age dependency ratio**, the number of inhabitants aged 20-64 over the number of inhabitants aged 65 or more.
- Years of **healthy life expectancy** at birth, which refers to the average number of years that a person can expect to live in "full health" by taking into account years lived in less than full health due to disease and/or injury. Health is an essential element of well-being and economic development. Health risks associated with low-quality environmental conditions such as chronic diseases, injuries and infectious diseases reduce people's well-being and impose economic costs on households, companies and governments.
- **Income inequality**, measured by the Gini coefficient bounded between 0 and 1 with higher values related to higher income inequality.
- **Access to education**, an indicator of a country's investment in human capital, is measured by university-level enrolment. The level of education is measured by university-level graduation rate of all students from tertiary-type of programs. Human capital development is a driver of growth in its own right. Education induces behavioural changes and raises skills, including for the adoption and adaption of environmentally-friendly processes, products and technologies.

Measurability and data quality

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.

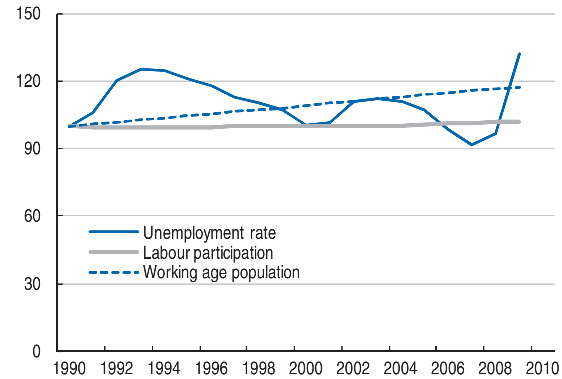
See also *Notes and definitions*.

LABOUR MARKET, EDUCATION AND INCOME INEQUALITY

LABOUR MARKET

Labour market dynamics, OECD, 1990-2009

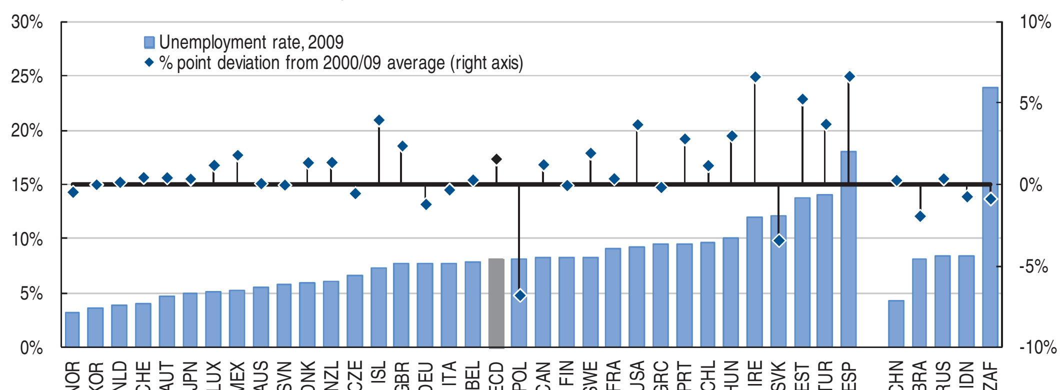
Index 1990=100



Source: OECD Labour Force Statistics and Main Economic Indicators.

StatLink http://dx.doi.org/10.1787/888932425175

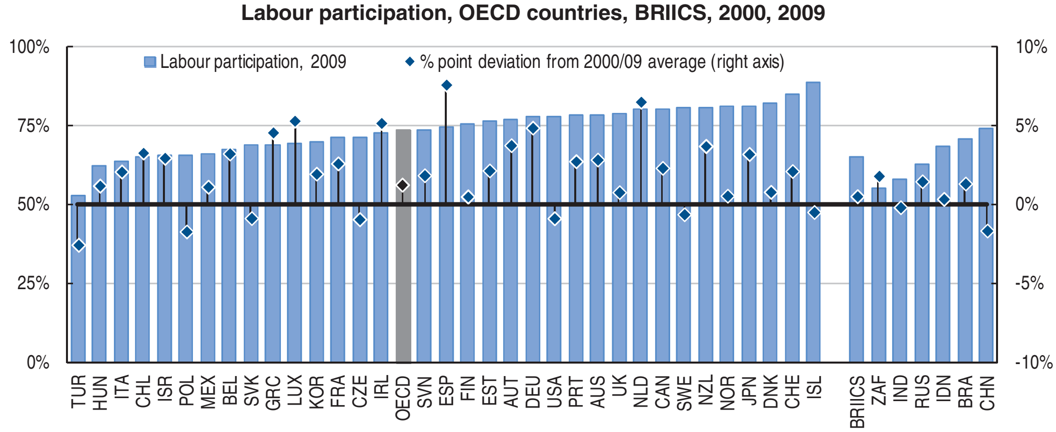
Unemployment rate, OECD countries, BRIICS, 2000 2009



Source: OECD Labour Force Statistics; IMF International Financial Statistics.

StatLink http://dx.doi.org/10.1787/888932425194

Labour participation, OECD countries, BRIICS, 2000, 2009



Source: OECD Labour Force Statistics; World Bank World Development Indicators.

StatLink http://dx.doi.org/10.1787/888932425213

LABOUR MARKETS, EDUCATION AND INCOME INEQUALITY

MAIN TRENDS

Labour demand has adjusted to the output shock…

Labour demand has adjusted to the fall in aggregate demand during the recession, reflected by a hike in the unemployment rate (8.1 % OECD average in 2009). There are still considerable differences across OECD countries with unemployment persisting over a longer time. Labour participation has on average remained stable in the OECD (below 1% deviation in 2009 from 2000/09 trend).

Increasing income dispersion across OECD countries (an average 2% cumulative increase in Gini coefficient since 1985) poses challenges for social policies.

Demographic ageing curbs growth prospects not only in OECD countries, but is also of some concern in emerging economies, for example China.

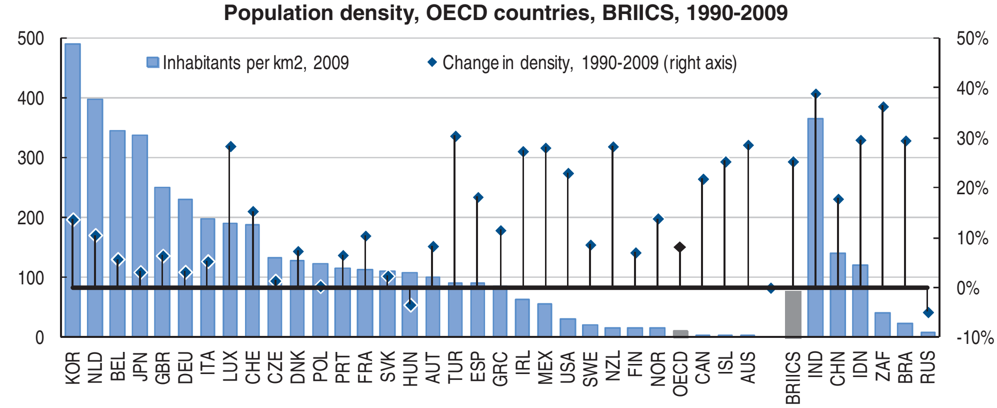
Improving human capital to boost competitiveness by enhancing innovation and absorption capacity

Building human capital through education and training programmes is particularly important. Young people who complete secondary education will likely face fewer difficulties to find work and move to environmentally oriented sectors. The proportion of students graduating from upper secondary programs grew by 7% on average in OECD countries between 1995 and 2008. Entry rates to university level education also rose substantially, by nearly 20%.

On average, graduation rates from university-level education have increased by 21% since the mid 1990s, across OECD countries.

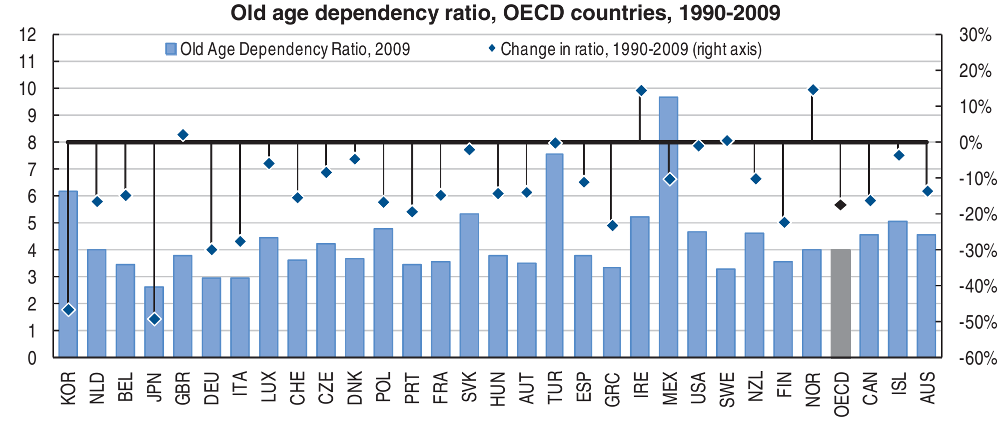
POPULATION TRENDS AND STRUCTURE

Population density, OECD countries, BRIICS, 1990-2009



Source: OECD, FAO.

Old age dependency ratio, OECD countries, 1990-2009



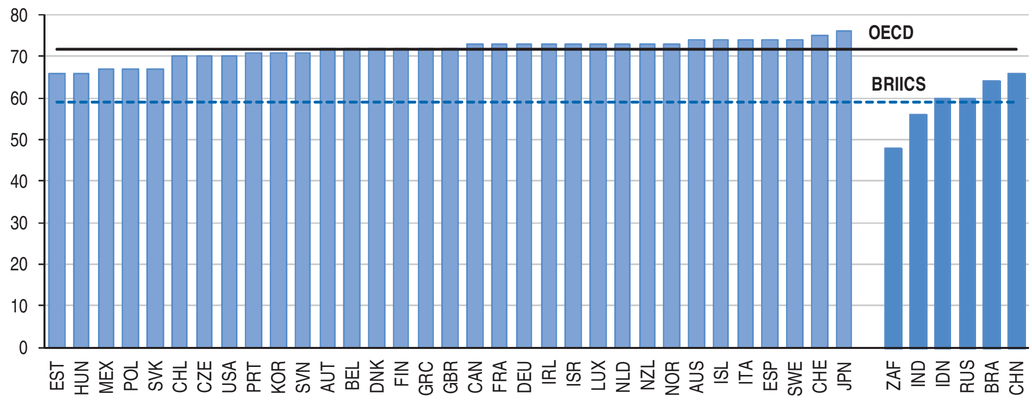
Source: OECD.

StatLink http://dx.doi.org/10.1787/888932425232

LABOUR MARKET, EDUCATION AND INCOME INEQUALITY

HEALTH AND INCOME

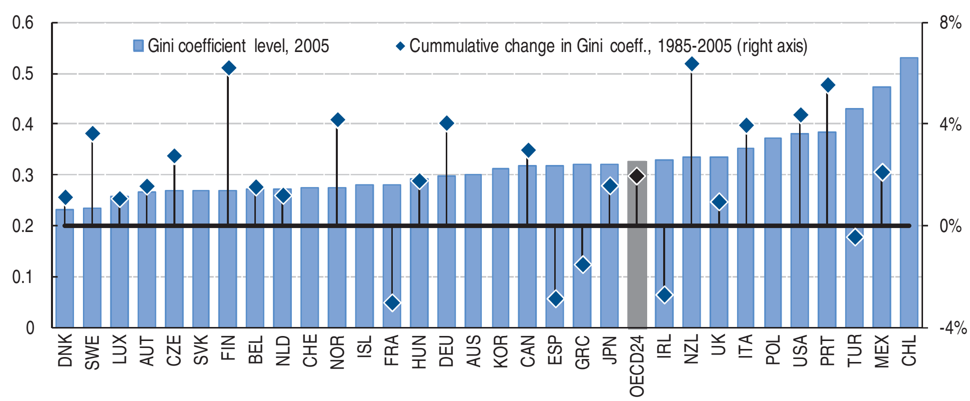
Years of healthy life expectancy at birth, OECD countries, BRIICS, 2007



Source: World Health Organisation.

StatLink http://dx.doi.org/10.1787/888932425251

Income inequality, OECD countries, mid-2000s and change since 1985

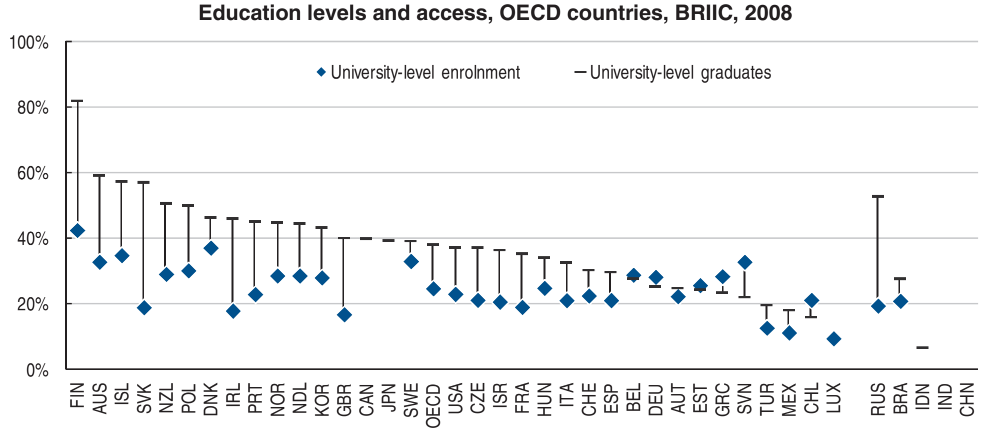


Source: OECD Factbook 2010, OECD (2008), Growing Unequal? Income Distribution and Poverty in OECD Countries.

StatLink http://dx.doi.org/10.1787/888932425270

EDUCATIONAL ATTAINMENT

Education levels and access, OECD countries, BRIIC, 2008



Source: OECD (2010), Education at a Glance 2010: OECD Indicators.

StatLink http://dx.doi.org/10.1787/888932425289

LABOUR MARKET, EDUCATION AND INCOME INEQUALITY

Notes and definitions

GDP

Aggregate real GDP index: based on chained constant USD and constant PPP (base year 2000 for OECD; 2005 for BRIICS). GDP structure: agriculture includes also hunting, forestry and fishing; industry includes manufacturing, mining, energy and construction; services exclude financial intermediation services indirectly measured. The % change refers to the difference between 3-year averages of 2007/09 and 1990/92 to avoid any bias due to potential annual variability of output.

Net disposable and national income

Aggregate net national disposable income: based on chained constant USD and constant PPP (base year 2000 for OECD). Real income has been obtained through deflation with a consumer price index. BRIICS: gross national income, base year 2005.

Trade weighted labour costs

Relative unit labour costs in manufacturing uses 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).

Relative importance of international trade

Indicator calculated as total trade flows, including exports and imports of goods and services, over GDP. The indicator is expressed as the annual average value for the period 2000-2009 and the period 1990-1995. For Australia, Japan, Mexico, New Zealand, Switzerland, United States and Russian Federation, the latest period refers to 2005-2008. For Chile, Estonia and Israel 1990-1995 refers to 1995 data. No data are available for 1990 for Hungary and Slovenia, and for 1990-1992 for the Slovak Republic.

Productivity

Labour productivity is defined as GDP per hour worked, with GDP expressed in national currency, at constant prices, OECD base year for individual countries; and expressed in US dollars, at constant prices, constant PPPs, OECD base year for country groups/zones. Labour input is defined as total hours worked by all persons engaged. Multi-factor 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 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). OECD total: 30 OECD countries.

Prices

Commodity prices refer to prices of primary commodities traded at the world's market. Crude oil price index: based on fob Brent spot price of crude oil. Other commodities: HWWI world price index (HWWI: Hamburg Institute of International Economics).

Labour-markets

The unemployment rate is the ratio of number of persons unemployed and the 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 in percentages. The criteria for a person to be considered as unemployed or employed are defined by the ILO guidelines.

Population density and dependency ratio

Population density expressed as inhabitants per km^2 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. OECD total: 30 member countries. Dependency ratio: Population aged 20-64 over population aged 65+.

Income inequality

Income inequality is measured by Gini coefficient bounded between 0 and 1 with higher values related to higher income inequality. OECD total: 24 OECD countries.

Education

Access to education is measured by university-level enrolment, i.e. enrolment in tertiary-type programs of 20-29 year-olds (% out of 20-29 year-old population). Level of education is measured by university-level graduation rate of all students from tertiary-type of programmes.

Years of healthy life expectancy (HALE)

The HALE refers to average number of years that a person can expect to live in "full health" by taking into account years lived in less than full health due to disease and/or injury.

Sources

- OECD National Accounts; OECD Main Economic Indicators; OECD Labour Force Statistics; OECD International Trade Indicators; OECD Productivity Database: see http://stats.oecd.org/index.aspx?
- OECD (2010) OECD Economic Outlook No 88 - December 2010 - Annual Projections for OECD Countries
- OECD (2010) OECD Employment Outlook 2010
- OECD (2010) OECD Education at Glance 2010
- OECD (2010) Factbook 2010: Economic, Environmental and Social Statistics;
- OECD (2008), Growing Unequal? Income Distribution and Poverty in OECD Countries.
- ILO – Labourstat; IMF International Financial Statistics; World Bank Development Indicators; World Health Organisation.

I

MONITORING 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 its evolution over time and space, and across sectors. Understanding this evolution and the factors that drive these changes, is an essential ingredient in developing green growth policies.

Progress can be monitored by relating the use of environmental services in production (use of natural resources and materials, including energy, generation of pollutants and other residuals) to the output generated and by tracking decoupling in trends of production and environmental services. Decoupling at the national level can partly be explained by displacement effects - such as the substitution of goods or services produced domestically, and requiring high levels of environmental services, with imports - that don't necessarily imply decoupling at the global level. Such shortcomings in production based measures can be addressed by focusing on the evolution of efficiencies, or otherwise, in relation to consumption.

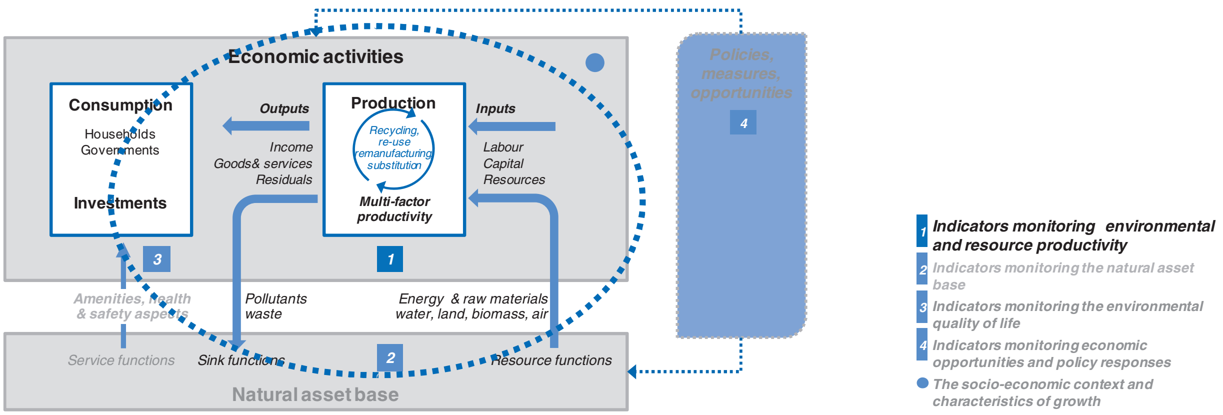
The main issues of importance to green growth include:

- **Carbon and energy productivity** that characterises among others interactions with the climate system and the global carbon cycle, and the environmental and economic efficiency with which energy resources are used in production and consumption, and that inform about the results of policies that promote low carbon technologies and cleaner energy.
- **Resource productivity** that characterises the environmental and economic efficiency with which natural resources and materials are used in production and consumption, and that 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 that reflect among others interactions with nutrient cycles and food production systems.

Other issues of importance include consumer behaviour, and household and government consumption patterns.

ENVIRONMENTAL AND RESOURCE PRODUCTIVITY

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	R	S	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	1	1	S	☑
	1.2. Demand-based CO_2 productivity Real income per unit of energy-related CO_2 emitted	M	1	2	S/M	☑
	2. Energy productivity					
	2.1. Energy productivity (GDP per unit of TPES)	M	2	1	S	☑
	2.2. Energy intensity by sector (manufacturing, transport, households, services)	M	2	1	S/M	☑ selected countries & sectors
	2.3. Share of renewable energy in TPES, in electricity production	M	1	1	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	1	3	M/L	–
	• Domestic material productivity (GDP/DMC) - Biotic materials (food, other biomass) - Abiotic materials (metallic minerals, industrial minerals)	P	1	2	S/M	☑
	3.2. Waste generation intensities and recovery ratios By sector, per unit of GDP or VA, per capita	M	1	1	M/L	☑ municipal waste
	3.3. Nutrient flows and balances (N,P)	M	1	3	L	–
	• Nutrient balances in agriculture (N, P) per agricultural land area and change in agricultural output	P	2	1	S/M	☑
	4. Water productivity VA per unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated)	M	1	1	M	–
Multi-factor productivity	**5. Multi-factor productivity reflecting environmental services** (comprehensive measure; original units in monetary terms)	M	1	2	M/L	–

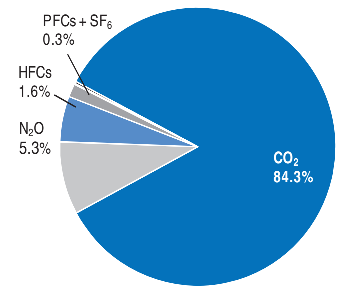
Notes: see Annex page 139.

I.1 CO_2 PRODUCTIVITY

POLICY CONTEXT

The issue

Climate change is a major global issue that could have significant effects on green growth and sustainable development. Main concerns relate to effects of increasing atmospheric greenhouse gas (GHG) concentrations on global temperatures and the earth's climate, and the consequences for ecosystems, human settlements, agriculture and other socio-economic activities that could affect in turn global economic output.



Source: UNFCCC

Main drivers behind climate change and GHG emissions include fuel combustion in economic activities and by households. Major GHG include CO_2, CH_4, N_2O, PFCs, HFCs and SF_6. CO_2 from the combustion of fossil fuels and from biomass is a major contributor to GHG emissions and to the enhanced greenhouse effect. Accounting for over 80% of total GHG emissions it determines the overall trend and is a key factor in countries' ability to deal with climate change. National emissions are further affected by changes in the geography of global demand and supply with increasing trade flows and the relocation of carbon intensive production abroad.

Main challenges

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

With current climate change mitigation policies and the increasing industrialisation of emerging and developing economies, a business-as-usual approach will see global CO_2 and other GHG emissions continue to grow over the next few decades. Progress in stabilising the concentration of GHGs in the atmosphere therefore is dependent on the development of national and international strategies to further decouple CO_2 and other GHG emissions from economic growth. The increasing interdependencies of international production networks and supply chains, requires that such efforts are placed in a global context and build on a good understanding of carbon flows associated with international trade among countries and world regions.

Current policy measures are designed to mitigate GHG emissions by focusing on producers. However, reductions in national emissions can be achieved by offshoring domestic production and, thus, the related emissions. Evidence of decoupling in measures that focus on emissions per unit of GDP or per capita, therefore, may only reveal part of the story; hence the need to focus, in addition, on complementary measures that reflect the impact of consumption on emissions.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed against the emission productivity of production and consumption and the level of decoupling achieved between CO2 and other GHG emissions and economic growth. This can further be related to domestic objectives and international commitments, and to changes in atmospheric concentrations of GHG.

The main international agreement is the United Nations Framework Convention on Climate Change (1992) and its 1997 Kyoto Protocol that established differentiated national or regional emission reduction or limitation targets for six GHG (CO_2, CH_4, N_2O, PFCs, HFCs and SF_6) for 2008-12 with 1990 as the reference year. Recent negotiations in Copenhagen and in Cancun led to progress on, inter alia, goals for emission reductions, including from developing countries; finance; adaptation and "Reducing Emissions from Deforestation and Degradation" (REDD).

I.1 CO_2 PRODUCTIVITY

Indicators of progress

The indicators presented here relate to CO_2 emissions from energy use (fossil fuel combustion). They include:

- Production based CO_2 productivity - GDP generated per unit of CO_2 emitted - and CO_2 intensities per capita for the period 1990 to 2008. The emissions presented here are gross direct emissions, emitted within the national territory and excluding bunkers, sinks and indirect effects. The CO_2 productivity of production informs about the relative decoupling between domestic production and carbon inputs. It also reflects other environmental issues, in particular emissions of greenhouse gases and air pollution that are correlated with the carbon intensity of economic production.
- Demand based CO_2 productivity – the real disposable income generated per unit of CO_2 emitted -for the period 1995 to 2005. Demand based emissions reflect the CO_2 emitted during all of the various stages of production of the goods and services consumed in domestic final demand, irrespective of where the stages of production occurred. Trends in emissions on this basis serve as a diagnostic complement to the more traditional production based measures.

Trends in GHG emissions are given as complements.

Interpretation

These indicators should be read in connection with other indicators and in particular on energy intensity and efficiency, on renewable energy, on energy prices and taxes, and carbon pricing.

Their interpretation should take into account the structure of countries' energy supply, the relative importance of fossil fuels and of renewable energy, trade patterns, as well as climatic factors.

Although the demand perspective is an important addition to the debate on global environmental issues, especially as a supplementary indicator that can explain movements in production based measures, 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 of these factors together; especially the benefits of trade in enabling growth and development.

Measurability and data quality

Data on GHG emissions are reported annually to the Secretariat of the UNFCCC with 1990 as a base year (Annex I countries). Significant progress has been made with national GHG inventories, though data availability over longer periods remains best for CO_2 emissions from energy use.

Continued efforts are being done to further improve national GHG inventories, and in particular to better evaluate sinks and indirect effects and to calculate comparable net GHG emissions for all countries, including non Annex I countries. More needs to be done to monitor the effects of domestic demand and of the use of international transactions and 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 that 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.

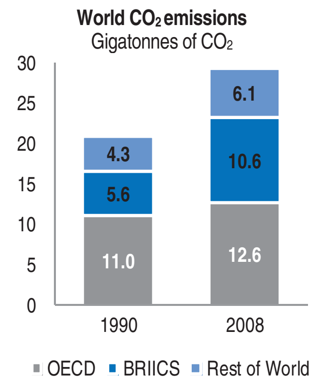
See also *Notes and definitions*.

I.1 CO2 PRODUCTIVITY

MAIN TRENDS AND STRUCTURAL CHANGES IN PRODUCTION BASED EMISSIONS

Relative decoupling

CO_2 and other GHG emissions are still growing in many countries, despite some progress achieved in decoupling domestic CO_2 emissions from GDP growth (relative decoupling), and improvements in energy efficiency.



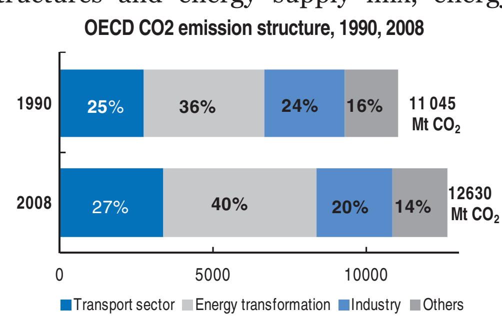
Source: IEA.

Overall, CO_2 emissions from energy use have grown more slowly in OECD countries as a group than they have world-wide and in developing countries. This trend was emphasised in the recent years by the rapid economic growth of Asian countries and of the BRIICS.

Individual OECD countries' contributions to the greenhouse effect, and rates of progress towards stabilisation, vary significantly, regardless of whether they are considered in absolute numbers, per capita amounts, or through carbon productivity.

Important variations across countries

CO_2 emissions from energy use continue to grow, particularly in the OECD Asia-Pacific region and North America. This can be partly attributed to energy production and consumption patterns and trends, often combined with overall low energy prices. In OECD Europe, CO_2 emissions from energy use stay more or less stable due to changes in economic structures and energy supply mix, energy savings, implementation of policies and, in some countries, of decreases in economic activity.



Source: IEA.

Important variations across sectors

Disaggregating the emission estimates shows substantial variations within individual sectors. Between 1990 and 2008, the combined share of electricity and heat generation and transport has continued to grow and now represents more than two-thirds of the total (67%).

... AND IN DEMAND BASED EMISSIONS

Overall trends

Total emissions generated to satisfy domestic demand (final consumption plus investment) in OECD countries rose quicker than emissions related to production only. The converse holds in particular for large emerging economies. This reflects a host of factors, including trends in the international specialisation in production and relative comparative advantages of different countries. It should be emphasised here that the estimates obtained are not "leakage" estimates obtained from a model (replete with assumptions about how actors may react to a price change); these are estimates based on observed trends in production, consumption and trade patterns.

Important variations across world regions

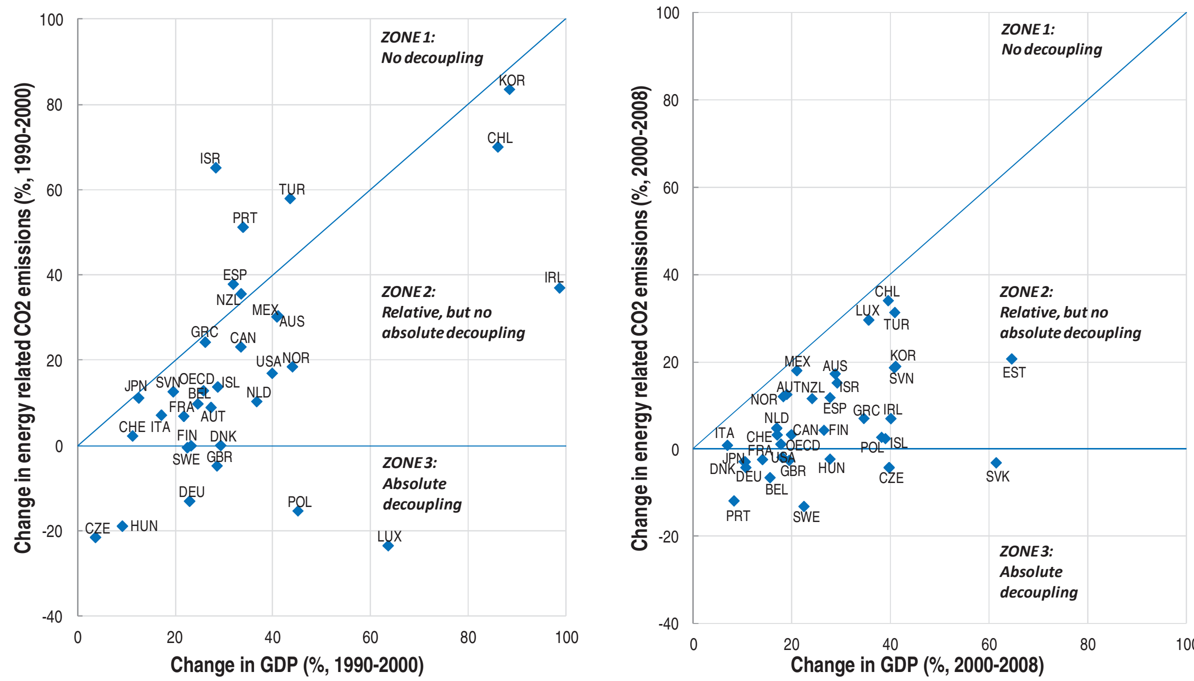
The relative decoupling of demand-based emissions from income is much less prevalent than on production side, which can be partly explained by displacement of domestic production by imports. For example, in many OECD countries the increase in GDP per unit of CO_2 emitted is at least partly explained by imports of goods with a relatively high carbon footprint from other countries, notably China.

I.1 CO2 PRODUCTIVITY

DECOUPLING TRENDS: PRODUCTION BASED CO_2 EMISSIONS

Change in production-based CO2 emissions versus change in GDP, OECD countries

1990-2000 | 2000-2008



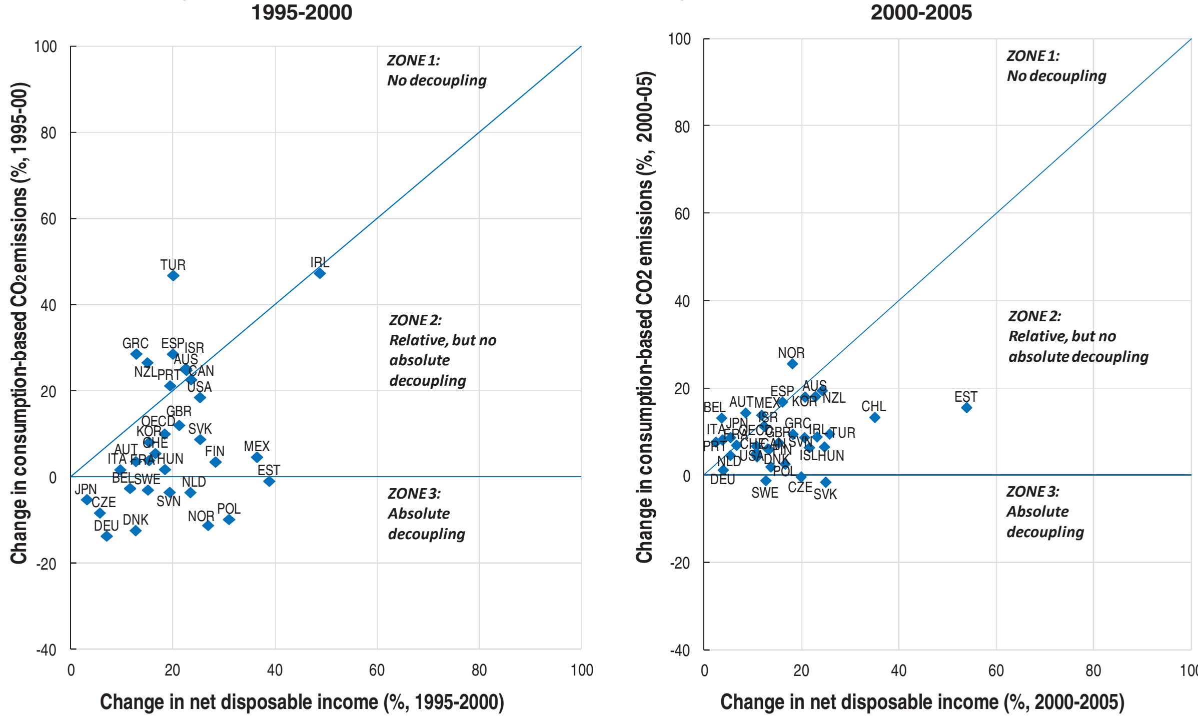
Source: OECD.

StatLink http://dx.doi.org/10.1787/888932425308

DECOUPLING TRENDS: DEMAND BASED CO_2 EMISSIONS

Change in demand-based CO2 emissions versus change in disposable income, OECD countries

1995-2000 | 2000-2005



Source: OECD

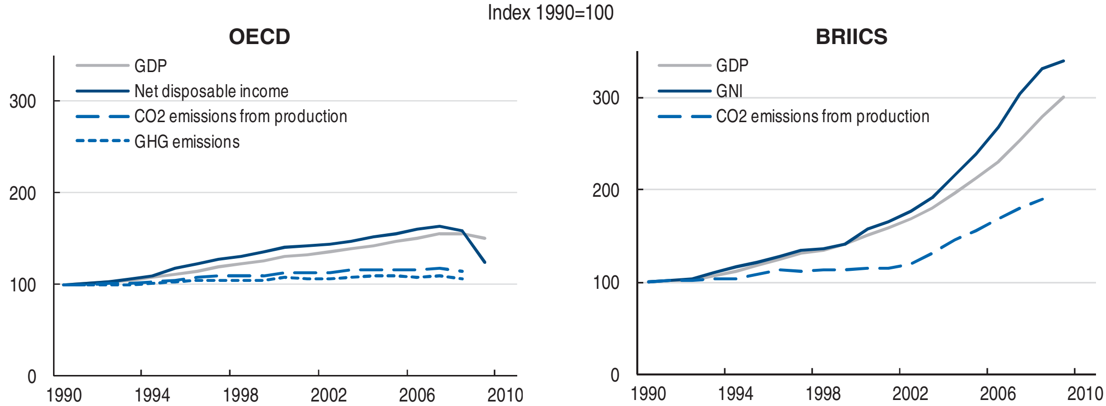
StatLink http://dx.doi.org/10.1787/888932425327

I.1 CO2 PRODUCTIVITY

DECOUPLING TRENDS: PRODUCTION BASED CO2 AND GHG EMISSIONS

CO_2 and GHG emissions versus GDP and real income, OECD, BRIICS, 1990-2008

Index 1990=100



* CO2: data refer to emissions from energy use (fossil fuel combustion).

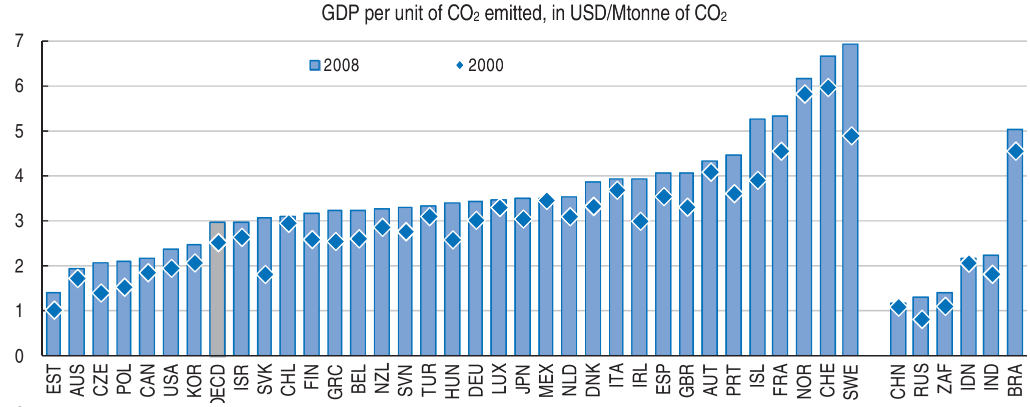
Source: OECD, IEA, UNFCCC.

StatLink http://dx.doi.org/10.1787/888932425365

PRODUCTION BASED CO_2 PRODUCTIVITY AND INTENSITY

Energy related CO_2 emission productivity, OECD countries, BRIICS, 2000, 2008

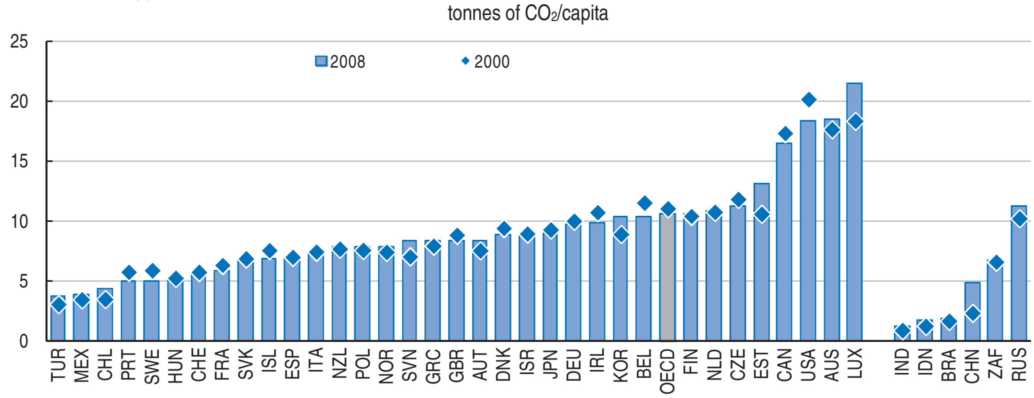
GDP per unit of CO_2 emitted, in USD/Mtonne of CO_2



Source: OECD, IEA.

Energy related CO_2 emission intensities per capita, OECD countries, BRIICS, 2000, 2008

tonnes of CO_2/capita



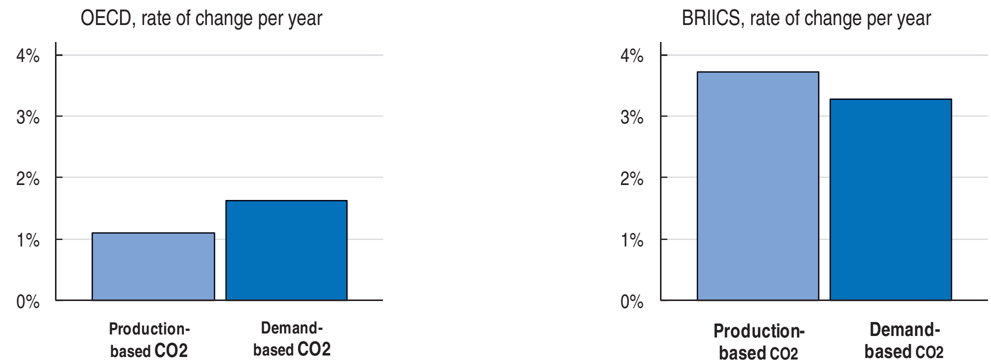
Source: OECD, IEA.

StatLink http://dx.doi.org/ http://dx.doi.org/10.1787/888932425346

I.1 CO2 PRODUCTIVITY

PRODUCTION VERSUS DEMAND BASED EMISSIONS

Change in production- and demand-based CO_2 emissions, OECD, BRIICS, 1995-2005



Source: OECD, IEA

StatLink http://dx.doi.org/10.1787/888932425384

Notes and definitions

Production-based CO2 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 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 CO2 emissions embodied in final domestic demand are calculated by the OECD using a combination of input-output tables, bilateral trade data and production based CO2 emissions, described above. The approach uses the bilateral trade data in conjunction with national input-output tables for 47 countries - responsible for 95% of global GDP and over 85% of global CO_2 emissions (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 with its final purchaser. Emissions from bunkers and fugitive emissions from fuel extraction are excluded.

Gross domestic product and net disposable income

Real gross domestic product (GDP, expenditure approach) and net national disposable income for the OECD countries are for comparative purposes expressed in constant US$ prices at PPPs (base year 2000). The aggregate volumes for real GDP and gross national income for BRIIC countries (i.e. Brazil, Russian Federation, India, Indonesia, China) are in constant US$ prices at PPPs (base year 2005).

Sources

- IEA (2010), CO2 Emissions from Fuel Combustion: 2009 Edition, IEA, Paris. www.iea.org/co2highlights/co2highlights.xls
- IEA (2010), World Energy Outlook 2009, IEA, Paris.
- OECD (2011) Demand based carbon dioxide emissions, OECD Statistics Working Paper, Paris, forthcoming
- UNFCCC, Greenhouse gas inventory data, http://unfccc.int/ghg_data/items/3800.php

Further information

- ECMT (2007), Cutting Transport CO2 Emissions: What Progress?, ECMT, Paris.
- IEA (2008), CO2 Capture and Storage: A Key Carbon Abatement Option 2008, IEA, Paris.
- IEA (2009), IEA Scoreboard 2009: 35 Key Energy Trends over 35 Years, IEA, Paris.
- IEA (2009), Transport Energy and CO2: Moving towards Sustainability, IEA, Paris.
- OECD (2003) Carbon dioxide emissions embodied in international trade in goods, OECD STI Working Paper, 2003/15, Paris
- OECD (2008), Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments, OECD, Paris.
- WMO, UNEP, OECD, IEA (1996), Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC/OECD/IEA, Paris.

I.2 ENERGY PRODUCTIVITY AND RENEWABLES

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.

Energy production and use have environmental effects that differ greatly by energy source. Main concerns relate to the effects on greenhouse gas emissions and on local and regional air pollution. Other effects involve water quality, land use, risks related to the nuclear fuel cycle and risks related 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 other challenges such as energy security.

Main challenges

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

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed against the energy productivity of the economy and against domestic objectives such as energy intensity or energy efficiency targets, and targets concerning the share of renewable energy sources. Progress can further be assessed against international environmental commitments that have direct implications for domestic energy policies and strategies (e.g. UNFCCC).

Indicators of progress

The indicators presented here relate to:

- Energy productivity and energy intensity by sector (manufacturing, freight transport, passenger transport). Energy productivity, expressed as GDP per unit of total primary energy supply (TPES), and intensities per capita, may reflect, at least partly, efforts to improve energy efficiency and to reduce carbon and other atmospheric emissions. They also reflect structural and climatic factors (see "*Interpretation*" below). The structure of energy supply is given as a complement.
- Share of renewables in TPES and in electricity production. The energy mix, i.e. the structure of energy supply, in terms of primary energy source as a % of TPES or of total electricity generation is closely related to consumption and production patterns and to environmental effects. Renewables are also used in heat generation. Main sources of renewable energy are combustible renewables (mainly wood) and waste, hydro, geothermal, wind and solar energy.

Interpretation

These indicators should be read in connection with other indicators and in particular with indicators on CO_2 productivity and intensities, on R&D and patents related to energy efficiency and renewable energy, on energy prices and taxes for households and industry, and on carbon pricing. They should further be complemented with information on energy-related air and water emissions and waste generation.

When interpreting these indicators, it should be kept in mind that energy productivity and intensities reflect structural and climatic factors as well as changes in energy efficiency, and should not be used to assess how efficient the use of energy is in a country.

- The energy productivity of an economy is a measure of how much national revenue is generated for each unit of energy used.

I.2 ENERGY PRODUCTIVITY AND RENEWABLES

- Efficiency is a contributing factor in productivity, but many other elements – often more significant – need also be considered. These include: the structure of the economy (presence of large energy-consuming industries, for instance); the size of the country (higher demand from the transport sector); the climate (higher demand for heating or cooling).

Cross country comparisons need to take into account countries' endowment in different types of energy resources.

Measurability and data quality

Data on total energy supply and consumption are available from international sources (IEA) for all OECD countries and other countries in the world. Efforts are being made by the IEA to further develop appropriate measures of energy efficiency and to improve the mandatory reporting of energy efficiency-related data.

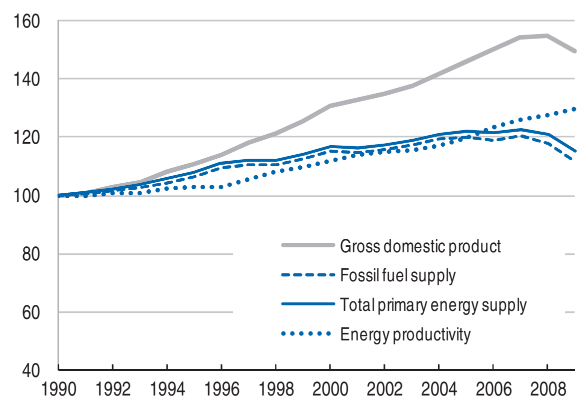
MAIN TRENDS AND STRUCTURAL CHANGES

Relative decoupling

While some decoupling of environmental effects from growth in energy use has been achieved, results to date are insufficient and the environmental implications of increasing energy use remain a major issue in most OECD countries. Progress in per capita terms has been slow, reflecting an overall increase in energy supply and increasing energy demands for transport activities.

Total primary energy supply versus GDP, OECD, 1990-2009

Index 1990=100



Source: OECD, IEA.

Important variations across countries and world regions

During the past two decades, energy productivity has generally increased in the OECD, but at a slower pace than during the 1980s. While in the first half of the 1990s, energy productivity did not improve in most countries, due to decreasing prices for energy resources (oil, gas, etc.), it improved slightly as of the second half of the 1990s as a consequence of structural changes in the economy, energy conservation measures, and in some countries decreases in economic activity.

Variations in energy productivity and intensity among OECD countries are wide and depend on national economic structure, geography (e.g. climate), energy policies and prices, and countries' endowment in different types of energy resources.

Important variations in the fuel mix

The supply structure varies considerably among countries. It is influenced by demand from industry, transport and households, by national energy policies and by national and international energy prices. During the 1990s, growth in total primary energy supply was accompanied by changes in the fuel mix: the shares of solid fuels and oil fell, while those of gas and other sources, including renewable energy sources, rose.

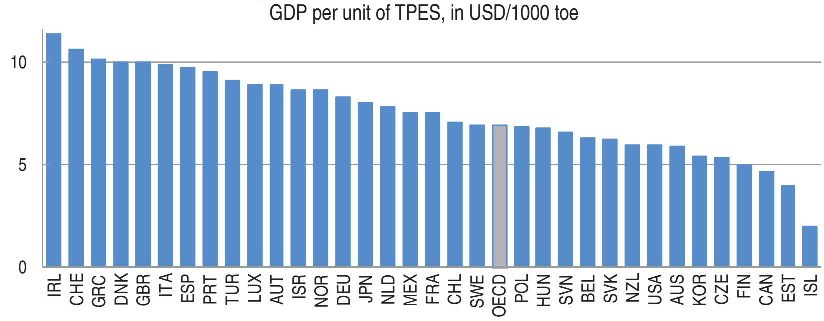
Energy end-use intensities

In the residential sector, there is still ample room for further efficiency gains. However, it is worth noting that differences in future demographic and income trends across OECD countries could spur the efficiency gains as measured in relative terms per capita or income levels. Space heating still accounts for more than half of household energy consumption in OECD countries; however the share of appliances is quickly growing.

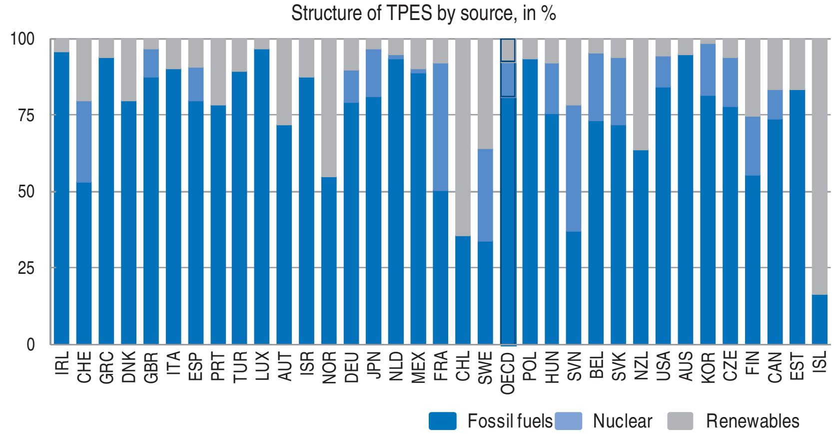
I.2 ENERGY PRODUCTIVITY AND RENEWABLES

ENERGY PRODUCTIVITY AND STRUCTURE

Energy productivity, OECD countries, 2009
GDP per unit of TPES, in USD/1000 toe



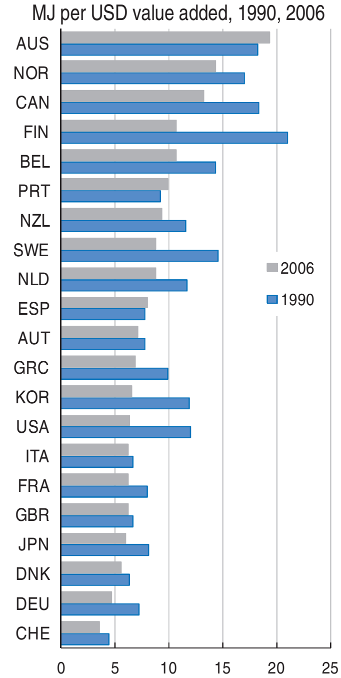
Energy mix, OECD countries, 2009
Structure of TPES by source, in %



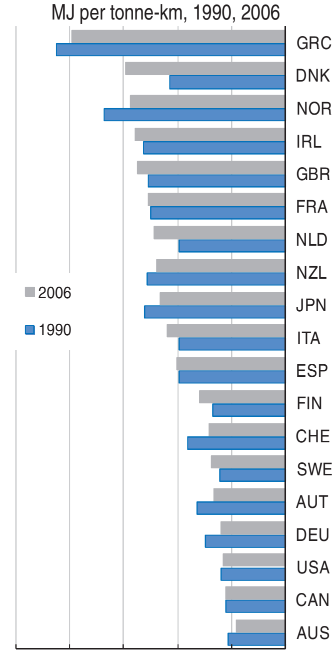
Source: OECD, IEA.

ENERGY INTENSITIES BY END-USE OR SECTOR

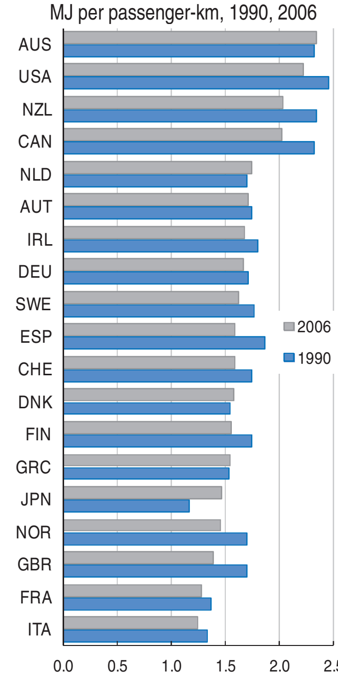
Manufacturing energy intensity
MJ per USD value added, 1990, 2006



Freight transport energy intensity
MJ per tonne-km, 1990, 2006



Passenger transport energy intensity
MJ per passenger-km, 1990, 2006

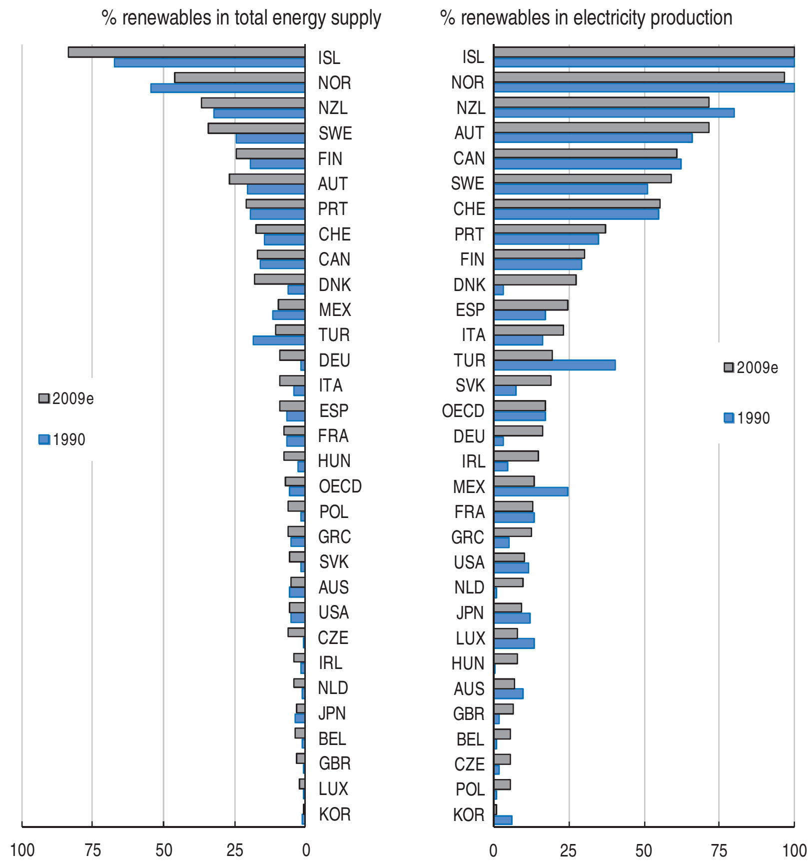


Source: IEA Scoreboard.

I.2 ENERGY PRODUCTIVITY AND RENEWABLES

SHARE OF RENEWABLE ENERGY

Share of renewable energy in energy use, OECD countries, 1990, 2009



Source: OECD-IEA.

Some increase in the share of renewables

Several OECD countries have made progress in promoting renewables in their energy mixes. Overall, the share of renewable energy has remained relatively stable for the OECD and accounts for about 7% of total supply, with a slight increase in recent years reflecting the growing role of bioenergy, liquid biofuels and wind in some countries. Biomass and hydro still represent the largest shares. Many obstacles remain and greater efforts are needed in terms of implementation of effective policies and technology improvement.

Despite the growth of electricity generation from renewable sources in absolute terms since 1990, its share in total electricity generation decreased for the OECD as a whole until 2001. During this period growth of renewables did not keep pace with growth of electricity generation from fossil fuels and nuclear. Since 2001 the trend is reversing: renewable electricity shares have been slightly increasing (reaching 17% in 2009), mainly thanks to government policies supporting the deployment of wind – and, to lesser extent, of biomass and solar.

The challenge in electricity generation is essentially about improving the cost-effectiveness of existing low-carbon technologies and putting in place the policies that enable their deployment. Because new capital investments in more energy-efficient technologies usually represent only a small fraction of the total capital stock, the gains from new technologies will only be gradual (see section on *technology & innovation*).

I.2 ENERGY PRODUCTIVITY AND RENEWABLES

Notes and definitions

Total primary energy supply and productivity

Total primary energy supply (TPES) equals production plus imports minus exports minus international marine and aviation bunkers plus or minus stock changes. The world total, international marine and aviation bunkers are not subtracted from TPES. Energy productivity is calculated as the amount of revenue (GDP here) generated per unit of energy used (TPES here).

Energy use by sector and end-use

These indicators, developed from an updated and expanded IEA database, describe energy use across three main end-use sectors in IEA countries: manufacturing (in megajoule per USD of value added), passenger transport (in megajoule per passenger-km) and freight transport (in megajoule per tonne-km). These indicators make it possible to examine how changes in energy efficiency, economic structure, income, prices and fuel mix have affected recent trends in energy use and CO_2 emissions.

Share of renewable energy sources in TPES and in electricity generation

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

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 wastes, and sulfite lyes (i.e. black liquor). Municipal waste comprises wastes produced by the residential and commercial and public service sectors (which are collected by local authorities for disposal in a central location for the production of heat and/or power).

N.B. The methodology used to calculate the TPES correspondent to a given amount of final energy has important implications on the respective 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.

Sources

- IEA (2010), Energy Statistics of OECD Countries, 2010, IEA, Paris.
- IEA (2010), World Energy Outlook 2010, IEA, Paris.
- IEA (2009), Energy Balances of Non-OECD Countries, IEA, Paris.
- IEA (2009), Energy Balances of OECD Countries, IEA, Paris.
- IEA (2009), Renewables Information, 2009, IEA.
- IEA (2009), IEA Scoreboard 2009: 35 Key Energy Trends over 35 Years, IEA, Paris.

Further information

- IEA (2009), Energy Technology Transitions for Industry: Strategies for the Next Industrial Revolution, IEA, Paris.
- IEA (2009), Sectoral Approaches in Electricity – Building Bridges to a Safe Climate, IEA, Paris.
- IEA (2009), Towards a More Energy Efficient Future: Applying Indicators to Advance Energy Policy, IEA, Paris.
- IEA (2008), Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis, IEA, Paris.
- IEA (2007), Energy Use in the New Millennium, Trends in IEA Countries, IEA, Paris.

Methodological publications

- Energy Statistics Manual, IEA, OECD, Eurostat

I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

POLICY CONTEXT

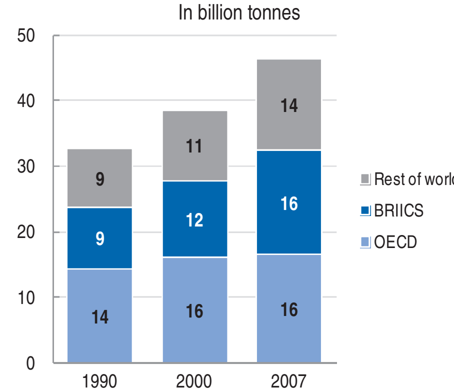
The issue

Economic growth is generally accompanied by growing demand for raw materials, energy and other natural resources with consequences on market prices and on trade flows of these resources.

Worldwide use of virtually every significant material has been rising over 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. At the same time, the amount of waste generated by economic activity has been rising in line with growing global demand for raw materials. Despite achievements in waste recycling and some relative decoupling of waste generation from economic growth, many valuable materials contained in waste continue to be disposed of and are potentially lost for the economy. This affects both the efficiency of material use and environmental quality in terms of land use, water and air pollution, and greenhouse gas emissions.

OECD countries represent one third of the world extraction of non-energy materials

In billion tonnes



Source: SERI.

The use of materials from natural resources and the attendant production and consumption processes have many economic, social and environmental consequences that often extend beyond the borders of single countries or regions. Ensuring that the flows of materials are managed in an effective and sound way through the economic system is thus critical, not only from an environmental perspective but also from an economic and trade perspective. 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.

Main 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, transportation, consumption, and 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 also implies internalising the costs of waste management into prices of consumer goods and of waste management services; and ensuring greater cost-effectiveness and full public involvement in designing measures.

I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be in part assessed against changes in the extraction of resources and domestic consumption of materials, and in the associated material productivity. These indicators complement existing productivity measures and hence facilitate the analysis related to economic output (value added) per amount of material resources used.

Indicators of progress

The indicators presented here relate to:

- Material extraction, i.e. domestic extraction "used" (DEU), expressed in absolute terms, and related changes for individual material groups and for aggregates. The focus is on non-energy materials.
- Material consumption, i.e. domestic material consumption (DMC), expressed in absolute terms, and related productivity ratios for individual material groups and for aggregates. Productivity is expressed as the amount of economic output generated for a unit of materials consumed. The focus is on non-energy materials.

Trends in municipal waste generated are given as a complement. While municipal waste is only one part of total waste generated, its management represents more than one third of the public sector's financial efforts to abate and control pollution.

Interpretation

These indicators should be read with information on commodity prices, flows of secondary raw materials and recovery ratios, waste management practices and costs, and consumption levels and patterns. Cross-country comparisons should also take into account countries' endowments in natural resources and the structure of their economy.

When interpreting these indicators, it should be kept in mind that they are first approximations of potential environmental pressure; more information is needed to describe the actual pressure.

Measurability and data quality

Material flows: A considerable amount of work on MFA has been carried out in the past decade, much of it focusing on the development of methodologies and the necessary "spade work" to set up accounts required for calculating material flow (MF) indicators. More needs to be done to:

- Capture flows that do not enter the economy as transactions, but that are relevant from an environmental point of view.
- Monitor physical trade flows by origin and destination.
- Measure indirect flows (domestic and trade related) and develop common conversion factors and coefficients.
- Monitor flows of secondary raw materials (recycled, reused) and of recyclable materials.
- Develop methods to assess the environmental impacts of materials use.
- Provide industry-level and material-specific information to indicate opportunities for improved performance and efficiency gains.

Waste: Despite considerable progress, data on waste generation and disposal remains weak in many countries. Further efforts are needed to:

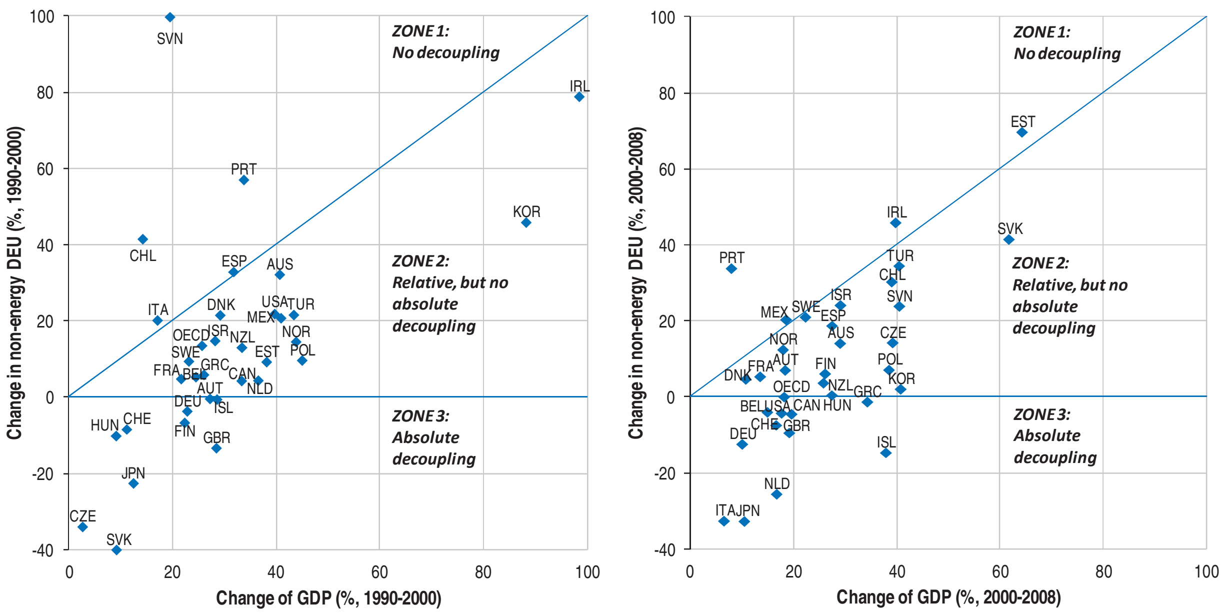
- Ensure an appropriate monitoring of all waste flows and of related management practices.
- Improve the international comparability of the data.
- Fill data gaps with respect to waste prevention measures and other measures related to the 3Rs (reduce, reuse, recycle).

I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

DECOUPLING TRENDS: MATERIAL EXTRACTION

Non-energy material extraction versus GDP, OECD countries, 1990-2008

1990-2000 **2000-2008**



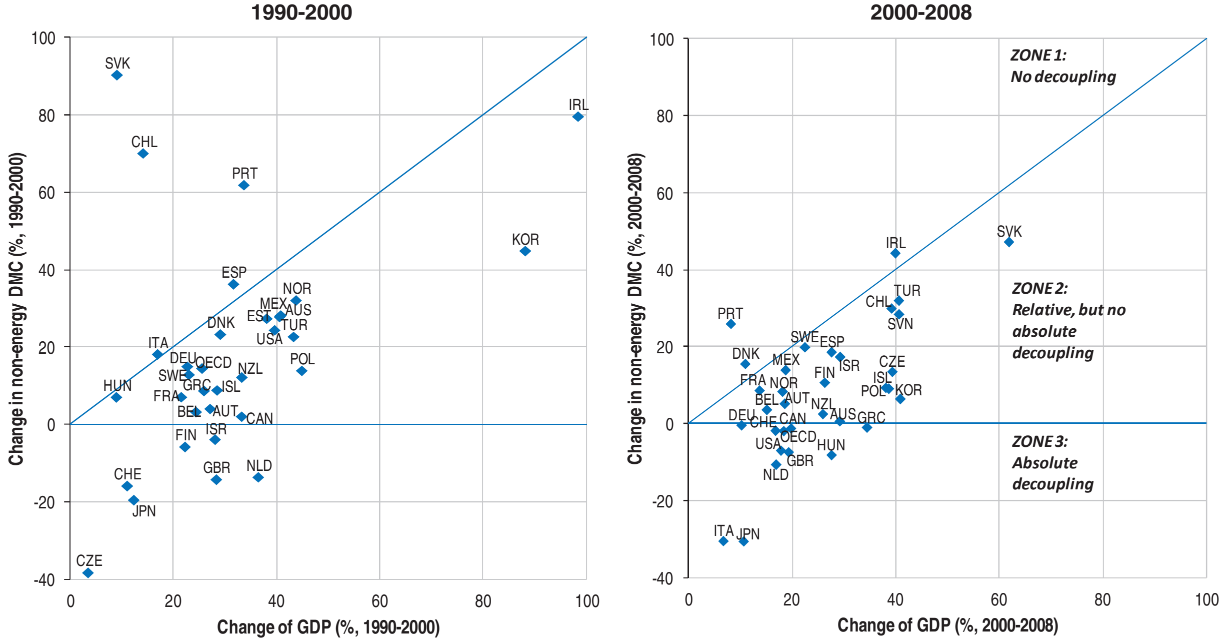
Source: OECD Material Flow Database.

StatLink http://dx.doi.org/10.1787/888932425403

DECOUPLING TRENDS: MATERIAL CONSUMPTION

Non-energy material consumption versus GDP, OECD countries, 1990-2008

1990-2000 **2000-2008**



Note: Not presented in the chart is Slovenia, its DMC increased by 108% and GDP by 20% from 1990 to 2000.

Note: Not presented in the chart is Estonia; its DMC increased by 140% and GDP by 64% from 2000 to 2008.

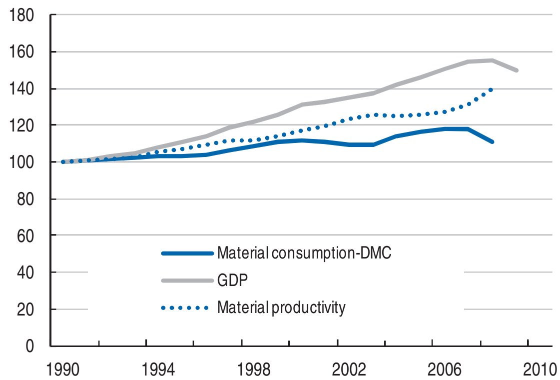
Source: OECD Material Flow Database.

StatLink http://dx.doi.org/10.1787/888932425422

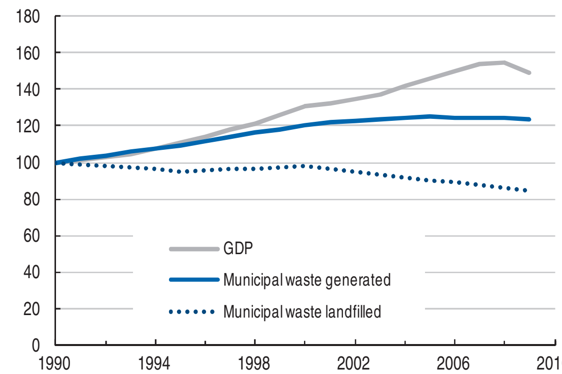
I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

DECOUPLING TRENDS: MATERIAL CONSUMPTION AND WASTE

Domestic material consumption versus GDP, OECD, 1990-2009
Index 1990=100



Municipal waste generation versus GDP, OECD 1990-2009
Index 1990=100

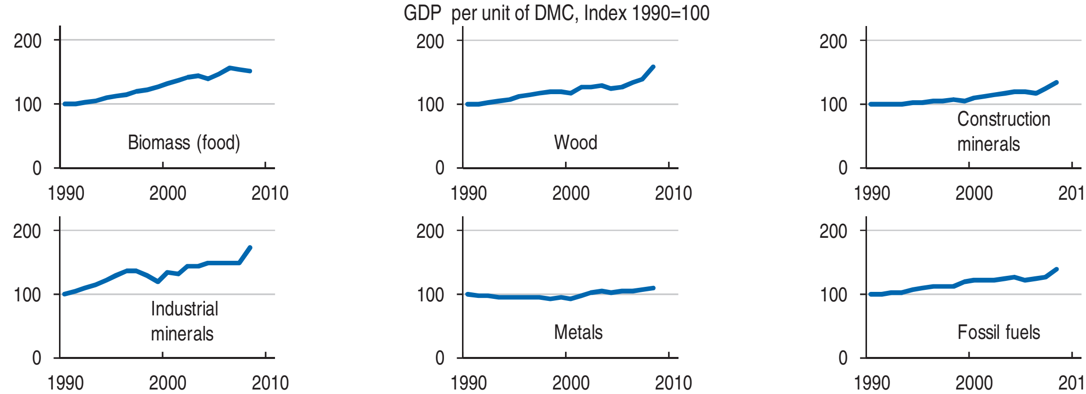


Source: OECD Material Flow database; OECD Environmental Data.

StatLink http://dx.doi.org/10.1787/888932425441

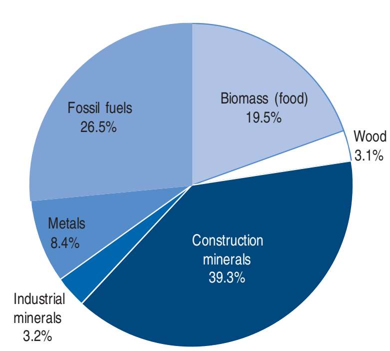
MATERIAL PRODUCTIVITY BY GROUP AND MATERIALS MIX

Material productivity by material group, OECD
GDP per unit of DMC, Index 1990=100

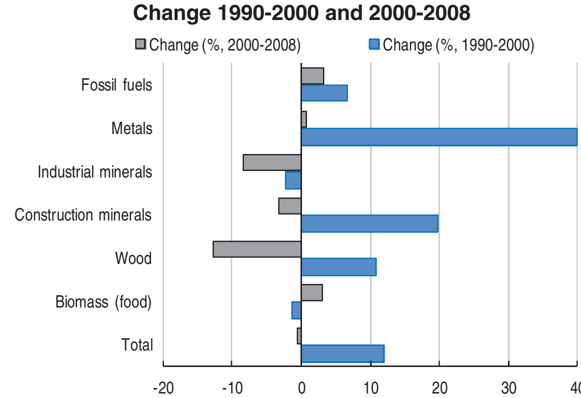


Composition of domestic material consumption (DMC) and change since 1990, OECD

State 2008



Change 1990-2000 and 2000-2008



Source: OECD Material Flow database

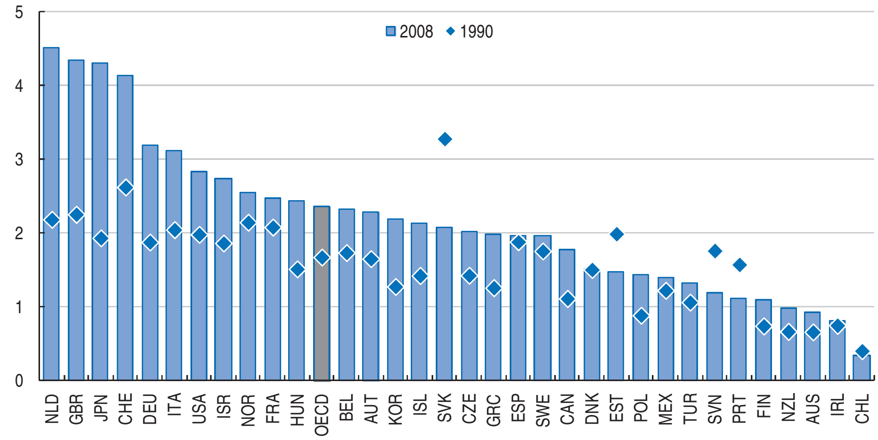
StatLink http://dx.doi.org/10.1787/888932425460

I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

DOMESTIC MATERIAL PRODUCTIVITY

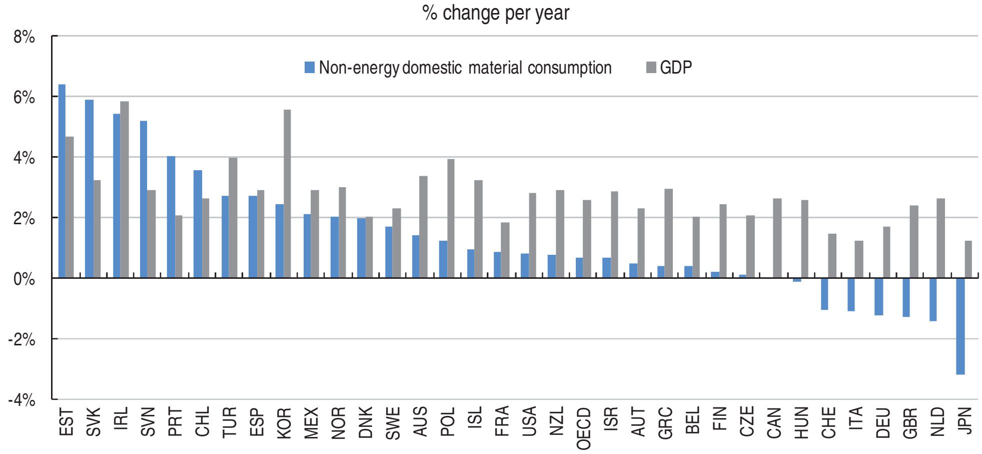
Non-energy domestic material productivity, OECD countries, 1990, 2008

GDP per unit of domestic material consumption (DMC), in USD/1000 tonnes



Change in non-energy domestic material consumption (DMC) and GDP, OECD countries, 1990-2008

% change per year



Source: OECD Material Flow database

StatLink http://dx.doi.org/10.1787/888932425479

MAIN TRENDS

Continued growth in consumption

Since 1990 the extraction and consumption of raw materials has continued to expand in OECD countries, although growth has slowed significantly compared to the previous decade. Abiotic materials (i.e. minerals, metals, fossil energy carriers) account for a dominant and growing share of consumption thanks in large part to strong growth in the consumption of construction minerals, which dominate the material mix. In 2008 abiotic materials represented nearly 80% of consumption with biotic materials (i.e. food, feed, wood and wood fibre) making up slightly over 20%.

Material consumption in OECD countries reached almost 22 Gt in 2008 meaning that the average person living in an OECD country consumed 18t of raw materials per year or roughly 50 kg of materials per day. Notwithstanding wide variation in per capita consumption level between member countries, people living in OECD countries, on average, consume significantly more than those in non-OECD countries. In 2007, per capita consumption in OECD economies was more than double the world average and three times greater than in non-OECD economies.

Excluding the fossil energy carriers from the material composition, non-energy domestic material consumption grew by 13% between 1990 and 2008.

I.3 RESOURCE PRODUCTIVITY: MATERIAL PRODUCTIVITY

Relative decoupling

The efficiency which with individual OECD countries use raw materials varies significantly, regardless of whether considered in absolute numbers, per capita amounts, or in terms of productivity. Although growing in absolute terms, progress has been made in decoupling material consumption from economic growth in relative terms. Material productivity in OECD economies is improving as more economic output (i.e. GDP) is being generated for each unit of raw material consumed. From 1990 to 2008, the non-energy material productivity of OECD economies increased from 1.7 USD/kg (constant 2005 PPP) to 2.3 USD/kg due to strong economic growth that outpaced growth in material consumption

These trends reflect to a certain degree efficiency gains in production processes, but other factors have to be taken into account, such as changes in the materials mix and substitution of domestic production by imports of intermediate and final goods.

Relative decoupling has been witnessed across all major material groups, but some absolute decoupling has also occurred for industrial minerals and metals in recent years. This trend is promising given growing supply security concerns and the amount of unused materials and waste associated with mining activities. Another pressing challenge remains fossil energy carriers, where a significantly lower degree of decoupling has taken place, given their importance for energy security and climate change (see section on *energy productivity and renewables*).

Notes and definitions

Material extraction

The most commonly used material extraction indicator is domestic extraction used (DEU). 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 the other, and are usually of economic value.

Material consumption

Domestic material consumption measures the total amount of materials used in an economy and is calculated as domestic extraction (used materials) minus export plus imports. Internationally comparable data are not available for individual non-OECD economies, only estimated values for the world aggregate.
Decoupling trends (scatter graph): For the following countries the period 1990-2000 refers to: 1996-2000 for Chile and Slovenia; 1991-2000 for Hungary; and 1995-2000 for Estonia and Israel.

All data on materials: The OECD total does not include Luxembourg.

Municipal waste

Municipal waste is 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. National definitions may differ.

Sources

- OECD material flow database; OECD environmental data; OECD national accounts; OECD economic outlook.
- SERI (Sustainable Europe Research Institute) online portal for worldwide data on global resource extraction: www.materialflows.net .Portal set up and administrated by SERI in cooperation with the Wuppertal Institute for Climate, Environment, Energy.

Further information

- OECD work on Sustainable Materials Management, under www.oecd.org/env/waste
- OECD (2011), Resource productivity in the G8 and the OECD – A report in the framework of the Kobe 3R Action Plan
- OECD (2008), Measuring material flows and resource productivity – OECD guide: http://www.oecd.org/dataoecd/46/48/40485853.pdf ; and www.oecd.org/environment/resourceefficiency.
- OECD (2001) Sustainable development – Critical issues, Chapter 10. Natural Resource Management, OECD
- UNEP (2010) Assessing the environmental impacts of consumption and production: Priority products and materials. http://www.unep.fr/scp/rpanel/
- EEA (2010) The European Environment - Thematic Assessment on Material resources and waste. www.eea.europa.eu/soer/europe/material-resources-and-waste
- Eurostat Material flow accounts http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Material_flow_accounts

I.4 RESOURCE PRODUCTIVITY: NUTRIENT BALANCES

POLICY CONTEXT

The issue

The sustainability of agro-food systems is at the centre of green growth considerations. Main concerns relate to food security, to the flows of potentially polluting nutrients (nitrogen, phosphorous) from excessive commercial fertiliser use and intensive livestock farming, and to pesticides 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 on 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. Farming can also provide sinks for greenhouse gases, contribute to conserving biodiversity and landscapes, and help prevent floods and landslides.

Main challenges

The main challenge is to progressively decrease the negative impacts and increase the positive 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 improving the productivity and sustainability of agro-food systems, for example through the reduction of waste in supply chains, better management of fisheries, attention to land management practices, and to minimise pollution discharges from agriculture, such as better management of nutrients (fertilisers and livestock manure), and addressing agricultural support policies linked to production that can encourage the intensity of production beyond that which would occur in the absence of these policies. More efficient management of food systems is also a key ingredient in stemming the rate of biodiversity loss in the world.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can, in part, be assessed against changes in agricultural nutrient balances and related intensities. Nutrient balances are an indication of the level of potential environmental pressures from nutrients on natural assets, in particular soil, water and air. For instance, soil fertility can decline in the case of a nutrient deficit or for a nutrient surplus there is a risk of polluting soil, air, and water (eutrophication).

Indicators of progress

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

- Agricultural nutrient intensity related to changes in agricultural output, expressed as changes in the nitrogen (N) and phosphorus (P) balance per ha of agricultural land versus changes in agricultural production.
- Nitrogen and phosphorus surplus intensities, expressed as the N and P balance per ha of agricultural land.

Interpretation

When interpreting these indicators it should be noted that they describe potential environmental pressures, and may hide important sub-national variations. More information is needed to describe the actual pressure. They should be read together with information on agricultural land use and farm management approaches.

Cross-country comparisons of change in nutrient surplus intensities over time should take into account the absolute intensity levels during the reference period.

It should also be noted that these indicators reflect nutrient balances from agriculture only, and do not consider nutrient balances from other food production systems such as fisheries or total nitrogen cycles in an economy.

I.4 RESOURCE PRODUCTIVITY: NUTRIENT BALANCES

Measurability and data quality

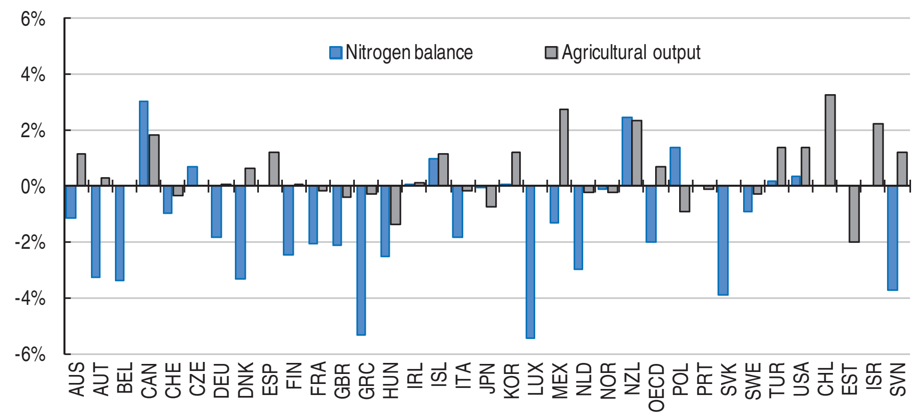
OECD data on nitrogen and phosphorus balances are available for 30 OECD countries until 2008. A comparable measure of agricultural output is available as an index number from the FAO. Improvements to the underlying methodology, nutrient conversion coefficients and primary data is currently being undertaken by OECD countries in cooperation with Eurostat and FAO as the nutrient balances are revised and updated.

In the long term, nutrient balances should also take into account nutrient losses through erosion, as well as nutrient inputs and outputs from other sources and economic activities.

NUTRIENT INTENSITIES: NITROGEN

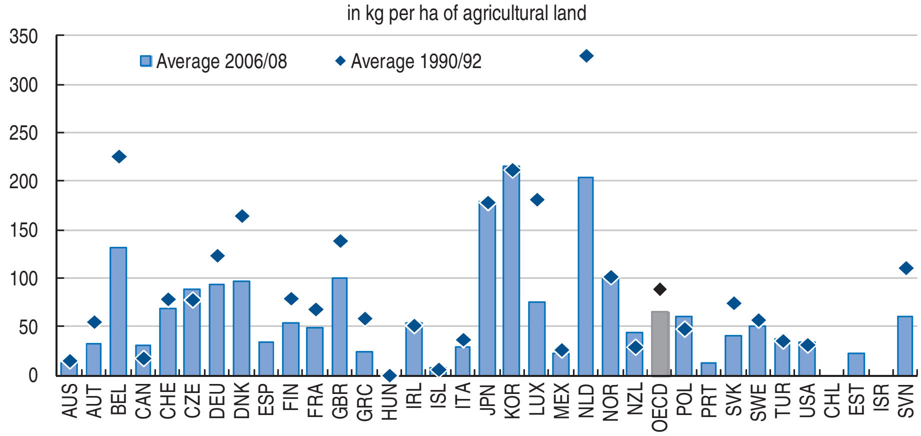
Change in nitrogen balance and agricultural output, OECD countries, 1990-2008

% change per year



Nitrogen surplus intensities, OECD countries, 1990/92 and 2006/08

in kg per ha of agricultural land



Source: OECD Agri-environmental indicators, Eurostat.

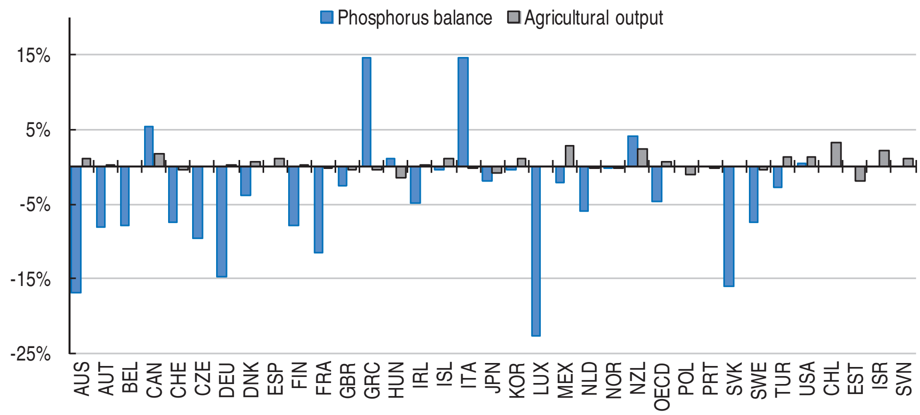
StatLink http://dx.doi.org/10.1787/888932425498

I.4 RESOURCE PRODUCTIVITY: NUTRIENT BALANCES

NUTRIENT INTENSITIES: PHOSPHOROUS

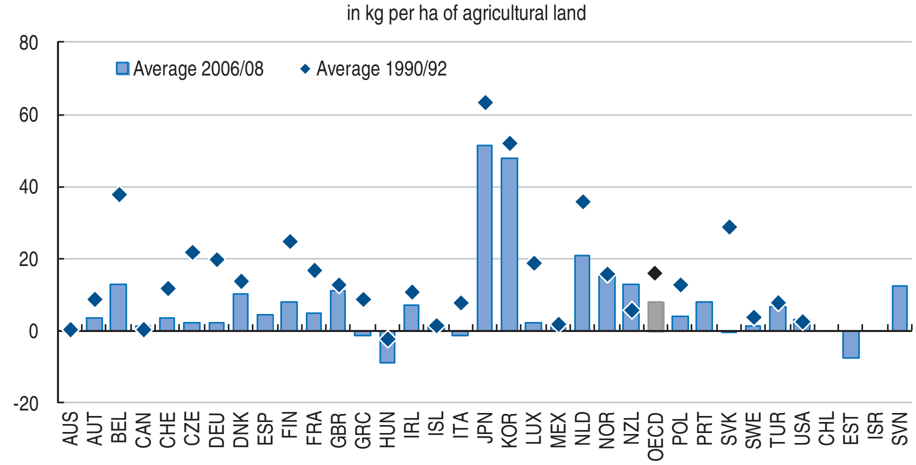
Change in phosphorous balance and agricultural output, OECD countries, 1990-2008

% change per year



Phosphorous surplus intensities, OECD countries, 1990/92 and 2006/08

in kg per ha of agricultural land



Source: OECD Agri-environmental indicators, Eurostat.

StatLink http://dx.doi.org/10.1787/888932425517

MAIN TRENDS

Some decoupling

For many OECD countries, nutrient surpluses (the potential transfer of nutrients to soil, water and air) relative to changes in agricultural output declined, signalling a process of relative decoupling of agricultural production from N/P-related environmental pressure.

… and important variations across countries

This reflects both improvements in nutrient use efficiency and the reduction in agricultural output. There are, however, sizable variations within and between countries in terms of the intensity and trends of nutrient surpluses.

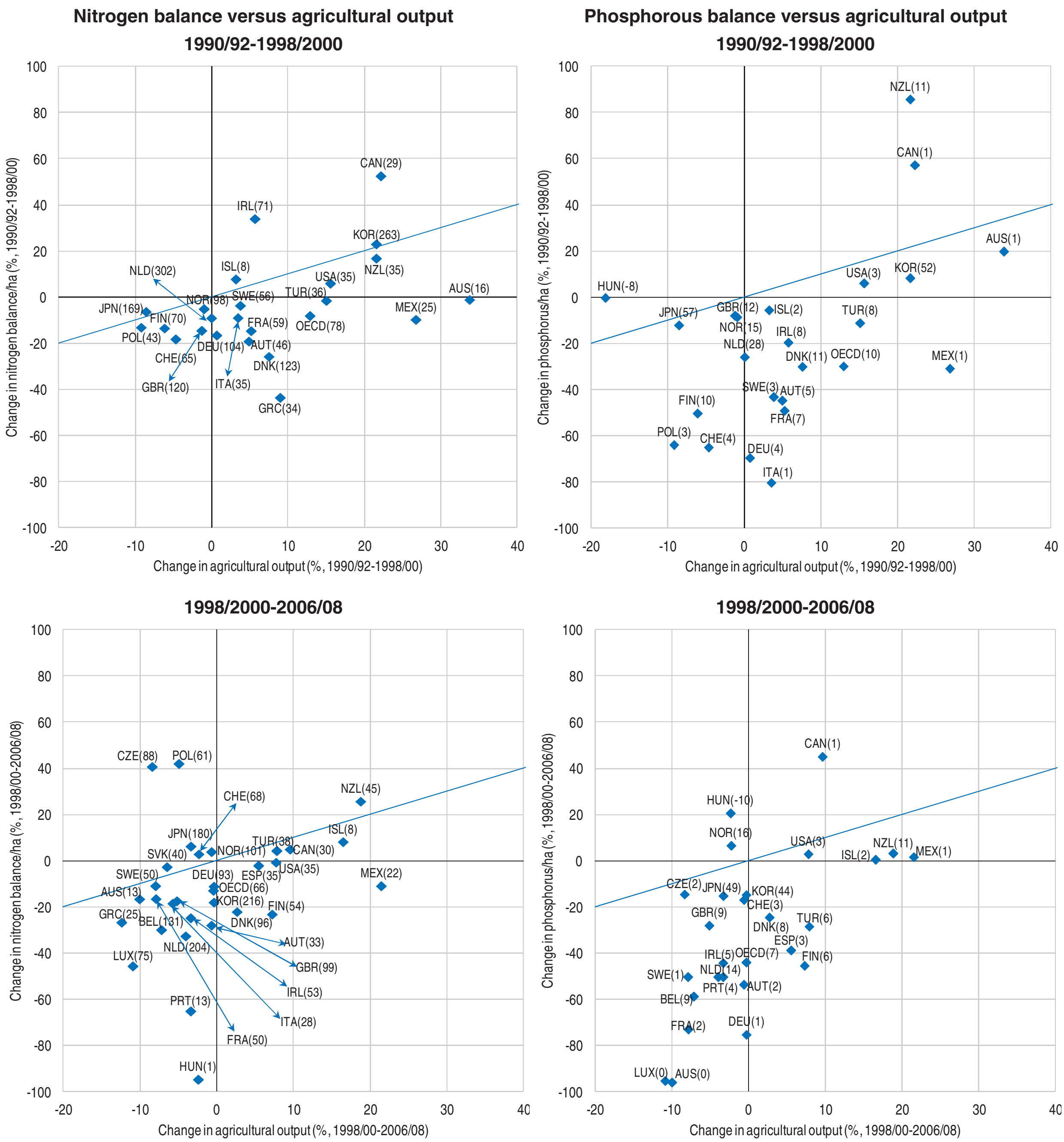
The absolute pressure on the environment (measured as the intensity of nitrogen and phosphorus surpluses per hectare) remains high in a number of countries.

… and within countries.

In most countries there is considerable variation in the level and trends of regional nutrient balance surpluses around national average values. Regional variations are explained by the spatial distribution of intensive livestock farming and cropping systems that require high nutrient inputs, such as maize and rice relative to wheat and oilseeds.

I.4 RESOURCE PRODUCTIVITY: NUTRIENT BALANCES

DECOUPLING TRENDS: NITROGEN AND PHOSPHOROUS



The values in brackets indicate the average nitrogen and phosphorous balance (kg/ha) in 1998/2000 and 2006/08 respectively. A 3-year average is considered to smooth the influence of natural events (such as drought and floods) on agricultural production over time.

Source: OECD Agri-environmental indicators, Eurostat.

StatLink *http://dx.doi.org/10.1787/888932425536*

I.4 RESOURCE PRODUCTIVITY: NUTRIENT BALANCES

Notes and definitions

Agricultural nutrient balances

Agricultural nutrient balances are calculated as the difference between the total quantity of nutrient inputs entering an agricultural system (mainly fertilisers and livestock manure), and the quantity of nutrient outputs leaving the system (mainly uptake of nutrients by crops and grassland).

The gross nitrogen and phosphorous balances

The gross nutrient balances are calculated as the difference between the total quantity of nutrient inputs entering an agricultural system, and the quantity of nutrient outputs leaving the system. 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 annum 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. The spatial variations in nutrient balances are usually explained by regional differences in farming systems, differing climates and types of soil, farming types and crops types, and also varying topography across the agricultural regions.

Scatter graphs:

The values in brackets indicate the average **nitrogen** balance (kg/ha) in 1998/2000 and 2006/2008 respectively. The OECD area excludes Chile, Estonia, Israel. A 3-year average is considered to address the short-term variability in the agricultural output, except for the United Kingdom for which the data are available only for 1990 in 1990/92 average and 2000 in 1998/2000 average, and Slovenia for which the data on phosphorus are not available before 1992 and for nitrogen before 1995. There are no data available on nitrogen balances in the period 1990/92 for Portugal and Spain. The nitrogen balance increased by 1100% from 1 to 12 kg/ha for Hungary between 1990/92-1998/00 and since it is an outlier it is not included in the OECD average.

The values in brackets indicate the average **phosphorus** balance (kg/ha) in 1998/2000 and 2006/2008 respectively. The OECD area excludes Chile, Estonia, Israel. A 3-year average is considered to address the short-term variability in the agricultural output, except for the United Kingdom for which the data are available only for 1990 in 1990/92 average and 2000 in 1998/2000 average, and Slovenia for which the data on phosphorus are not available before 1992 and for nitrogen before 1995. There are no data available on phosphorus balances in the period 1990/92 for Portugal and Spain. The phosphorus balance decreased by 433% from 1.0 to -3.3 kg/ha for Italy, decreased by 400% from 0.3 to -1.0 kg/ha for Slovakia, and increased by 175% from 2.7 to 7.3 kg/ha for Poland between, and increased by 133% for Greece between 1998/00-2006/08 while decreased by 118% between 1990/92-1998/00 (not presented in the graph).

Sources

- OECD Agri-environmental indicators: www.oecd.org/tad/env/indicators
- OECD (2008), Environmental performance of agriculture in OECD countries since 1990.
- OECD (2008), Environmental Performance of Agriculture at a Glance.

Further information

- OECD-FAO (2010), Agricultural Outlook 2010-2019.
- Eurostat, Agri-Environmental Statistics, Gross nutrient balance
  http://epp.eurostat.ec.europa.eu/portal/page/portal/agri_environmental_indicators

II

MONITORING 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, and support the provision of environmental and social services that are necessary to develop man-made, human and social capital (see box next page). The extraction and consumption of resources affects the quality of life and well-being of both current and future generations. This includes oil and gas extraction, mining, fishing and forestry.

Natural resources differ in their physical characteristics, abundance and value to different 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 the environmental impacts associated with the extraction and processing of natural resources, so as 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 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:

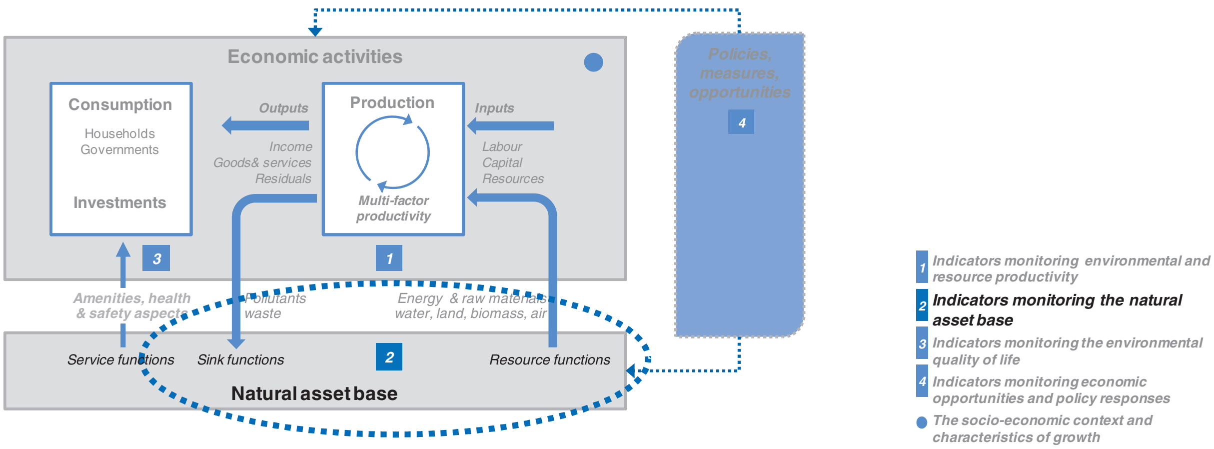
◆ **The availability and quality of renewable natural resource stocks** including freshwater, forest, fish.

◆ **The availability and accessibility of non-renewable natural resources stocks** in particular mineral resources, including metals, industrial minerals and fossil energy carriers.

◆ **The biological diversity and ecosystems** including species and habitat diversity, and the productivity of land and soil resources.

NATURAL ASSET BASE

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	R	S	M)	Indicators presented here
Renewable stocks	**6. Freshwater resources** Available renewable resources (groundwater, surface water, national, territorial) and related abstraction rates	M	1	1	S/M	☑
	7. Forest resources Area and volume of forests; stock changes over time	M	1	1	S/M	☑
	8. Fish resources Proportion of fish stocks within safe biological limits (global)	M	1	1	S	☑
Non-renewable stocks	**9. Mineral resources** Available (global) stocks or reserves of selected minerals (tbd): metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates	M	1	2	M/L	–
Biodiversity and ecosystems	**10. Land resources** Land cover types, conversions and cover changes State and changes from natural state to artificial or man-made state	M	1	1	M/L	☑ illustrative example
	• Land use: state and changes	P	1	2	S/M	☑
	11. Soil resources Degree of top soil losses on agricultural land, other land	M	1	2	M/L	–
	• Agricultural land area affected by water erosion by class of erosion	P	1	2	S/M	–
	12. Wildlife resources (tbd) • Trends in farmland or forest bird populations or in breeding bird populations	P	1	2	S/M	☑ illustrative example
	• Species threat status: mammals, birds, fish, vascular plants in % species assessed or known	P	2	2	S	☑ selected groups
	• Trends in species abundance	P	1	2	S/M	–

Notes: see Annex page 139.

II.1 RENEWABLE NATURAL STOCKS: 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 abstractions, by pollution loads from human activities (agriculture, industry, households), and by climate and weather.

Main concerns relate to the inefficient use of water and to its 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. Although at the national level most OECD countries show sustainable use of water resource, most still face at least seasonal or local water quantity problems and several have extensive arid or semi-arid regions where water is a constraint to sustainable development and to the sustainability of agriculture.

Main challenges

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

MONITORING PROGRESS THROUGH INDICATORS

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

Indicators of progress

The indicators presented here relate to:

- Available freshwater resources expressed as the long term annual average availability in m^3 per capita.
- Abstraction rates and water stress: the intensity of use of freshwater resources, expressed as gross abstractions as a % of total available renewable freshwater resources (including inflows from neighbouring countries) and as a % of internal resources (i.e. precipitations–evapotranspiration).

Trends in water abstractions by major use and intensities of water abstractions per capita are given as complements.

Interpretation

When interpreting these indicators, it should be noted that relating resource abstraction to renewal of stocks is a central question concerning sustainable water resource management. It should however be kept in mind that it only gives 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. This indicator should be read in connection with other environmental indicators and in particular with indicators on water supply prices, cost recovery ratios, water productivity and water quality.

II.1 RENEWABLE NATURAL STOCKS: FRESHWATER RESOURCES

Measurability and data quality

Information on the intensity of the use of water resources can be derived from water resource accounts and is available for most OECD countries.

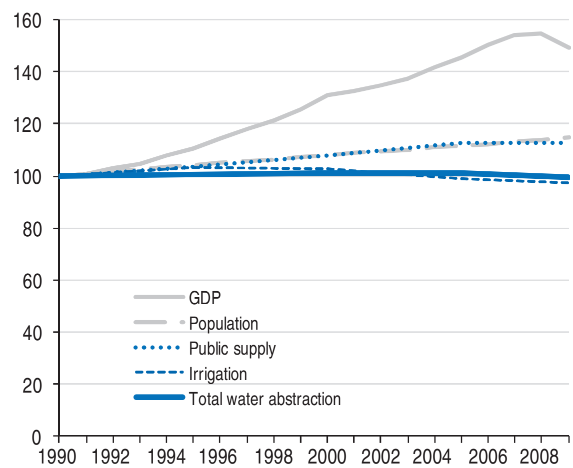
More work is however needed to improve the completeness and historical consistency of data on water abstractions, and to further improve estimation methods for renewable water resources.

More work is also needed to mobilise data at sub-national level, and to reflect the spatial distribution of resource use intensity. This is particularly important for countries with larger territories where resources are unevenly distributed.

DECOUPLING TRENDS: FRESHWATER ABSTRACTIONS

Freshwater abstraction by major use versus GDP, OECD

Index 1990=100



Source: OECD Environmental Data.

StatLink http://dx.doi.org/10.1787/888932425555

MAIN TRENDS

Decoupling has been achieved

… but seasonal and local water scarcities remain

… and great variations exist among and within countries

Most OECD countries increased their water abstractions over the 1970s in response to demand by the agricultural and energy sectors. In the the 1980s, some countries have stabilised their abstractions through more efficient irrigation techniques, the decline of water intensive industries (e.g. mining, steel), increased use of cleaner production technologies and reduced losses in pipe networks. Agriculture remains the largest user of water worldwide, with an increase in global abstractions for irrigation by over 60% since 1960.

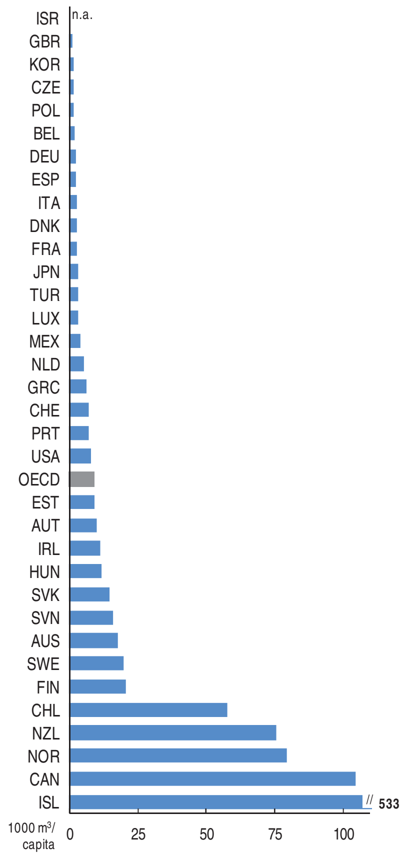
Trends since 1990 indicate a more general stabilisation of water abstractions and a relative decoupling between water use and GDP growth in many OECD countries; about one third of OECD countries have achieved absolute decoupling. Most countries continue however to face seasonal or local water quantity problems and several countries have extensive arid or semi-arid regions where water is a constraint to economic development.

Indicators of water stress –intensity of use of available resources - show great variations among and within individual countries. The national indicator may thus conceal unsustainable use in some regions and periods, and high dependence on water from other basins.

II.1 RENEWABLE NATURAL STOCKS: FRESHWATER RESOURCES

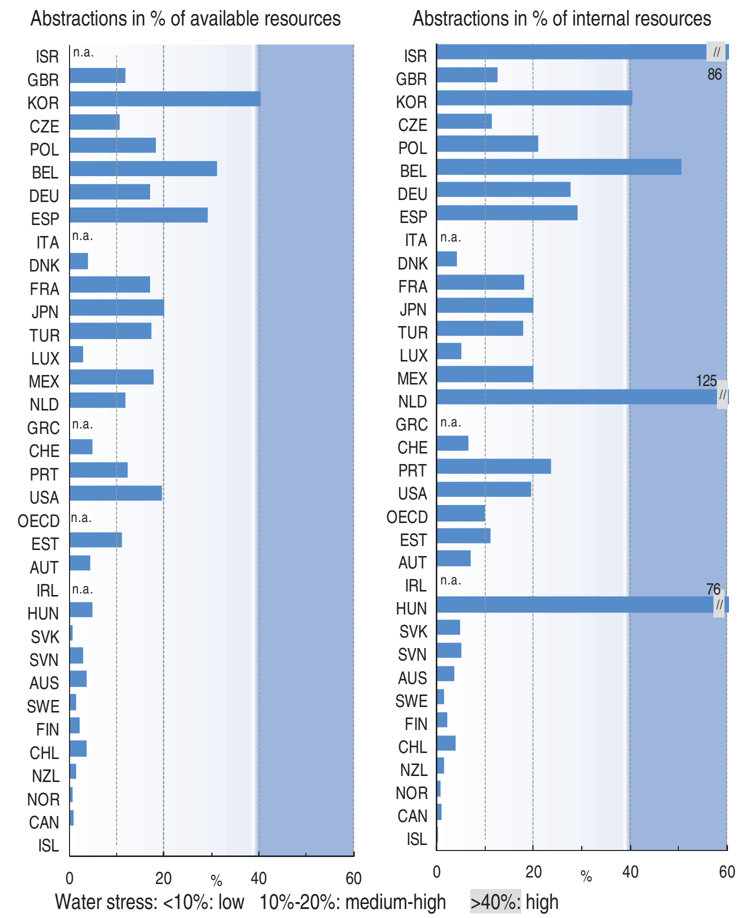
AVAILABLE FRESHWATER RESOURCES AND WATER STRESS

Renewable freshwater resources per capita, OECD countries, latest year available



Source: OECD Environmental Data.

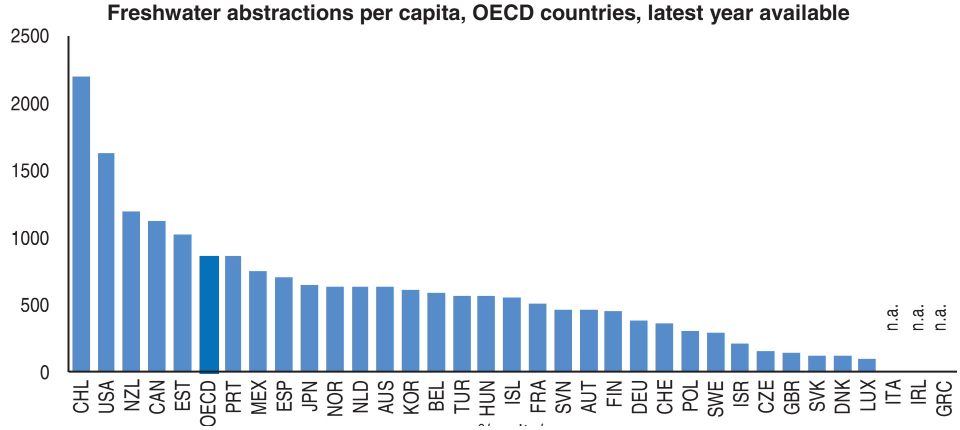
Water stress, OECD countries, latest year available



StatLink http://dx.doi.org/10.1787/888932425574

WATER ABSTRACTION INTENSITY

Freshwater abstractions per capita, OECD countries, latest year available



Source: OECD Environmental Data.

StatLink http://dx.doi.org/10.1787/888932425593

II.1 RENEWABLE NATURAL STOCKS: FRESHWATER RESOURCES

Notes and definitions

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 abstractions in % of total available renewable freshwater resources (including inflows from neighbouring countries), or in % of internal resources (i.e. precipitations - evapotranspiration).

- Low (less than 10 per cent): generally there is no major stress on the available resources.
- Moderate (10 to 20 per cent): indicates that water availability is becoming a constraint on development and significant investments are needed to provide adequate supplies.
- Medium-high (20 to 40 per cent): implies the management of both supply and demand, and conflicts among competing uses need to be resolved.
- High (more than 40 per cent): 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 sub-national (e.g. river basin) level; in particular 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 (e.g. Chile) and not to actual abstractions.

Sources

- OECD (2011), Key Environmental indicators
- OECD Environmental data, http://stats.oecd.org/

Further information

- OECD Horizontal Water Programme: www.oecd.org/water
- OECD (2010), Sustainable Management of Water Resources in Agriculture. www.oecd.org/agriculture/water
- OECD (2010), OECD Factbook
- OECD (2006), Environment at a Glance: OECD Environmental Indicators 2006.
- The Water Information System for Europe (WISE), http://water.europa.eu/
- FAO AquaStat database: www.fao.org/nr/water/aquastat/main/index.stm

II.2 RENEWABLE NATURAL STOCKS: 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; deliver recreation benefits and ecosystem services including regulation of soil, air and water; are reservoirs for biodiversity; and commonly act as carbon sinks.

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

Main challenges

The main challenges are to ensure a sustainable management of forest resources, so as to maintain timber value as well as environmental, social and aboriginal values. This includes avoiding overexploitation and degradation, so as to maintain adequate supply of wood for production activities, and to ensure the provision of essential environmental services, including biodiversity and carbon sinks.

This implies integrating environmental concerns into forestry policies, including eco-certification and carbon sequestration schemes, and defining optimal harvest rates, not to high to avoid excessive use of the resource, and not too low (particularly where age classes are unbalanced), which can reduce productive capacity. A new UNFCCC mechanism, Reducing Emissions from Deforestation and Degradation (REDD) in developing countries, will help mobilise finance to mitigate deforestation and thus GHG emissions.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed against national objectives and international principles on sustainable forest management adopted at UNCED (Rio de Janeiro, 1992) and reaffirmed at the WSSD (Johannesburg, 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.

Indicators of progress

The indicators presented here relate to:

- The area of forest and wooded land, as a percentage of total land area and in km^2 per capita, and related changes since 1990.
- The volume of forest resource stocks, expressed in m^3 , and related changes since 1990.

Interpretation

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

Ideally the indicators should inform about the volume distribution by major tree species group within each biome, and the share of disturbed/deteriorated forests in total forest area.

II.2 RENEWABLE NATURAL STOCKS: FOREST RESOURCES

Measurability and data quality

Data on the area of forests and wooded land are available for all countries with varying degrees of completeness. Trends over longer periods often lack comparability due to continued improvements in international definitions and in national forest inventories.

Data on the intensity of use of forest resources can be derived from forest accounts and from international forest statistics and Forest Resource Assessments (from FAO and UNECE) for most OECD countries. Interpretability is however limited due to differences in the variables monitored. Historical data often lack comparability or are not available over longer periods.

More work needs to be done to monitor the state and trends in the quality of forest resources and in related management and protection measures.

MAIN TRENDS

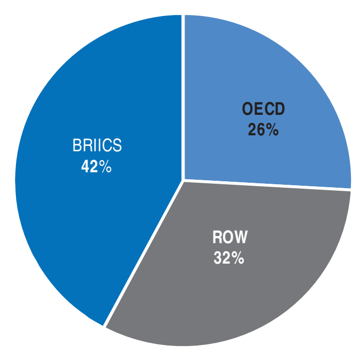
The area of forest has been decreasing at world level ...

The total global forest area is about 4 billion hectares, corresponding to 30% of the total land area or to an average of 0.62 hectares per capita. This is unevenly distributed, the ten most forest-rich countries accounting for two-thirds of total forest area. OECD countries' forests account for about one fourth of the world's forest area.

... but remained stable in most OECD countries.

Over the past 50 years, the area of forests and wooded land has remained stable or has slightly increased in most OECD countries, but has been decreasing at world level due in part to continued deforestation in tropical countries, mainly to provide land for agriculture, to graze cattle and logging.

OECD forests as % of world forests, 2008



Source: FAO.

Intensity of use

At national levels most OECD countries present a picture of sustainable use of their forest resources in quantitative terms, but with significant variations within countries. For those countries for which trends over a longer period are available, intensity of forest resource use does not generally show an increase and has even decreased in most countries from the 1950s. In recent years, wood requirements to achieve policy objectives for renewable energy have been playing an increasingly important role.

Protection status

The area of protected forests is increasing. About 13.5% of the world's forests are protected according to IUCN categories I-VI and 7.7 per cent (about 300 million hectares) for categories I-IV. The area of protected forests has increased by 94 million hectares since 1990; two-thirds of this increase has happened since 2000 (FAO 2010).

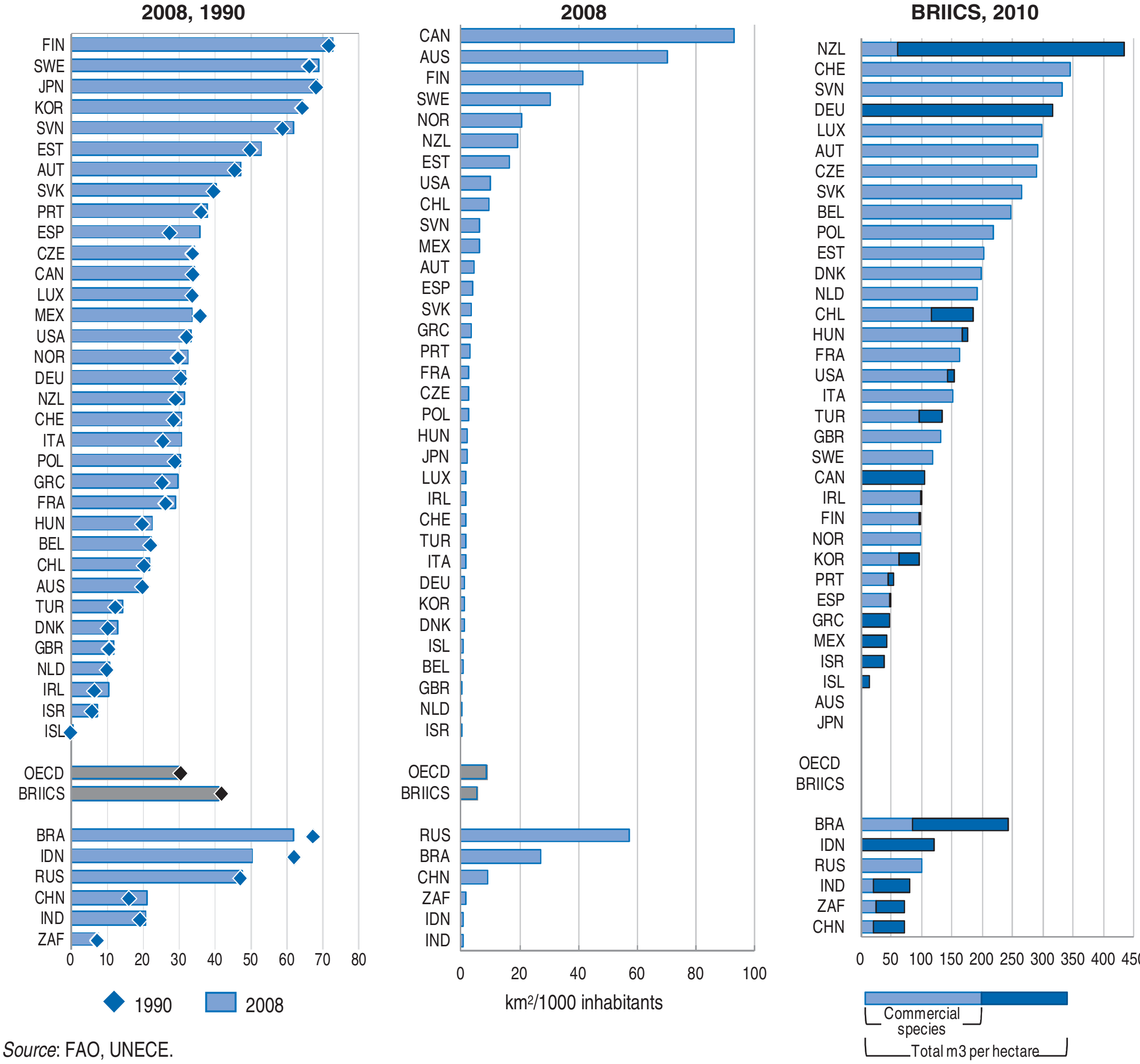
II.2 RENEWABLE NATURAL STOCKS: FOREST RESOURCES

CHANGES IN FOREST AREAS AND IN GROWING STOCK

Forest area as share of land area, OECD countries, BRIICS, 2008, 1990

Forest area per inhabitant, OECD countries, BRIICS, 2008

Growing stock in forest and other wooded land, OECD countries, BRIICS, 2010



Source: FAO, UNECE.

StatLink http://dx.doi.org/10.1787/888932425612

Notes and definitions

Forest area

Forest area refers to land spanning more than 0.5 hectare and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. This excludes woodland or forest predominantly under agricultural or urban land use and used only for recreation purposes.

Growing stock

Growing stock: Volume over bark of all living trees more than X cm in diameter at breast height (or above buttress if these are higher). Includes the 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 across countries; generally the data refer to a diameter of more than 10cm at breast height.

Sources

- FAO, UNECE, Global Forest Resource Assessment http://www.fao.org/forestry/fra/en/
- OECD (2011), Key Environmental indicators
- OECD Environmental data, http://stats.oecd.org/

II.3 RENEWABLE NATURAL STOCKS: FISH RESOURCES

POLICY CONTEXT

The issue

Fish resources play key roles for human food supply and aquatic ecosystems. Main pressures include fisheries, coastal development and pollution loads from land-based sources, maritime transport, and maritime dumping. Main concerns relate to the impacts of human activities on fish stocks and habitats in the marine and fresh waters, and to their consequences for biodiversity and for the supply of marine protein (fish) for human consumption and other uses.

Many valuable fish stocks are fully or over- exploited. The trend towards increased global fish catch has been achieved partly through exploitation of new and/or less valuable species and partly through aquaculture. Though global fish catch seems to have stabilised recently, Illegal, Unreported and Unregulated (IUU) fishing is widespread and hinders the achievement of sustainable fishery management objectives.

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.

Natural variability and climate change have significant implications for the productivity and the management of capture fisheries and aquaculture development.

Main challenges

The main challenge is to ensure a sustainable ecosystem based management of fish resources so that resource extraction does not exceed the renewal of the stocks over an extended period, and does not undermine the sustainability of the ecosystem.

This implies setting and enforcing limits on total catches, which may include managing the types of fishing methods employed, managing the areas in which and/or times during which fisheries may occur; and strengthening international co-operation.

MONITORING PROGRESS THROUGH INDICATORS

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), 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, international efforts are being made to address the issue of illegal, unreported and unregulated (IUU) fishing.

Indicators of progress

The indicators presented here relate to:

- The proportion of fish stocks within safe biological limits (global), expressed as the percentage of fish stocks exploited within their level of maximum biological productivity, i.e. stocks that are underexploited, moderately exploited, and fully exploited. Safe biological limits are the precautionary thresholds advocated by the International Council for the Exploration of the Sea. 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 and for major species groups are given as complements.

II.3 RENEWABLE NATURAL STOCKS: FISH RESOURCES

Interpretation

When interpreting these indicators it should be kept in mind that they give insights into the biological status of fish resources. The trend in fish production from aquaculture compared to the production of capture fisheries informs about shifts from using wild resources to more industrialised fish production. There are however important linkages between the two industries, as described below.

It should be noted that the indicator presented here is designed for global and regional assessments, and is not well suited for country assessments. For monitoring fisheries management at the national level, more specific indicators are needed.

Measurability and data quality

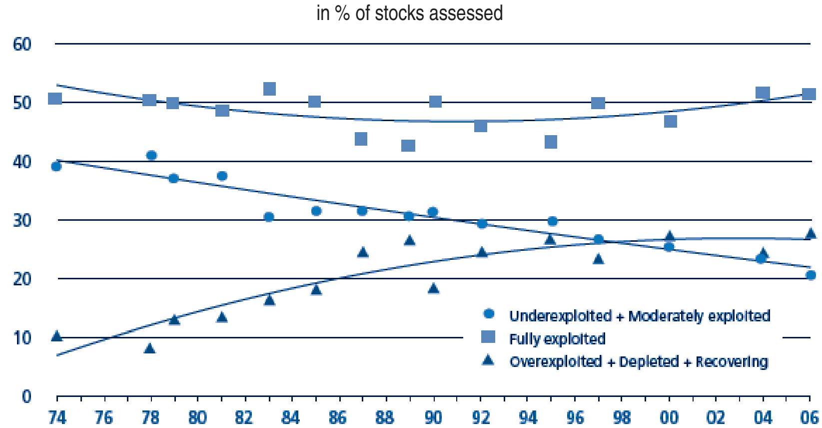
Fish catch and production data are available from international sources (FAO) at significant detail and for most OECD countries.

Data on the size of major fish populations exist but are scattered across national and international sources. Specific assessment data on internationally managed stocks are available from regional fisheries management organisations and from ICES. At a global level, some information on the state of fish stocks is available from the biennial FAO report on The State of World Fisheries and Aquaculture (SOFIA). More work needs to be done to better evaluate the status of fish stocks, and to relate fish captures to available resources.

STATE OF WORLD FISH STOCKS

Global trends in the state of world marine stocks, since 1974

in % of stocks assessed

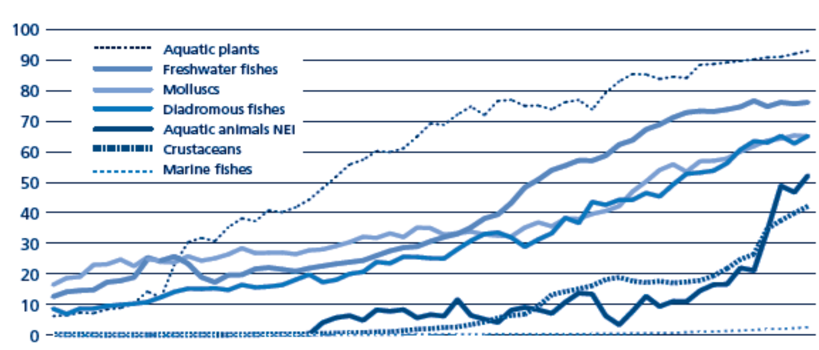


Source: FAO, The State of World Fisheries and Aquaculture 2008.

TRENDS IN FISH PRODUCTION

Contribution of aquaculture to world fish production by major species groups

in %



Source: FAO, The State of World Fisheries and Aquaculture 2008.

II.3 RENEWABLE NATURAL STOCKS: FISH RESOURCES

MAIN TRENDS

Overview

Capture fisheries and aquaculture supplied the world with about 110 million tonnes of food fish in 2006, providing an apparent per capita supply of 16.7 kg (in live weight equivalent).

Global production of marine capture fisheries peaked in 1997 at 88.4 million tonnes and has since declined slightly, to about 83.5 million tonnes in 2006. From 1980 there has been a consistent trend toward greater exploitation, with the proportion of stocks that are moderately exploited or underexploited declining from 40% to 20%. Slightly more than half of the stocks (52%) are fully exploited, producing catches at or close to their maximum sustainable limits. The remaining stocks are either overexploited (19%), depleted (8%) or recovering from depletion (1%), thus yielding less than their maximum potential owing to excess fishing pressure in the past. Together these account for 28% of all stocks, which is a significant increase from the 10% of stocks that fell into these categories in 1974. Thus, 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.

It should be noted that there is still a large number of stocks for which it had not yet been possible to determine stock status.

In the European Union, despite temporary improvements in the early 2000s, 21% of total fish catches in 2006 were from stocks outside safe biological limits, and total catch considerably exceeded sustainable levels of exploitation.

Aquaculture plays an increasing role in fish supply.

In the last three decades, aquaculture has grown rapidly and has surpassed capture fisheries as a source of fish production in many countries (fish, crustaceans, molluscs and other aquatic animals). In the 1970s, aquaculture accounted for about 6% of fish available for human consumption and for about 4% of total supply; in 2006 it accounted for 47% of human consumption and 36% of total supply. This growth has occurred more quickly in some regions of the world than in others. The same pattern appears when production is broken down by species. However, in recent years the rate of growth in global aquaculture production has been slowing.

Unlike capture fisheries, aquaculture offers opportunities to use farming systems and management practices to enhance food production while alleviating pressures on natural stocks. While aquaculture may help to alleviate some of the stress from capture fisheries, it also has negative effects on local ecosystems and its dependence, at least in the case of farming carnivorous species, on fishmeal/oil products can add to the pressure on some fish stocks. Aquaculture has developed to an extent where its dependence on fishmeal/oil products is in competition with other markets, which in turn could become a limiting factor of aquaculture development.

Important variations across world regions and countries

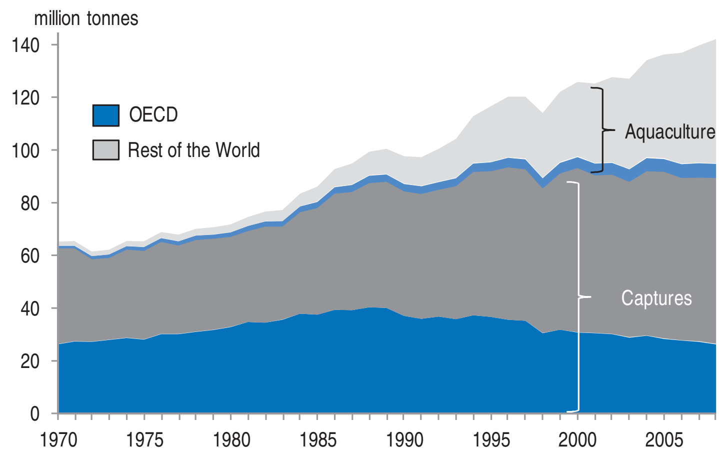
The share of fisheries and associated industries in the economy varies widely among countries.

Analysis shows 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 by the largest producer, though capture fisheries and aquaculture production statistics for China are under review and still entail uncertainties.

II.3 RENEWABLE NATURAL STOCKS: FISH RESOURCES

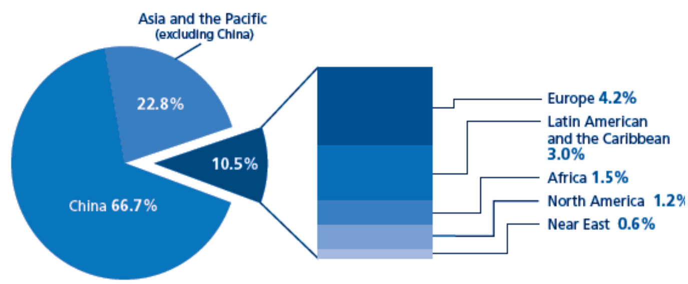
TRENDS IN FISH PRODUCTION

Trends in world fish production, 1970-2008



Source: FAO.

Aquaculture production by world region, 2006



Source: FAO.

Notes and definitions

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, and fully exploited. Safe biological limits are the precautionary thresholds advocated by the International Council for the Exploration of the Sea (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 catches and production in aquaculture

Fish catches are expressed as % of world captures and changes in total catches since 1979-81. To capture fisheries in inland and marine waters, including freshwater fish, diadromous fish, marine fish, crustaceans, molluscs and miscellaneous aquatic animals; excludes aquaculture.

The data cover capture fisheries and aquaculture in fresh, brackish and marine waters.

Sources

- FAO State of the World's Fisheries and Aquaculture 2008, http://www.fao.org/docrep/011/i0250e/i0250e00.htm
- FAOSTAT, FISHSTAT databases, annual updates, Rome. http://faostat.fao.org/
- International Council for the Exploration of the Seas. ICES: www.ices.dk.

Further information

- OECD (2011), Fisheries Policy Reform: National Experiences
- OECD (2011), The Economics of Adapting Fisheries to Climate Change
- OECD (2009), Review of Fisheries in OECD Countries 2009: Policies and Summary Statistics
- European Commission, Advisory Committee on Fisheries and Aquaculture. http://ec.europa.eu/fisheries/partners/acfa
- World Bank, Fisheries and Aquaculture.

II.4 BIODIVERSITY AND ECOSYSTEMS: LAND RESOURCES

POLICY CONTEXT

The issue

Land and soil resources are both a private property and a global common. They are essential components of the natural environment and of the natural asset base of the economy. They 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; it affects water and air quality; determines erosion risks and plays a role in flood protection. It further affects emissions of greenhouse gases (carbon, methane, nitrous oxide). Its economic value derives from food and other biomass production (agriculture, forestry), 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.

Land is a factor input into most economic activities; this leads to competing demands and conflicting uses that may become a constraint to both economic development and environmental protection. Competing demands for land and main drivers behind land use changes and conversions include:

- agriculture and food production;
- urbanisation and infrastructure development;
- water and flood management;
- forestry and biomass; and production of biofuels and non-food crops;
- other renewable energy production (hydroelectricity; windmills);
- mining and quarrying activities;
- 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).

Main challenges

The main challenge is to ensure a 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, protected area networks.

MONITORING PROGRESS THROUGH INDICATORS

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.

Indicators of progress

The indicators presented here relate to:

- Land use changes since 1990 in the OECD and the world: arable and permanent crop land; permanent pastures; forest land, and other land, including inland waters and built-up areas.

Examples of net conversion of agricultural to other land uses in selected countries are given as complements, as well as land cover changes for 2000-2006, and the share of land sealed by urban and infrastructure development in Europe.

Interpretation

These indicators should be read in connection with information on wetlands; protected areas; land degradation through erosion and desertification; and soil pollution (acidification by acid precipitation, excessive use of fertilisers and pesticides, hazardous waste dumping, sludge spreading).

Their interpretation should take into account the levels of economic development and the structure of countries' economies related trade pattern. Geographic factors and population density also play a role.

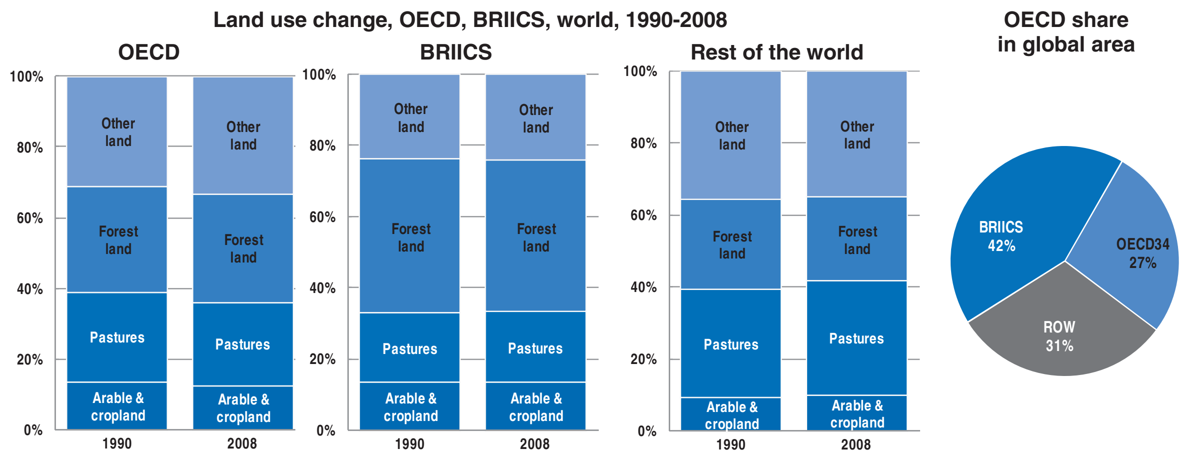
II.4 BIODIVERSITY AND ECOSYSTEMS: LAND RESOURCES

Measurability and data quality

Because internationally harmonised statistics on conversions from one type of land use to another are not yet available, only net changes are shown here. It has to be noted that the definitions used in different countries may show variations and limit the comparability of data. Changes of definition over time within a country can also sometimes alter the validity of trend series.

More needs to be done to exploit satellite images to monitor changes in land cover and land conversions over longer periods, and to fill gaps with respect to the extent of wetlands and and changes over time.

LAND USE CHANGE



Source: FAO.

StatLink http://dx.doi.org/10.1787/888932425631

TRENDS AND STRUCTURAL CHANGES

Land use changes

In nearly all OECD countries the agricultural land area decreased over the period 1990-92 to 2002-04. Farmland has been mainly converted to use for forestry and urban development.

While the total areas of wetlands converted to farmland were only a small share of the total farmed area over the period 1985-89 to 2001-03, there has been a net loss of wetlands converted to agricultural use, although at a declining rate of loss. Wetlands are highly valued habitats for biodiversity and their loss is of international significance.

A major share of agricultural semi-natural habitats consists of permanent pasture, which for most OECD countries has declined (1990-92 to 2002-04), mainly being converted to forestry, although for some countries pasture has also been converted for cultivation of arable and permanent crops. However, for some types of semi-natural agricultural habitats (farm woodland and fallow land) the area has increased or remained stable for a number of countries.

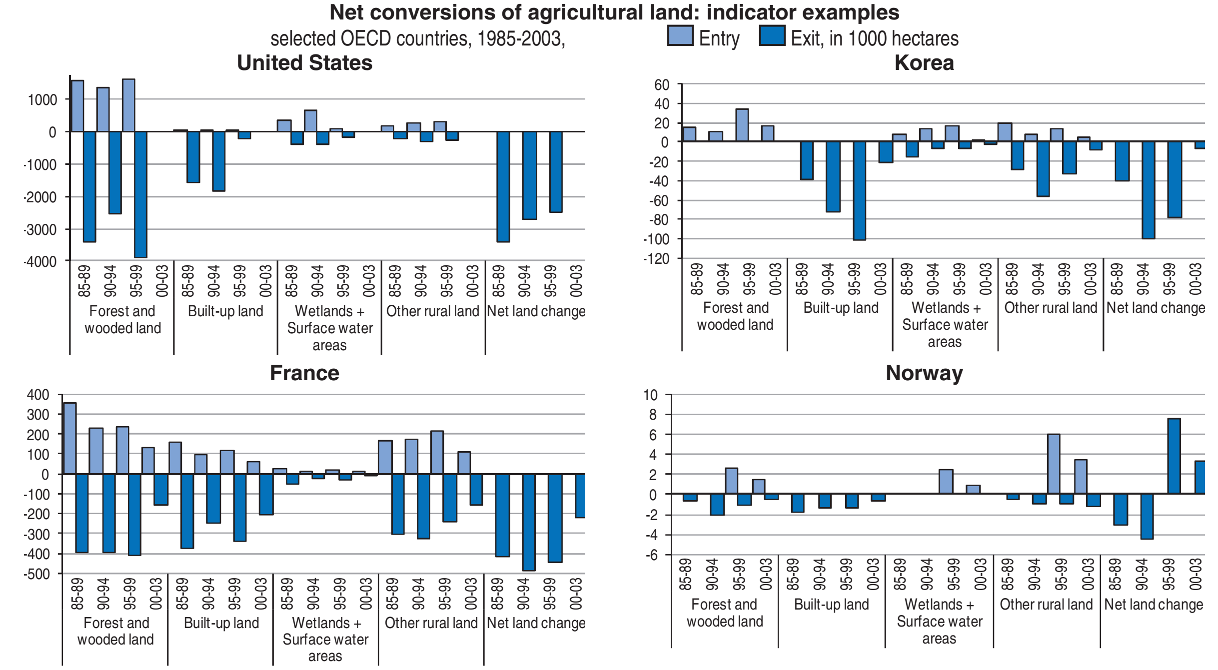
Land cover changes

Data on land-cover change in Europe from 2000–2006 (Corine land cover) show that growth in built-up areas and forest land leads to a continued loss of agricultural land. Although the land change rate in Europe has slowed since the 1990s, biodiversity-rich natural and semi-natural areas continue to decline, partly through intensification in agriculture but mostly through conversion to forest.

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 ecosystem services on the area concerned.

II.4 BIODIVERSITY AND ECOSYSTEMS: LAND RESOURCES

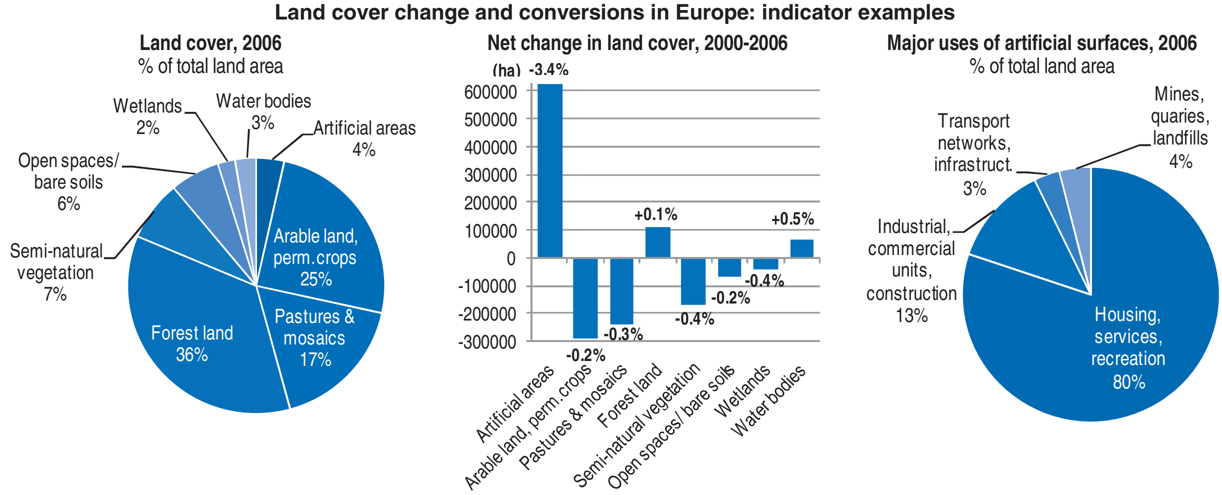
Net conversions of agricultural land: indicator examples



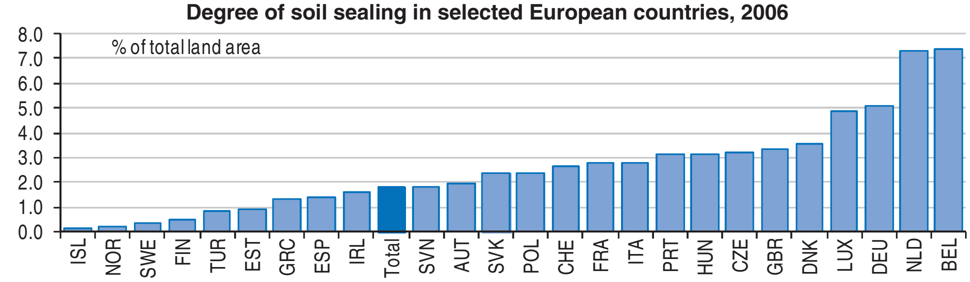
Notes: Net conversions are calculated as the difference between land converted to agricultural use (land entry) and land leaving agriculture (land exit), covering wetlands, forests, built-up areas (i.e. for urban use and transport) and other rural land uses, such as land left to grow in a "wild" state.

Source: Extracts from OECD (2008) Environmental performance of agriculture in OECD countries since 1990

Land cover change and conversions in Europe: indicator examples



Degree of soil sealing in selected European countries, 2006



Source: EEA (2010), The European Environment - State and Outlook 2010: Thematic Assessment on Land Use

II.4 BIODIVERSITY AND ECOSYSTEMS: LAND RESOURCES

Notes and definitions

Land use

Arable and permanent crop land refers to (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 refer to permanent grassland, i.e. land used for five years or more for herbaceous forage, either cultivated or growing wild.

Forest land refers to land spanning more than 0.5 hectare and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. This excludes woodland or forest predominantly under agricultural or urban land use and used only for recreation purposes.

Other land includes 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. Unit of observation is proportion of each category of land use changed to another land use over a given period of time. Land use defined in this way establishes a direct 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. By this definition, land use provides a basis for analysis of social, economic and environmental characteristics and allows distinctions between land uses, where required.

Land cover change and soil sealing

Land cover change presents information on distribution of land-cover types across the total terrestrial area, agricultural and natural. Soil sealing relates to covering the soil surface by impervious materials and changing the nature of the soil into an impermeable medium.

Sources

- FAOSTAT, Land use database: http://faostat.fao.org/
- EEA (2010), The European Environment - State and Outlook 2010: Thematic Assessment on Land Use. http://www.eea.europa.eu/soer/europe/land-use/key-facts
- CLC (2006), Corine land cover; Corine land cover 2006 raster data: www.eea.europa.eu/data-and-maps/data/ corine-land-cover-2006-raster.

Further information

- OECD (2008), Environmental performance of agriculture in OECD countries since 1990. www.oecd.org/tad/env/indicators
- OECD (2008), Environmental performance of agriculture at a Glance. www.oecd.org/tad/env/indicators

II.5 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. Biological diversity can be defined as the variety of and variability among living organisms; it covers both diversity at the ecosystem and species levels and genetic diversity within species.

Conservation of biodiversity is a key concern nationally and globally. Main concerns relate to the impacts of human activities on biodiversity. Pressures can be physical (habitat alteration and fragmentation through changes in land use and cover), chemical (toxic contamination, acidification, oil spills, other pollution) or biological (alteration of population dynamics and species structure through the release of exotic species or the commercial use of wildlife resources). 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.

Main challenges

The main challenge is to maintain or restore the diversity and integrity of ecosystems, species and genetic material and to ensure a sustainable use of biodiversity. This implies strengthening the actual 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 using a mix of instruments that address both demand and supply, including economic and market-based instruments (pricing, removal of environmentally harmful subsidies, environmentally-related taxes, charges, fees; payments for ecosystem services, biodiversity offsets, tradable permits, e.g. fishing quotas), supported with regulations, voluntary approaches and information based instruments. Benefits are also expected from climate change mitigation and adaptation measures.

MONITORING PROGRESS THROUGH INDICATORS

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 the Conservation of Migratory Species of Wild Animals (1979), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973), the Convention on Wetlands of International Importance (1971) and the Convention on the Conservation of European Wildlife and Natural Habitats (1979). A target endorsed at the WSSD (Johannesburg, 2002) aimed to significantly reduce the global, regional and national rate of loss of biodiversity by 2010. Parties to the CBD further adopted (Nagoya, 2010) a Strategic Plan for Biodiversity 2011-2020, including 20 headline targets (the "Aichi Biodiversity Targets") and five strategic goals.

Indicators of progress

The indicator presented here relates to:

- The number of threatened species compared to the number of known or assessed species. Data cover mammals, birds, and vascular plants.
- The state of farmland or forest birds in Europe and the United States. Birds are seen as good "indicator species" for the integrity of ecosystems and biological diversity. Being close to or at the top of the food chain, they reflect changes in ecosystems rather rapidly compared to other species.

Interpretation

When interpreting these indicators, it should be kept in mind that they 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 other indicators, in particular with indicators on the sustainable use of biodiversity as a resource (e.g. forest resources, fish resources) and on habitat alteration. It should further be complemented with information on the density of population and economic activities.

II.5 BIODIVERSITY AND ECOSYSTEMS: WILDLIFE RESOURCES

Measurability and data quality

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.

Bird population indices are currently only available from Europe and North America. Bird population data are available from BirdLife International. Efforts are being made under the Biodiversity Indicators Partnership (BIP) to develop a global wild bird index (WBI), building on national data.

More generally, accurate, comprehensive and comparable time-series data on wildlife populations still need to be fully developed. More needs also to be done to monitor ecosystem integrity and to develop indicators that better reflect the state of and changes in biodiversity at the habitat/ecosystem level.

MAIN TRENDS

Overview

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

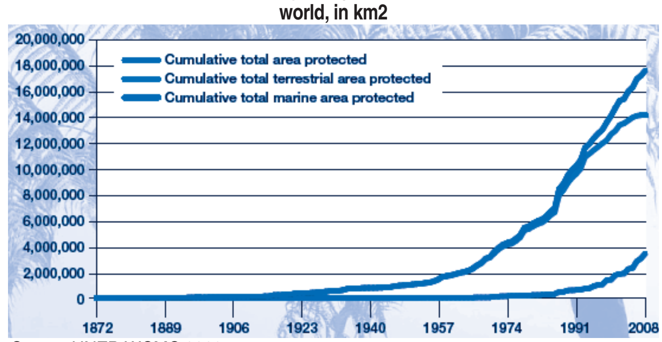
The 2010 biodiversity target has not been achieved, at least not at the global level. The diversity of genes, species and ecosystems continues to decline, as the pressures on biodiversity remain constant or increase in intensity mainly, as a result of human actions. Scientific consensus projects a continuing loss of habitats and high rates of extinctions throughout this century if current trends persist.

Species

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.

In OECD countries agricultural land is a primary habitat for certain wild species, in particular certain bird and insect species. Farmland bird populations declined over 1991-2004, but the decrease was less pronounced than over the 1980s, and for some countries populations have been rising since the late 1990s. The main causes of declining wild species impacted by agriculture are: changes to the habitat quality or its loss to other uses; pesticide and fertiliser use; lowering groundwater tables and river flows; and clearance of native vegetation, such as forests.

Growth in nationally designated protected areas, world, in km2



Source: UNEP-WCMC 2009

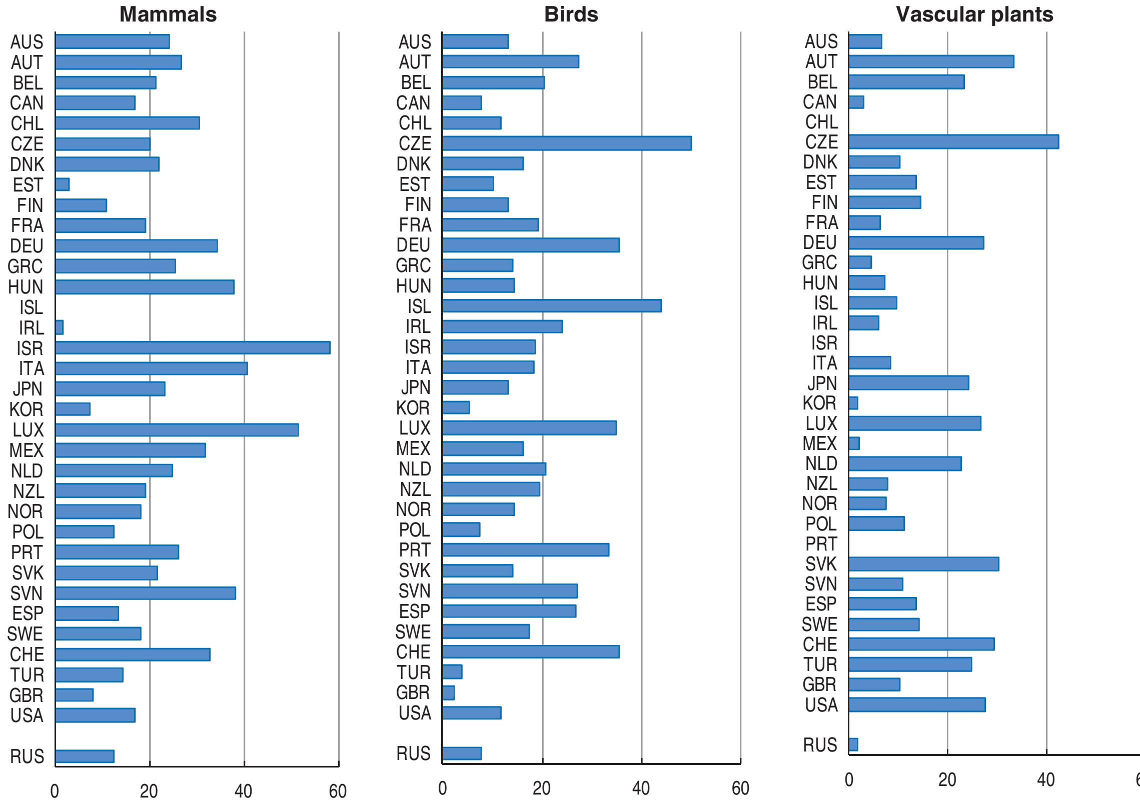
Protected areas

Protected areas have grown significantly since 1980 in almost all countries, reaching about 16 per cent of total area for the OECD as a whole. Actual protection levels and related trends are more difficult to evaluate, as protected areas change over time: new areas are designated, boundaries are revised and some sites may be destroyed or changed by pressures from economic development or natural processes. Environmental performance depends both on the designation of the area and on management effectiveness.

II.5 BIODIVERSITY AND ECOSYSTEMS: WILDLIFE RESOURCES

STATE OF SPECIES

Threatened species, OECD countries, latest year available
in % of species known

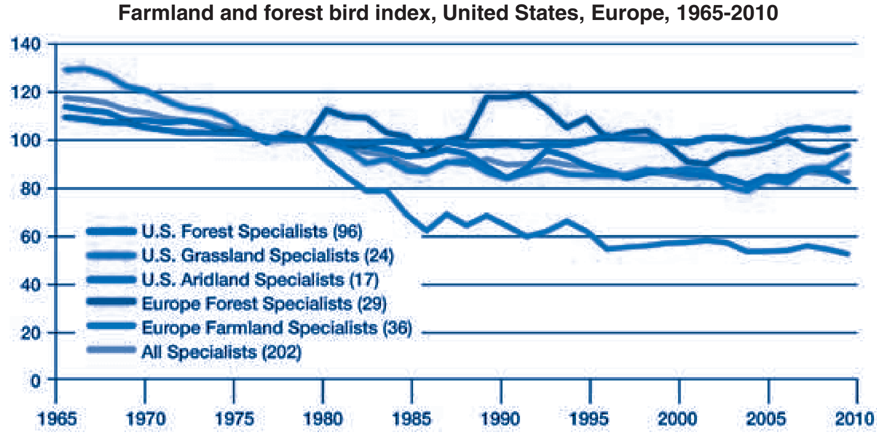


Source: OECD Environmental Data.

StatLink http://dx.doi.org/10.1787/888932425650

TRENDS IN BIRD POPULATIONS

Farmland and forest bird index, United States, Europe, 1965-2010



Source: Bird life international.

II.5 BIODIVERSITY AND ECOSYSTEMS: WILDLIFE RESOURCES

Notes and definitions

Threatened species

"Threatened" refers to the "endangered", "critically endangered" and "vulnerable" species, i.e. species in danger of extinction and species soon likely to be in danger of extinction. Data cover mammals, birds, fish, reptiles, amphibians and vascular plants. Other major groups (e.g. invertebrates, fungi) are not covered at the present time.

Protected areas

Protected areas, i.e. areas under management categories I to VI of the World Conservation Union (IUCN) classification that refer to different levels of protection, and 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)

The global wild bird index (WBI) is an average trend in a group of species suited to track trends in the condition of habitats. A decrease in the WBI means that the balance of species' population trends is negative, representing biodiversity loss. If it is constant, there is no overall change. An increase in the WBI means that the balance of species' trends is positive, implying that biodiversity loss has halted. However, an increasing WBI may, or may not, always equate to an improving situation in the environment. It could in extreme cases be the result of expansion of some species at the cost of others, or reflect habitat degradation. In all cases, detailed analysis must be conducted to interpret accurately the indicator trends. The composite trend can hide important trend patterns for individual species.

Sources

- OECD Environmental data.
- European Bird Census Council (EBCC): www.ebcc.info/
- Global Wild Bird Index: http://www.bipindicators.net/wbi
- North American Bird Conservation Committee (NABCC): http://www.nabci-us.org/
- UNEP, World Conservation Monitoring Centre: www.unep-wcmc.org/

Further information

- OECD (2011), Recent OECD work on biodiversity: http://www.oecd.org/dataoecd/63/39/46226558.pdf
- OECD (2010), Paying for biodiversity: Enhancing the cost-effectiveness of payments for ecosystem services
- OECD (2010), Policy Statement on Integrating Biodiversity and Associated Ecosystem Services into Development and Co-operation
- OECD (2009), Promoting Biodiversity Co-Benefits in REDD, ENV/WKP, 2009/6, OECD Environment Working Papers, No.11.
- OECD (2008), Environmental performance of agriculture in OECD countries since 1990, www.oecd.org/tad/env/indicators
- OECD (2008), People and Biodiversity Policies: Impacts, Issues and Strategies for Policy Action,
- OECD (2004), Council Recommendation on "The Use of Economic Instruments in Promoting the Conservation and Sustainable Use of Biodiversity", [C(2004)81].
- EEA (2010), The European Environment - State and Outlook 2010: Thematic Assessment on Nature and biodiversity http://www.eea.europa.eu/soer/europe/biodiversity
- FAO, Biodiversity: http://www.fao.org/biodiversity/

III

MONITORING THE ENVIRONMENTAL QUALITY OF LIFE

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

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

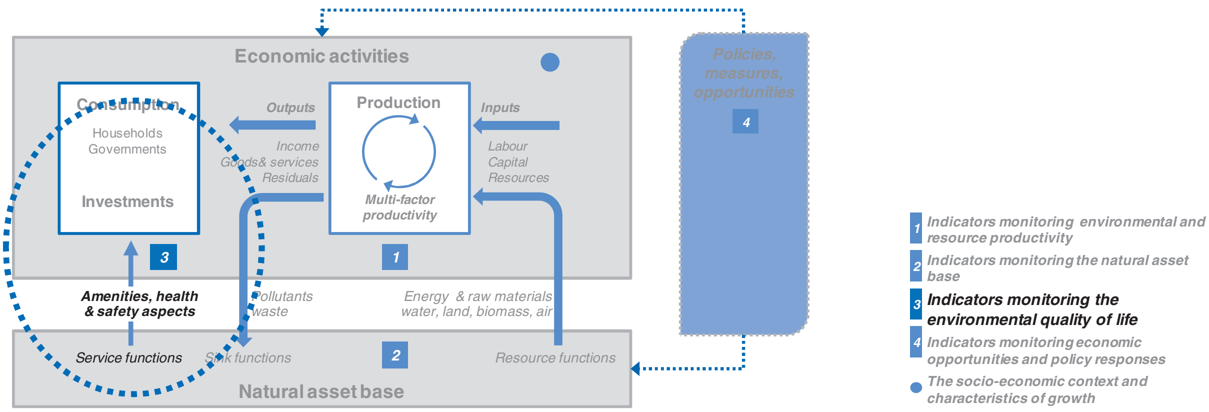
The main aspects of importance to green growth include:

- **Human exposure to environmental 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** that characterises 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.

These indicators can usefully be complemented by subjective measures of people's perceptions about the quality of the environment they live in (forthcoming in OECD(2011), How's Life?).

ENVIRONMENTAL QUALITY OF LIFE

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	R	S	M	Indicators presented here
Environmental health and risks	**13. Environmentally induced health problems & related costs** (e.g. years of healthy life lost from degraded environmental conditions)	M	1	3	L	–
	• Population exposure to air pollution	P	2	2	S/M	☑ illustrative example
	14. Exposure to natural or industrial risks and related economic losses	M	1	2	L	–
Environmental services and amenities	**15. Access to sewage treatment and drinking water**	M				
	15.1. Population connected to sewage treatment (at least secondary, in relation to optimal connection rate)		2	2	S/M	☑
	15.2. Population with sustainable access to safe drinking water	–	1	2	S/M	☑ from the MDG

Notes: see Annex page 139.

III.1 ENVIRONMENTAL HEALTH AND RISKS: AIR QUALITY

POLICY CONTEXT

The issue

Atmospheric pollutants from energy transformation and energy consumption, but also from industrial processes, are the main contributors to regional and local air pollution. Major concerns relate to their effects on human health and ecosystems. Human exposure is particularly high in urban areas where economic activities are concentrated. Causes of growing concern are concentrations of fine particulates, NO_2, toxic air pollutants, and acute ground-level ozone pollution episodes in both urban and rural areas.

Main 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, technological progress, energy savings and environmentally sustainable transport policies.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed against changes in the number of people exposed to certain levels of air pollution in urban areas paying particular attention to vulnerable persons (children, elderly peoples). Progress can also be assessed against the health costs induced by degraded air quality and against domestic objectives and international commitments regarding air emissions and quality.

Indicators of progress

The indicator examples presented here relate to:

- Population exposure to air pollution expressed as population weighted concentrations of fine particulates and of ozone in selected European countries. Fine particulates (PM10) can be carried deep into the lungs where they can cause inflammation and worsen the condition of people with heart and lung diseases. Ozone (O_3) is a photochemical oxidant, which causes serious health problems and damage to ecosystems, agricultural crops and materials. Human exposure to high O_3 concentrations can give rise to respiratory problems and decreases in lung functions. Ground-level O_3 is a 'secondary' pollutant: it forms when precursor gases (nitrogen oxides, volatile organic compounds, carbon monoxide, methane) come into contact in the presence of sunlight.

Measurability and data quality

Information on population exposure to air pollution is scattered. Efforts are needed to monitor and/or estimate overall population exposure, and exposure of sensitive groups of the population. Data on concentrations of major air pollutants are available for major cities in OECD countries, but more work is needed to maintain longer time series, to improve international comparability, and to link these data to national standards. More needs also to be done to explore the impacts of environmental degradation on human health and the associated distributional and equity issues, and identifying suitable indicators.

Another more ambitious avenue that could be pursued in the longer term, is tracking the effects of pollution and residuals on human capital by considering the economic effects due to the reduction of people's earning capacity due to reduced health or reduced life expectancy.

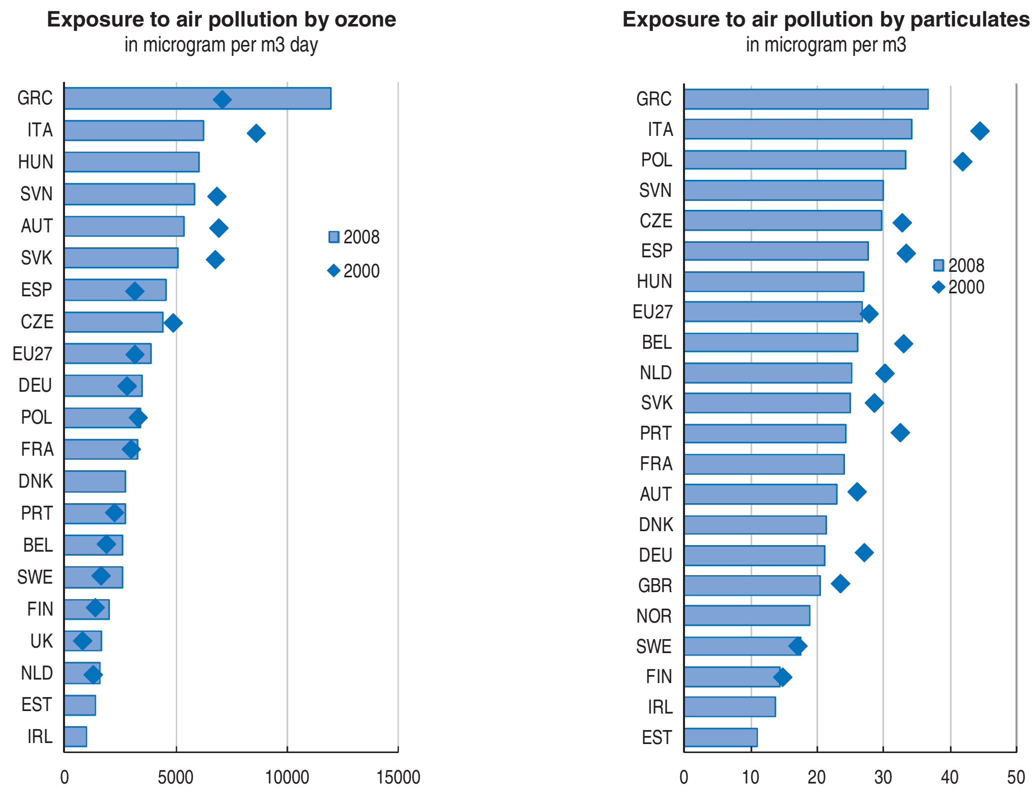
Interpretation

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

III.1 ENVIRONMENTAL HEALTH AND RISKS: AIR QUALITY

POPULATION EXPOSURE TO AIR POLLUTION

Population exposure to urban air pollution in Europe, selected countries, 2000, 2008



Source: Eurostat (2009), European Environment Agency (EEA).

MAIN TRENDS

Exposure to ozone and particulates ...

While urban air quality with respect to SO_2 concentrations has generally improved; ground-level ozone, NO_2 concentrations, fine particulates and toxic air pollutants and related health effects raise growing concern, largely due to the concentration of pollution sources in urban areas and to the increasing use of private vehicles for urban trips.

In Europe, since 2000 people in the EU have been more exposed to ozone as well as to particulate matter. Exposure to ozone has increased in the EU-27 between 2000 and 2007 by 2.5 % per year on average, with considerable variation from one year to the other.

... and its effects on human health remain a concern in many countries.

Urban air pollution is estimated to cause about 2 million premature deaths (a loss of 6.4 million years of life) each year. Potential benefits of pollution mitigation can be considerable. In the United States the measurable public health benefits from the Clean Air Act in 2010 are estimated to be 13 million prevented lost work days and USD 2 trillion, and outweigh related costs by (of $65 billion) a factor of 30 to 1 (USEPA, 2011). In Europe, outdoor air pollution is estimated to take a toll of up to 20 % of disability-adjusted life years, translating into 100,000 premature deaths and the loss of 725,000 working days annually (WHO, 2004).

III.1 ENVIRONMENTAL HEALTH AND RISKS: AIR QUALITY

Notes and definitions

Population exposure to pollution by fine particulates (Europe)

Population weighted annual mean concentration of fine particulate matter (PM10, i.e. particulates whose diameter is less than 10 micrometers) at urban background stations in agglomerations. Based on calculations by the European Environment Agency.

Population exposure to pollution by ozone (Europe)

Population weighted yearly sum of maximum daily 8-hour mean ozone concentrations above a threshold (70 microgram Ozone per m3) at urban background stations in agglomerations. Based on calculations by the European Environment Agency.

Sources

- Eurostat (2009), Sustainable development in the European Union, 2009 monitoring report of the EU sustainable development strategy, Theme 5: public health http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/indicators/theme5
- European Environment Agency (2010), The European Environment - State and Outlook 2010: Thematic Assessment on Air pollution: http://www.eea.europa.eu/soer/europe/air-pollution

Further Information

- OECD (2011), Valuation of Environment-Related Health Risks for Children
- OECD (2006), Economic Valuation of Environmental Health Risks to Children
- OECD (2005), Children's environmental health indicators – A survey: http://www.oecd.org/dataoecd/18/12/35381349.pdf
- US Environmental Protection Agency (2011), Benefits and Costs of the Clean Act: Second Prospective Study - 1990 to 2020.
- World Health Organisation (2004), Burden of Disease project: http://www.who.int/healthinfo/global_burden_disease/
- World Bank (2011), Air Quality Management in East Asia and Pacific Region.

III.2 ENVIRONMENTAL SERVICES AND AMENITIES: ACCESS TO SEWAGE TREATMENT

POLICY CONTEXT

The issue

Water quality, 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 public water supply, swimming or 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.

Some countries have extensive water infrastructure, but do not provide safe drinking water and sanitation because the water infrastructure, from water treatment plants, delivery pipes to waste water facilities, has been deteriorating over time.

Main challenges

The main challenge is to protect and restore all bodies of surface and ground water to ensure the achievement of water quality objectives, and to ensure an appropriate public access to wastewater treatment and the supply of permanently safe drinking water to the entire population.

This implies further reducing pollution discharges, through appropriate treatment of waste water and a more systematic integration of water quality considerations in agricultural and other sectoral policies. It also implies appropriate investments in water infrastructure. Social aspects, such as the affordability of the water bill for low income households also need to be taken into account.

MONITORING PROGRESS THROUGH INDICATORS

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

Indicators of progress

The indicator presented here relates to:

- Public access to waste water treatment services. It shows the percentage of the national resident population actually connected to waste water treatment plants and to sewerage in OECD countries in 2008 or the latest available year. The extent of secondary (biological) and/or tertiary (chemical) treatment provides an indication of efforts to reduce pollution loads.

Indicators on public access to an improved drinking water source, and to an improved sanitation facility, used to monitor the Millennium Development Goals (MDG), are given as complements.

Interpretation

When interpreting the indicator of public access to waste water treatment services, it should be noted that waste water treatment is at the centre of countries' financial efforts to abate water pollution. It should be related to an optimal national connection rate taking into account national specificities such as population in remote areas. It should be read in connection with other environmental indicators, including on public waste water treatment expenditure, water prices for households and the related cost recovery ratios and the quality of rivers.

When interpreting the indicators on improved access to drinking water source and sanitation facility, it should be noted that these indicators might not entirely capture whether the tap water is actually safe, whether it is available at all times and whether the water and sanitation systems are being maintained.

III.2 ENVIRONMENTAL SERVICES AND AMENITIES: ACCESS TO SEWAGE TREATMENT

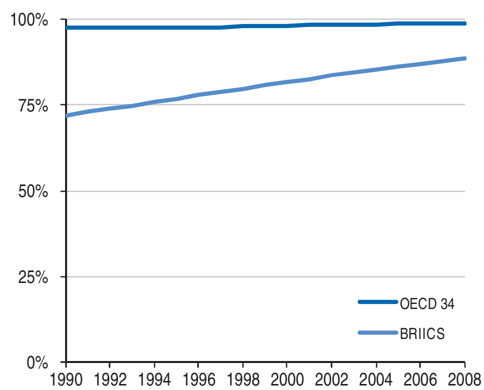
Measurability and data quality

Data on the share of the population connected to waste water treatment plants are available for almost all OECD countries. In some countries, data relate to population equivalent and are thus not fully comparable. Information on the level of treatment remains partial.

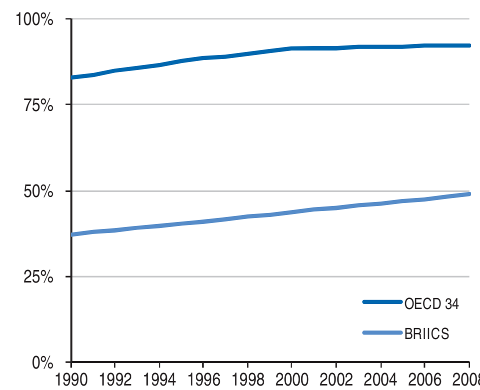
Further work is needed to provide complementary information on leakage in the water distribution network, continuity of water supply, pipe-breaks throughout the water supply and sanitation networks, and the quality of water at the beginning and the end of distribution networks.

ACCESS TO IMPROVED DRINKING WATER AND SANITATION

Population using an improved drinking water source, OECD, BRIICS, 1990-2008
In % of total population



Population using an improved sanitation facility, OECD, BRIICS, 1990-2008
In % of total population



Source: UNSD Millennium Development Goals.

MAIN TRENDS

Waste water treatment has progressed ...

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 50% in the early 1980s to more than 70% 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 varies significantly among OECD countries: secondary and tertiary treatment has progressed in some while primary treatment remains important in others. Some countries have reached the economic limit in terms of sewerage connection and must find other ways of serving small, isolated settlements.

... with some variations across OECD countries.

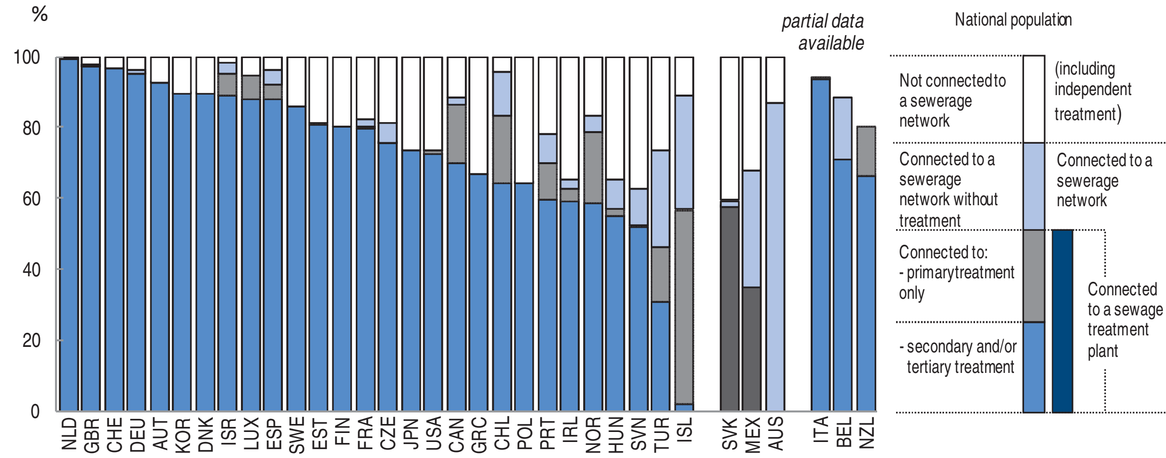
While access to improved drinking water sources and sanitation facilities is less of an issue in OECD countries, much progress is needed in developing countries. In the BRIICS countries significant improvements have been made over the past two decades with an average of 89% of the population of the BRIICS having access improved drinking water sources.

III.2 ENVIRONMENTAL SERVICES AND AMENITIES: ACCESS TO SEWAGE TREATMENT

WASTE WATER TREATMENT CONNECTION RATES

Population connected to waste water treatment plants, OECD countries, 2009 or latest

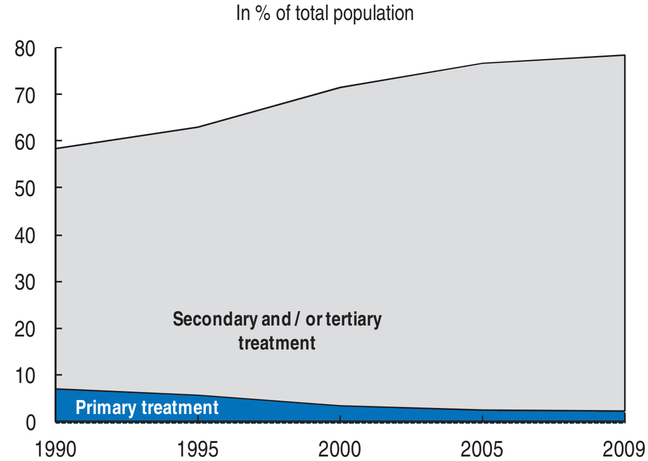
In % of total population



Source: OECD Environmental Data.

Trends in population connected to waste water treatment plants, OECD, 1980-2009

In % of total population



Source: OECD Environmental Data.

StatLink http://dx.doi.org/10.1787/888932425669

III.2 ENVIRONMENTAL SERVICES AND AMENITIES: ACCESS TO SEWAGE TREATMENT

Notes and definitions

Population connected to waste water treatment plants

"Connected" means actually connected to a waste water treatment plant through a public sewage 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 of the incoming wastewater is reduced by at least 20% before discharge and the total suspended solids of the incoming wastewater 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 a BOD removal of at least 70% and a COD removal of at least 75%. Tertiary treatment refers to treatment of nitrogen and/or phosphorous and/or any other pollutant affecting the quality or a specific use of water: microbiological pollution, colour etc . The optimal connection rate is not necessarily 100 per cent; it may vary among countries and depends on geographical features and on the spatial distribution of habitats.

Population using an improved drinking water source

Population using any of the following types of water supply for drinking: piped water into dwelling, plot or yard; public tap/standpipe; borehole/tube well; protected dug well; protected spring; rainwater collection and bottled water (if a secondary available source is also improved). It does not include unprotected well, unprotected spring, water provided by carts with small tanks/drums, tanker truck-provided water and bottled water (if the secondary source is not an improved source) or surface water taken directly from rivers, ponds, streams, lakes, dams, or irrigation channels. Definitions and a detailed description of these facilities can be found at www.wssinfo.org .

Population using an improved sanitation facility

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 -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. Definitions and a detailed description of these facilities can be found at the website of the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation at www.wssinfo.org .

Sources

- OECD (2011), Environmental Data
- UNSD (2011), Millennium Development Goals; UN Water: http://www.unwater.org

Further Information

- OECD Horizontal Water Programme: http://www.oecd.org/water
- OECD (2011), “Benefits of Investing in Water and Sanitation: An OECD Perspective.
- OECD (2009), “Strategic Financial Planning for Water Supply and Sanitation”, 5th WWF, May 2009.
- OECD (2009), “Managing Water for All: An OECD Perspective on Pricing and Financing”, 5th WWF, March 2009.
- EEA (2005), “Effectiveness of Urban Wastewater Treatment Policies in Selected Countries: An EEA Pilot Study”, EEA Report No. 2/2005, Copenhagen, Denmark, www.eea.europa.eu/publications/eea_report_2005_2.
- WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation at www.wssinfo.org

IV

MONITORING ECONOMIC OPPORTUNITIES AND POLICY RESPONSES

Governments have an important role in fostering green growth by setting framework conditions that stimulate greener production and consumption through economic and other instruments; by encouraging cooperation and sharing of good practices among enterprises; by developing and promoting the use of new technologies and innovations; and by increasing coherence among policies. The main challenge is to harness environmental protection as a source of growth and as a source of international competitiveness, trade and employment.

Businesses have an important role in adopting "greener" management approaches; developing and using new technologies; carrying out R&D and spur innovation. Business, governments and civil society also play an important role in providing 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:

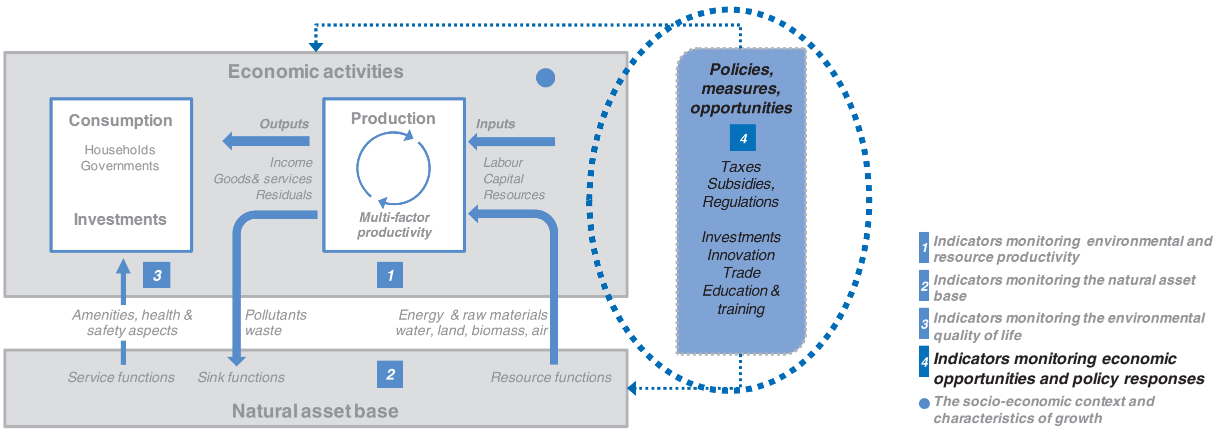
- **Technology development and innovation** that are important for growth and productivity in general and for green growth in particular. They are important for managing natural resources and to minimise the pollution burden. Innovation also contributes to the establishment of new markets and leads to the creation of new jobs;
- **Production of environmental goods and services** that reflect an important, albeit partial aspect of the economic opportunities that arise in a greener economy;
- **International financial flows** that are key to the uptake and dissemination of technology and knowledge, foster the cross-country exchange of knowledge and are one important aspect in combining development and environmental objectives;
- **Prices and financial transfers** that provide important signals to producers and consumers and, along with regulations, are tools to internalise externalities and to influence behaviour of market participants towards more environmentally-friendly patterns.

Ideally, indicators on economic instruments should be complemented by indicators on regulations. However, data availability and comparability of regulations across countries hamper the construction of such indicators.

These indicators can also be complemented with indicators on **international trade** as a source of economic opportunities, including green growth opportunities. Since trade in "green" products provides a very partial picture of this role, no specific trade-related indicator has been put forward in this section. General indicators on international trade and competitiveness can be found in the section on the socio-economic context.

ECONOMIC OPPORTUNITIES AND POLICY RESPONSES

FRAMEWORK



PROPOSED INDICATORS

Theme	Proposed indicators	Type	R	S	M	Indicators presented here
Technology and innovation	**16. R&D expenditure of importance to GG**	M	1	1	S/M	☑
	- Renewable energy (in % of energy related R&D)		1	1	S	
	- Environmental technologies (in % of total R&D, by type)		1	1	S	
	- All purpose business R&D (in % of total R&D)		1	1	S	
	17. Patents of importance to GG (in % of country applications under the Patent Cooperation Treaty)	M	1	1	S	☑
	- Environmentally related and all-purpose patents		1	1	S/M	
	- Structure of environmentally related patents		1	1	S/M	
	18. Environment-related innovation in all sectors	M				☑ illustrative example
Environmental goods and services	**19. Production of environmental goods and services (EGS)**	M	1	2	S/M	☑ illustrative example
	19.1. Gross value added in the EGS sector (in % of GDP)					
	19.2. Employment in the EGS sector (in % of total employment)					
International financial flows	**20. International financial flows of importance to GG** In % of total flows; in % of GNI		2	1	L	
	20.1. Official Development Assistance		2	1	S	☑
	20.2. Carbon market financing		2	1	S	☑
	20.3. Foreign Direct Investment		3	3	L	–
Prices and transfers	**21. Environmentally related taxation**	M	2	2	S/M	☑
	- Level of environmentally related tax revenues (in % of total tax revenues, in relation to labour related taxes)					
	- Structure of environmentally related taxes (by type of tax base)		2	2	S/M	
	22. Energy pricing (share of taxes in end-use prices)	M	1	1	S	☑
	23. Water pricing and cost recovery (tbd)	M	1	2	S/M	–
	To be complemented with indicators on:					
	• *Environmentally related subsidies*		1	3	M/L	
	• *Environmental expenditure: level and structure*		2	1	L	
Regulations and management approaches	*Indicators to be developed*		..	..	..	
Training and skill development	*Indicators to be developed*		..	..	..	

Notes: see Annex page 139.

IV.1 TECHNOLOGY AND INNOVATION

POLICY CONTEXT

The issue

Technology developments and innovation are important drivers for growth and productivity in an economy. They are important for managing energy and material flows successfully and have a bearing on policies intended to preserve natural resources and materials and minimise the pollution burden.

Many technologies associated with energy use result in reduced emissions. Innovation in new technologies supports the move towards more integrated approaches to materials production and management (e.g. clean technologies; information and communications technology - ICT). Innovation in education and governance structures plays an important role in supporting shifts toward new management methods, greater transparency in decision-making, the adoption of co-operative approaches and partnerships, and the diffusion of knowledge.

While technology and innovation have a huge potential, one should not forget that new technologies can also generate additional environmental pressures or strain material availability. New technologies often involve new or substituting materials, the consequences of which need to be known. The same applies to the development and marketing of new products that affect air pollution, chemical safety, recyclability and waste disposal.

Main challenges

The main challenges are to strengthen research, and foster innovation and the use of new technologies in production, and to encourage the creation of markets and the uptake of these technologies by consumers. This requires using an appropriate mix of policy tools and instruments, such as procurement, financing incentives, economic instruments and voluntary initiatives. Support from government R&D budgets is often needed for reducing the costs of new technologies and helping to bring them to market competitiveness.

Further efforts are needed to disseminate good practices and foster entrepreneurship and partnerships. On a global level transfer of technologies and diffusion of knowledge play important roles in fostering resource-efficient societies around the world (see section on international financial transfers).

MONITORING PROGRESS THROUGH INDICATORS

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

Indicators of progress

The indicators presented here relate to:

- R&D expenditure in public and business sector of importance to green growth in energy- and environment-related technologies, expressed in % of all-purpose R&D expenditures.
- Patents of importance to green growth with a focus on (i) patents in energy and climate change mitigation technologies and (ii) patents in pollution abatement and waste management technologies, expressed in number of applications under the Patent Cooperation Treaty (PCT).
- System innovation in all sectors of importance to green growth in terms of firms' environment-related innovation procedures and underlying determinants, expressed in % of all innovating and manufacturing enterprises (illustrative example for selected EU countries).

IV.1 TECHNOLOGY AND INNOVATION

Interpretation

When interpreting these indicators, it should be noted R&D expenditure is an input measure, and environmental R&D thus reflects an intent towards green growth, not a green growth outcome.

While patent applications reflect inventive performance, it should be noted that not all technologies or processes are the subject of patent applications, and that not all enterprises wish to disclose their technological advances through patent applications for various reasons pertinent to market conditions.

Measurability and data quality

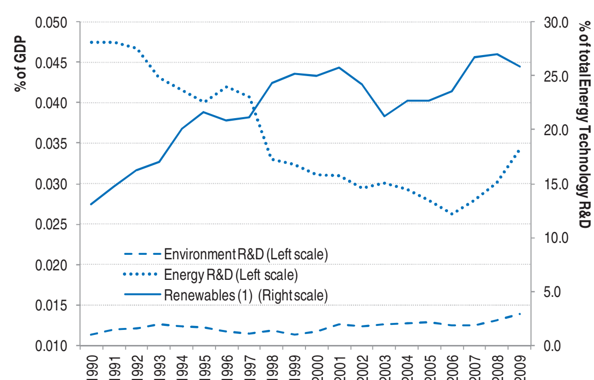
Data on government appropriations and outlays for R&D (GBAORD) are available for most OECD countries. They are structured by socioeconomic objectives and cover energy related and environmentally related R&D separately. Significant gaps exists concerning harmonised data on private-sector R&D expenditures on climate change mitigation, as well as harmonised micro-data on the development and adoption of climate change mitigation technologies.

Data on public-sector energy-related R&D budgets are also available from the International Energy Agency (IEA) for OECD and a small number of non-member countries. More needs to be done to mobilise data on other non-member countries and to monitor technology transfers. See also *Notes and definitions*.

The indicators on patent applications under the PCT are based on inventors' addresses, hence it might occur that the inventor resides in one country but the patent is owned by the headquarters of an enterprise in another country. Little information is available on the related non-technological innovation, such as changes in business models, work patterns, city planning or transportation arrangements, that are also instrumental in driving green growth.

R&D AND PATENTS OF IMPORTANCE TO GREEN GROWTH

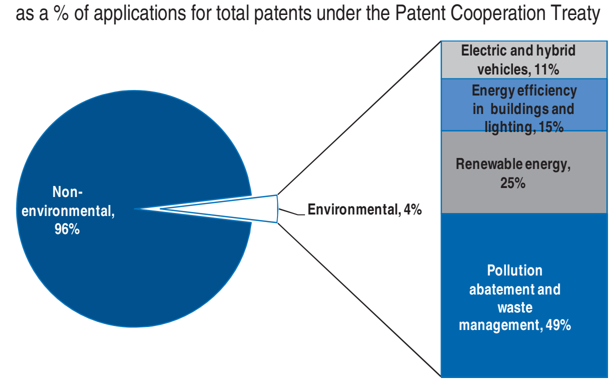
Public spending in energy- and environment-related R&D, OECD, 1990-2009



Source: Energy and environment R&D as a % of GDP based on OECD (2011), Research and Development Statistics Database; Renewables as % of total Energy R&D from IEA (2011) RD&D Budget Database, covering the 28 IEA member countries.

Structure of patents, 2006-2008

as a % of applications for total patents under the Patent Cooperation Treaty



Source: OECD Science and Technology Dataset.

StatLink http://dx.doi.org/10.1787/888932425688

IV.1 TECHNOLOGY AND INNOVATION

MAIN TRENDS

Decline in public environment-related R&D relative to GDP…

While the share of GDP dedicated to public environment- and energy related R&D expenditure has slightly decreased since 1990, the amount dedicated to renewable energy and energy efficiency has gained in importance in recent years. This reflects growing concerns about climate change, rising energy prices and the scarcity of fossil fuels.

…an upward trend in 'green' patents…

Green technology development is accelerating in all areas. Between 1990 and 2008, in most regions and countries there has been an increase in the share of total patents related to air pollution control and renewable energy. The developments are still much taking place at the margin, and are unlikely to be sufficient to deliver major changes in key environmental domains like clean fossil fuel and energy technology development.

..a high degree of specialisation

Evidence at the plant level shows differences in innovation efforts across sectors and countries. Most of the green technology development is concentrated in a relatively small number of countries and there is a considerable specialisation across countries. OECD economies are generally the active innovators in air and water pollution abatement and solid waste management. Countries like Australia (water pollution), Denmark (renewable, wind energy) Germany (air pollution), and Spain (solar energy) are also important sources of invention in specific fields, as are the BRIICS (Brazil, Russian Federation, India, Indonesia, China, South Africa), which are increasingly involved in waste management, water pollution control and renewable energy.

Climate change mitigation technologies are gaining in importance

OECD work indicates that predictability, flexibility and stringency of environmental policies often lead to higher investment in innovation. Innovation in climate change mitigation technologies has been increasing. Some countries, have begun to invest considerable resources in advanced climate change mitigation technologies that are most promising in terms of long-term abatement. Examples include solar photovoltaic energy, hydrogen and fuel cells, carbon capture and storage and other clean fossil fuel technologies (e.g. clean fossil fuel technologies in Canada).

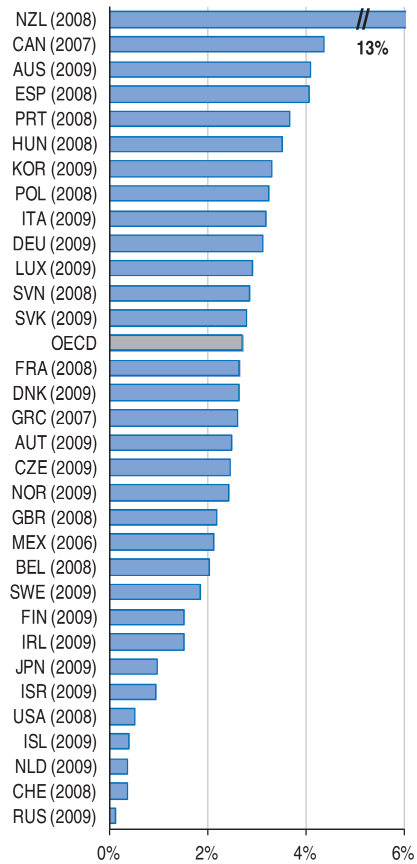
In electric and hybrid vehicles fields, the efforts are concentrated in Japan, Germany, and France, while Hungary is taking edge in energy efficiency in buildings and lightning.

IV.1 TECHNOLOGY AND INNOVATION: R&D EXPENDITURE AND PATENTS

R&D EXPENDITURE OF IMPORTANCE TO GREEN GROWTH

Government R&D budget related to the environment, OECD countries, 2009 or latest

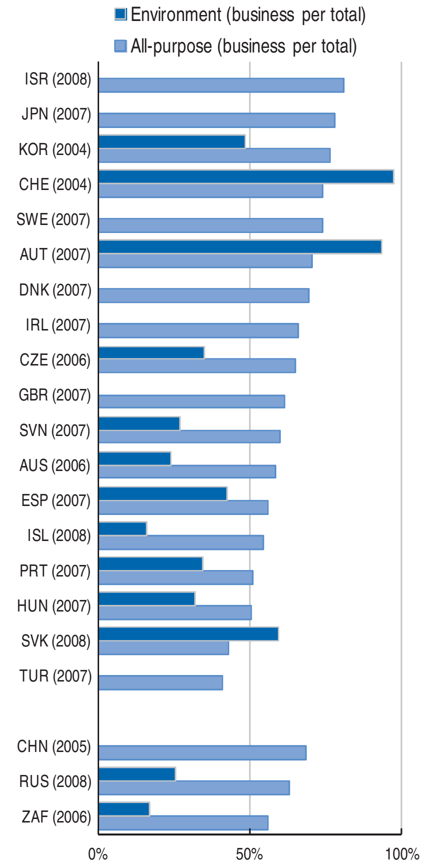
as a % of total government R&D budget



Source: OECD (2011) Science and Technology Indicators Dataset, Government budget appropriations or outlays for R&D.

Business R&D investment, selected countries, 2008 or latest

as a % of total R&D (incl. business, government and other)



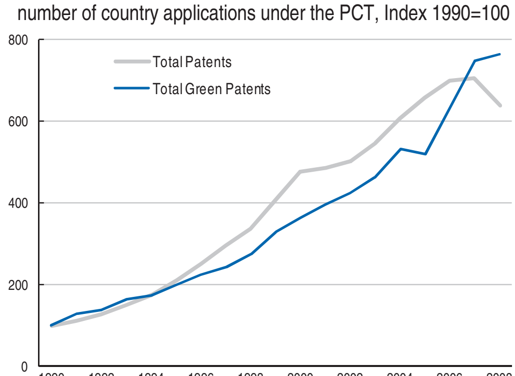
Source: OECD (2011) R&D expenditure database, R&D by sector of performance and socio-economic objective in NABS2007.

StatLink http://dx.doi.org/10.1787/888932425707

PATENTS OF IMPORTANCE TO GREEN GROWTH

Patents under the Patent Cooperation Treaty, OECD, 1990-2008

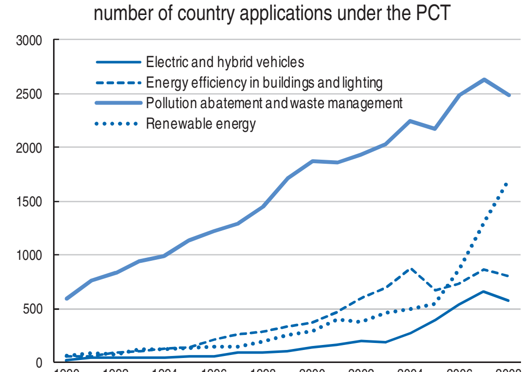
number of country applications under the PCT, Index 1990=100



Source: OECD Patent database.

Patents of importance to green growth, OECD, 1990-2008

number of country applications under the PCT



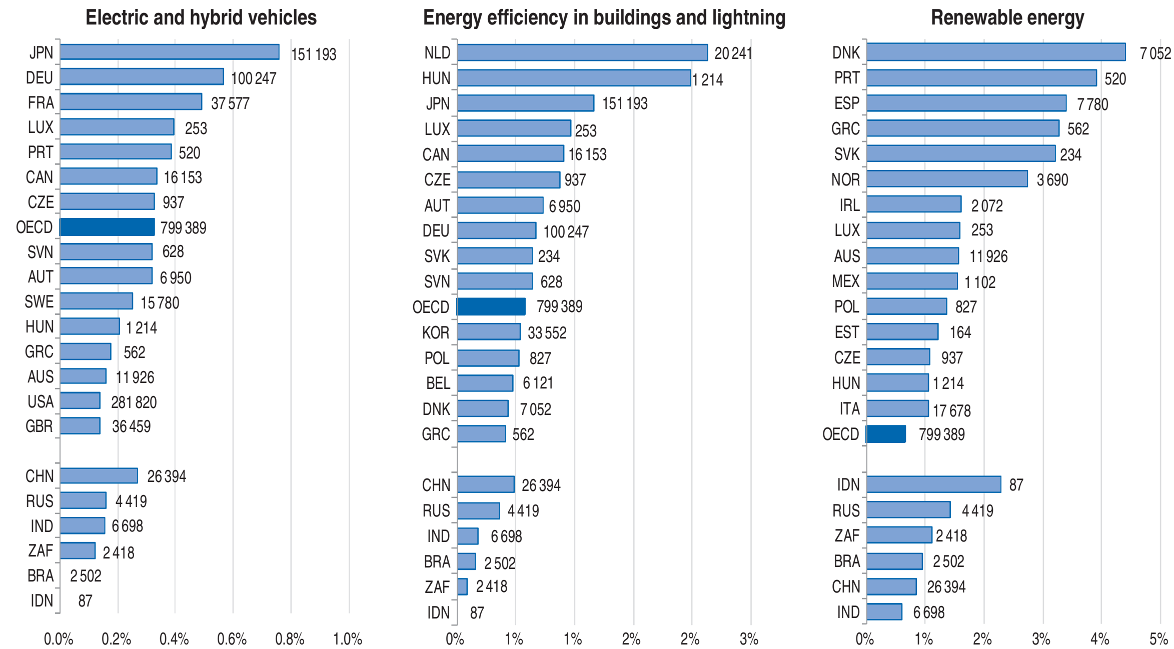
StatLink http://dx.doi.org/10.1787/888932425726

IV.1 TECHNOLOGY AND INNOVATION: PATENTS

PATENTS IN ENERGY AND CLIMATE CHANGE MITIGATION TECHNOLOGIES

Patents in selected climate change and energy technologies, Top 15 OECD countries, BRIICS

as a % of total PCT patent applications, 2003-08



Notes: The numbers above the bars are the total number of PCT patent applications filed in 2003-2008, rounded to the nearest integer.

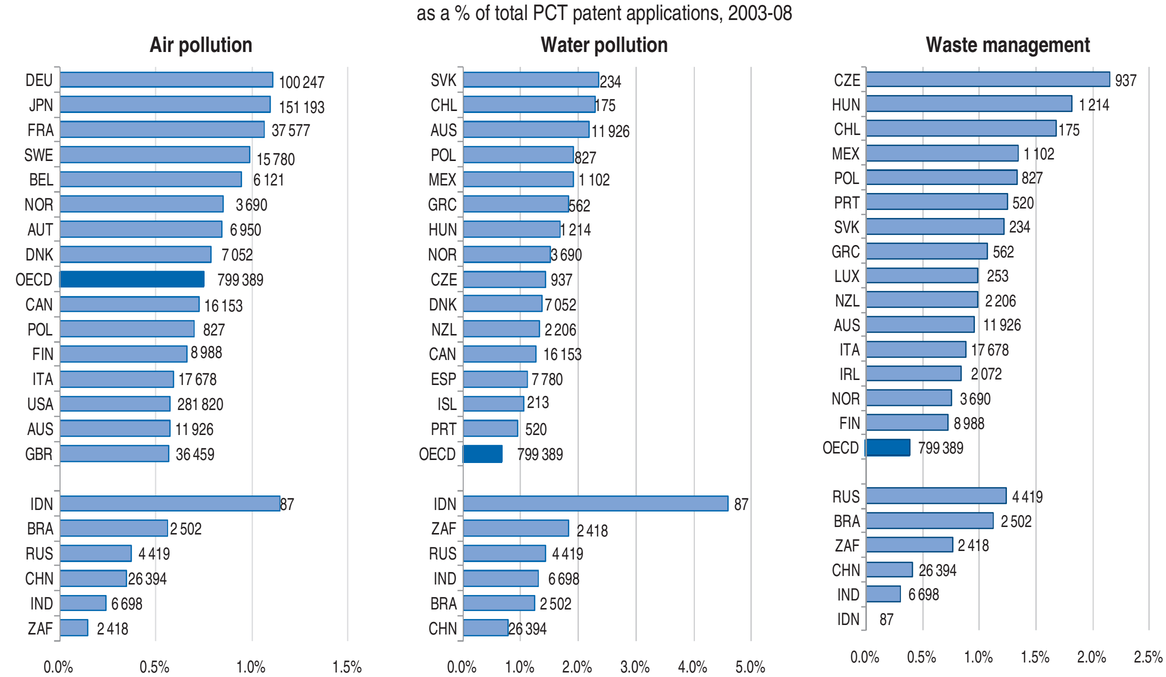
Source: OECD Patent Database.

StatLink http://dx.doi.org/10.1787/888932425745

PATENTS IN POLLUTION ABATEMENT AND WASTE MANAGEMENT TECHNOLOGIES

Patents in selected pollution abatement and waste management technologies, Top 15 OECD countries, BRIICS

as a % of total PCT patent applications, 2003-08



Source: OECD Patent Database.

StatLink http://dx.doi.org/10.1787/888932425764

IV.1 TECHNOLOGY AND INNOVATION: ENVIRONMENT RELATED INNOVATION IN ALL SECTORS

EXAMPLES OF SYSTEM INNOVATION OF IMPORTANCE TO GREEN GROWTH

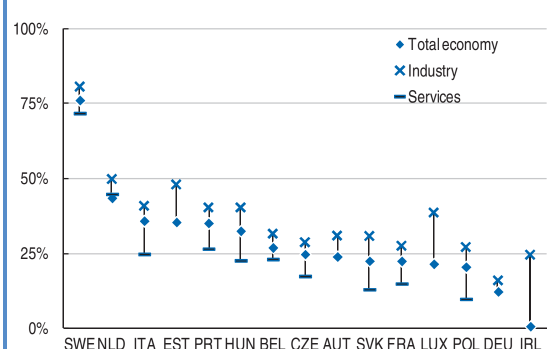
Firm-level innovation data reveals that most innovating firms introduce system innovation comprising product and process innovations as well as marketing and organisational innovations.

Environmentally related innovation across all sectors is still rather limited in most countries. In 2008, on average less than one third of surveyed innovators introduced procedures to regularly identify and reduce environmental impacts. Sweden is an exception with about three quarters of all innovating firms making efforts towards environment related innovation. The industrial sector is currently taking a lead, although services sector is not lagging far behind with roughly 10% points lower share of eco-innovating enterprises.

Environmental regulations (and taxes) and market demand appear to be the main drivers of environmental innovation, given the available data. The figures vary across countries, but on average one quarter of surveyed firms perceived the existing regulation and taxes as an incentive device to introduce eco-innovation, as opposed to 18% for expected market demand and only 7% for the government support.

Environmentally related innovation in all sectors

Selected EU countries, 2008

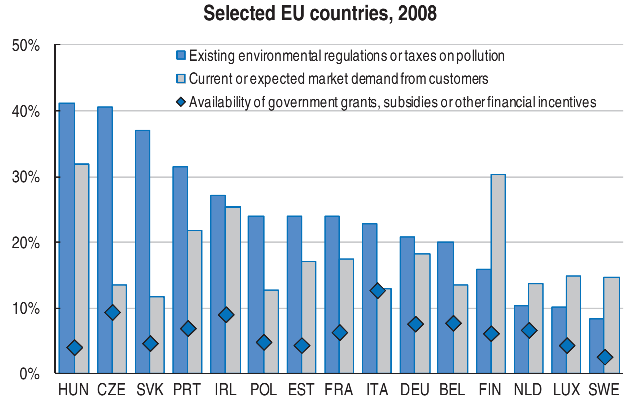


Notes: The share of enterprises with procedures in place to regularly identify and reduce environmental impacts as % of all surveyed enterprises with innovation activity (product, process, ongoing or abandoned, organisational and marketing innovation). All firm sizes.

Source: Eurostat (2010), Community Innovation Statistics (CIS-2008).

Determinants of environmentally related innovation

Selected EU countries, 2008



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

IV.1 TECHNOLOGY AND INNOVATION

Notes and definitions

R&D expenditure

The Frascati Manual is the internationally recognised methodology for collecting and using research and development (R&D) statistics.

Government budget appropriations or outlays for R&D (GBAORD) measures the funds committed by the federal/ central government for R&D. It can be broken down by various socioeconomic objectives, including control and care for the environment as well as energy.

Energy R&D

It should be noted that in addition to R&D (which includes basic research, applied research and experimental development), the IEA data series on energy R&D also include technical demonstration and are referred to as RD&D.

Patent applications

Data refer to patent applications filed under the Patent Cooperation Treaty (PCT). The OECD uses search algorithms to generate data on patent applications for environmental technologies. The data are being further refined with inputs from the European Patent Office. The OECD total includes 34 OECD countries. The 5-year averages are considered to avoid the potential bias arising from variability of patent applications over time.

Total 'green' patents comprise patents in climate change mitigation and energy and pollution abatement and waste management.

- Patents in climate change mitigation and energy include renewable energy; fuel cells and energy storage; alternatively fuelled vehicles; energy efficiency in the electricity, manufacturing and building sectors. Renewable energy patents include energy‐ generation technologies such as wind, solar, geothermal, ocean, hydro, biomass and waste-to-energy. The OECD triadic patent families are defined as a set of patents protecting the same invention filed at the European Patent Office (EPO), at the Japan Patent Office (JPO) and granted by the US Patent and Trademark Office (USPTO).
- Patents in pollution abatement and waste management technologies include air pollution control, water pollution control and wastewater treatment. Waste management technologies cover disposal of solid waste, waste material re-use and recycling, and energy recovery from waste.

Innovation

Innovation activity is difficult to capture with measured indicators. The latest available information from the EU Community Innovation Survey (CIS) is used to give a snapshot view of possible indicator of the environment-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 CIS was carried out in 27 Member States, Candidate Countries, Norway and Iceland; it was launched in 2009, based on the reference period 2008, with the observation period 2006 to 2008.

Total economy includes all Core NACE activities related to innovation activities (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

- OECD (2010) Measuring Innovation: A New Perspective - OECD
- OECD (2009) OECD Science, Technology and Industry Scoreboard 2009
- OECD (2007) Business and the Environment, OECD, Paris.
- IEA (2009), IEA Scoreboard 2009: 35 Key Energy Trends over 35 Years, IEA, Paris.
- Eurostat (2011), Community Innovation Statistics.

Further information

- For further details on classifications see www.oecd.org/environment/innovation/indicator .
- OECD Project on Environmental Policy and Corporate Behaviour (www.oecd.org/env/cpe/firms).

Online databases

- OECD, Research & Development Database
- OECD, Patent Database
- Eurostat, Community Innovation Statistics (http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis)

IV.2 PRODUCTION OF ENVIRONMENTAL GOODS AND SERVICES

POLICY CONTEXT

The issue

Producing environmental goods and services has potential for growth and employment while contributing to a shift towards greener growth. The process started by addressing the most visible environmental issues through end-of-pipe solutions and has gradually shifted towards process innovation and integrated clean technologies to prevent pollution from the outset, increase resource efficiency and minimise resource use.

Main challenges

The main challenge is to foster the production of environmental goods and services across a wide range of sectors. This requires appropriate market conditions and institutional frameworks to support entrepreneurial development in this field. Capacity building, stronger industry-science links, training and development of skills are particularly important for small and medium sized enterprises to seize the opportunities of doing green business.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed by examining the share of the environmental goods and services sector in the economy in terms of employment and value-added, along with the framework conditions in place for doing business and accessing financing. It can also be assessed against transformations in economic sectors and moves from traditional business activities to greener activities.

Indicators of progress

The indicator examples presented here relate to:

- Employment in the environmental products sector, for selected countries and selected sectors, expressed as a % of the total employment. The sectors covered include: recycling (ISIC 37); collection, purification and distribution of water (ISIC 41); sewage and refuse disposal, sanitation and similar activities (ISIC 90).
- Share of "green" enterprises in the economy, expressed as a % of the total number of enterprises. The sectors covered include: retreating (ISIC 25.12); recycling (ISIC 37); collection, purification and distribution of water (ISIC 41).

Interpretation

When interpreting these indicators, it should be noted that they only provide a partial picture of activities relevant for green growth, and that they do not reflect an internationally agreed classification (see the discussion in Part I of this report). An international standard is yet to be implemented, although it has already been proposed at the European level and is emerging at the international level through the UN System of Environmental Economic Accounting (SEEA).

Measurability and data quality

Data on the environmental goods and services sector are available from Eurostat for several European countries. Data on employment in core environmental industries are available from the OECD.

The scope for monitoring progress remains however limited. Most indicators used to describe entrepreneurial performance are not available at the level of detail required to capture activities characterised as 'green'. Further improvements are needed to generate internationally comparable data for all OECD countries and for major non-OECD countries. Comparable and coherent data on, for example, environmental goods and services turn-over, value added, exports and employment, are needed to identify the importance of environmental activities in the economy. In addition, there is a need for further developing terms, definitions, and classifications.

IV.2 PRODUCTION OF ENVIRONMENTAL GOODS AND SERVICES

MAIN TRENDS

'Green' industries represent a modest share in the economy…

The share of "green" sectors today is rather small as judged simply by the size of industries involved in the production of environmental products. The share of employment in selected "green" industries on average represents only about 1.5% of total employment. The number is even below 0.5%, if the indicator is expressed in terms of number of firms primarily active in selected "green" industries. The interpretation of these numbers very much depends on how exactly 'green' industries are defined.

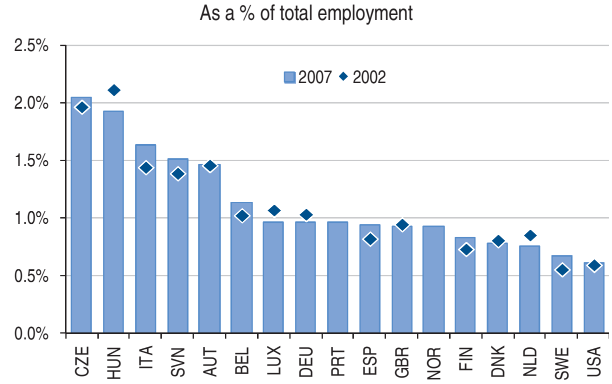
…but what counts is the 'green' transformation of the economy

An important complement to measures of 'green' industries is information on opportunities arising from environmental considerations throughout the economy, independently of whether particular products serve environmental purposes. This would for instance require surveys akin to the information on innovation mentioned above. General indications about entrepreneurship can also be helpful. Barriers to entrepreneurship are likely to determine the entrance and job creation of all firms, regardless of their share of environmentally related activities. However, quantifying these effects goes beyond the development of indicators and requires modelling.

THE ENVIRONMENTAL GOODS AND SERVICES SECTOR – INDICATOR EXAMPLES

Employment in the environmental goods and services sector, 2002, 2007, selected EU countries

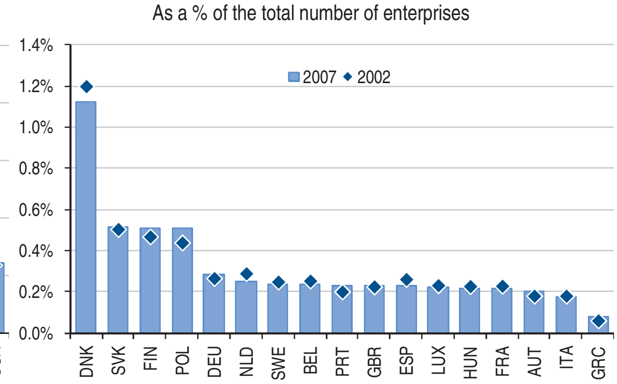
As a % of total employment



Source: OECD Structural and Business Statistics (SDBS), STAN database

Enterprises in the environmental goods and services sector, 2002, 2007, selected EU countries

As a % of the total number of enterprises



Source: Eurostat New Cronos database

Notes and definitions

Share of enterprises in the EGS sector: expressed as a % of the total number of enterprises in the economy. Ttotal economy corresponds to ISIC Rev3 sectors 10 to 74, excluding sectors 65 to 67. Belgium, Greece and Poland: 2002 data refer to 2003.

Sources

- OECD Structural and Business Statistics (SDBS) database, and STAN database for ISIC sector 90.
- Eurostat New Cronos database

Further information

- Eurostat (2009); The Environmental Goods and Services Sector; Luxembourg.
- OECD, Eurostat (1999); The environmental goods and services industry: manual for data collection and analysis; Luxembourg.
- OECD (2009), Measuring entrepreneurship: A digest of indicators, OECD, Paris, based on the OECD, Entrepreneurship Financing Database; based on data from Thomson Financial, PwC, EVCA, National Venture Capital Associations, Australian Bureau of Statistics and Venture Enterprise Center.
- New Zealand Ministry of the Environment (2010); Green Economy: Some Facts and Figures for New Zealand; Ministry for the Environment Information Directorate 11/2010.
- U.S. Department of Commerce (2010); Measuring the Green Economy; Washington D.C.

Online databases (http://stats.oecd.org/ ***)***

- OECD Structural and Business Statistics (SDBS) database
- OECD Product Market Regulation database
- OECD STAN database

IV.3 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 one important aspect in combining development and environmental objectives. The transfer of technologies and the diffusion of knowledge through investment projects play an important role in fostering resource-efficient progress of societies around the world.

Main challenges

The main challenge is to strengthen the use of public financing to leverage private money in projects fostering transition to greener growth, for example in the water and energy markets. There is also a need to build the capacity of environmental staff to interact with their finance ministry colleagues and help steering budget-support resources towards achieving green growth objectives.

Further efforts are also needed to disseminate best practices and foster comprehensive entrepreneurship and partnerships. On a global level, countries need assistance to transform the assessments of their sectoral needs into a coherent identification of innovation priorities.

MONITORING PROGRESS THROUGH INDICATORS

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 aid 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.

Indicators of progress

The indicators presented here relate to:

Official Development Assistance

- Total Official Development Assistance (ODA), expressed in % of gross national income; and the share of ODA to environment and renewable energy, expressed in US dollars and in % of total ODA.
- Official Development Assistance targeting the objectives of the Rio Conventions including biodiversity related aid, desertification related aid and climate change related aid, expressed in US dollars.

Carbon markets

- Trading of carbon allowance 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 and $GtCO_2$.
- The structure of supply and demand of certified emissions reductions (CER) credits issued by the Kyoto Protocol's Clean Development Mechanism (CDM) projects in the pipeline, expressed in % of all projects by regions and sectors. Private finance here comprises the flows generated through allocation of carbon market allowances, with a focus on CDM projects.

IV.3 INTERNATIONAL FINANCIAL FLOWS

Interpretation

When interpreting these indicators, 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.

With respect to carbon market financing, there may be duplicates in the spot or secondary transactions not accounted for in reporting, which could lead to a slightly upward biased indicator of total carbon market in terms of carbon allowances. The structure of the 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. The latter is currently not included due to data availability issues.

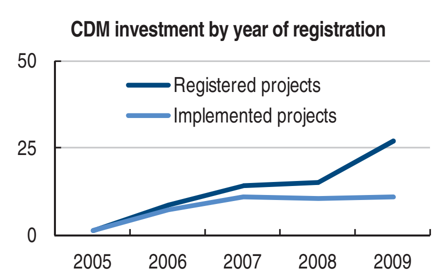
The limitation of this indicator is that it does not track directly the financial flows between OECD countries. A green FDI-based indicator could fill this gap but lack of an agreed definition and very patchy data do not permit presenting data at this stage.

Measurability and data quality

The main statistical challenge refers to additionality and monitoring of financial flows of environmental importance. Although some standards exist (e.g. the OECD Development Assistance Committee's Creditor Reporting System), it remains difficult to determine the environmental purpose of existing aid commitments and investment schemes.

The ODA donors are requested to screen each aid activity reported to the Creditor Reporting System (CRS), though data gaps remain for some donors. 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.

Public financing is also provided through official export credits and through multilateral development banks (MDBs), which can facilitate and leverage private investments. Official export credits relate to direct export credit financing, export credit insurance and export credit guarantees facilitated by the government support. MDBs are increasingly managing dedicated environment-related funds, for example, the Climate Investment Funds, the Global Environment Facility Trust Fund by the UNDP, the Green Investment Scheme by the World Bank, and the Congo Basin Forest Fund managed by the African Development Bank. Regarding leveraging of public international finance, MDBs and bilateral donors gather some data and report on leveraging performance of development assistance, but there is currently no agreed methodology on how to track these flows in a consistent manner.



Source: OECD-CCXG personal communication, E. Haites, S. Seres, G. Kirkman, 2010.

The UNEP-RISO CDM project database contains no statistical data on value of investments or price of certified emissions reductions (CERs). An alternative way to measure the finance flowing through CDM would be to monitor investment flows associated with CDM projects. While there are increasing efforts to assess annual investment flows into the CDM, there is still lack of standard methodologies to provide a comprehensive measurable indicator without a risk of double-counting private flows.

IV.3 INTERNATIONAL FINANCIAL FLOWS

MAIN TRENDS

Environmental ODA continued to rise…

Despite the financial crisis, the total ODA flows have continued to rise to 2009, and are expected to reach USD 126 billion in 2010. The ODA targeted to environmental purposes amounted to 26 billion USD in 2009, a 45% increase from 2007. Similarly, aid for renewable energies recently surpassed the aid for non-renewable energy. In addition, there is more than 3 billion USD under operation in various climate funds, and developed countries committed to make 30 billion USD available as "fast-start" finance in 2010- 2012 and 100 billion USD per year by 2020.

In value terms, close to 80% of mitigation-related aid was reported in the sectors of energy, general environmental protection, transport and storage, water and forestry. With foreign direct investment and other private flows to low-income countries on the decline, the development aid has a role to play in countering the development impact of the recent crisis and in fostering the transition to greener growth.

Trends in aid targeting the objectives of the Rio Conventions have shown an increase since the late 1990s. In 2008, DAC members allocated approximately USD 3.4 billion for biodiversity-related aid, USD 8.4 billion for climate change-related aid and USD 2.4 billion for desertification-related aid. Until recently, other environment aid has remained stable until 2005. The recent upsurge is explained by stronger support of bilateral donors for water- and climate-change related programs. Aid for renewable energy decreased significantly until 2003, but has been rising since 2005. This is largely due to hydro-power related projects, which represented about 93% of aid for renewable energy in 1990, 32% in 2003 and 43% in 2005.

…carbon markets slowed during the crisis but keeps growing

The global economic crisis adversely affected the carbon market, which demonstrated maturity by responding to macro-economic trends. On the demand side, the reduced industrial output has led to lower demand for carbon allowances. On the supply side, the investors responded to the crisis by diversifying portfolio positions towards safer asset markets. In spite of depressed demand exerting downward pressure on the carbon price, the market increased its value by 6% to USD 144 billion in 2009, for the amount of 8.7 $GtCO_2$ traded allowances.

The European Union Emission Trading Scheme is the main driving force of the carbon market, accounting for 96% of total allowances value in 2009. The EU ETS turnover almost doubled to 6.3 GtCO2 in 2009 compared to the previous year. The value of the market exhibited less sharp increase of 15% to USD 118 billion in 2009 as prices declined. In the US, the Regional Greenhouse Gas Initiative (RGGI) had a good start by growing almost 10-fold to USD 2.2 billion during 2008-2009, while in Australia the New South Wales GHG Abatement Scheme plummeted from USD 309 to 50 million and the Chicago Climate Exchange from USD 183 to 117 million over 2008-2009.

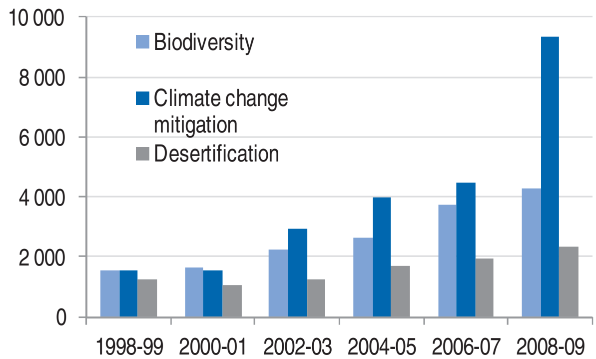
Project-based transactions also contracted. The value of Clean Development Mechanism (CDM) projects representing 79% of all transactions, declined by 59% (2009/2008) in response to the crisis. China remained the key seller of Certified Emission Reductions (CERs) issued by the CDM projects (41% of CDM projects). Other BRIICS countries have also started to attract funding. The CDM projects are important to facilitate low-carbon investments in projects of importance to green growth. While traditionally attractive investment in landfill gas projects has declined, the renewable energy and industrial energy efficiency now represent about two thirds of the market. Given that key financial players in the carbon market operate in European exchange markets, the European region of OECD countries accounts for the lion share (62%) of total demand for CDM projects.

IV.3 INTERNATIONAL FINANCIAL FLOWS: DEVELOPMENT ASSISTANCE

OFFICIAL DEVELOPMENT ASSISTANCE OF IMPORTANCE TO GREEN GROWTH

Aid targeting the objectives of the Rio Conventions, OECD DAC members

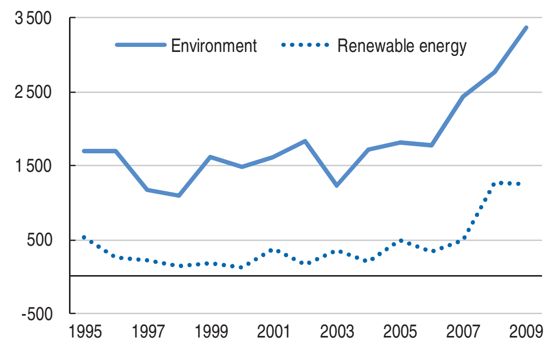
Million USD



Source: OECD-DAC Development Aid database

Trends in ODA for the environment and renewable energy, OECD DAC members

Million USD

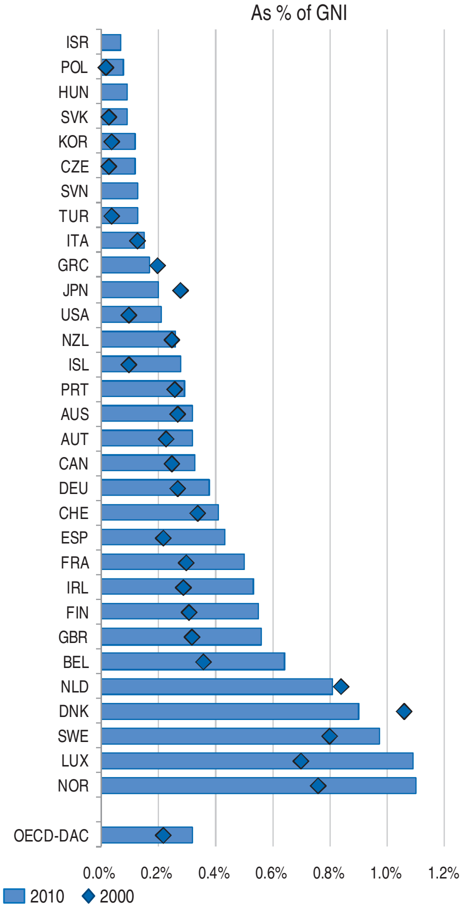


Source: OECD-DAC Development Aid database.

StatLink http://dx.doi.org/10.1787/888932425783

Total ODA, OECD countries, 2000, 2010

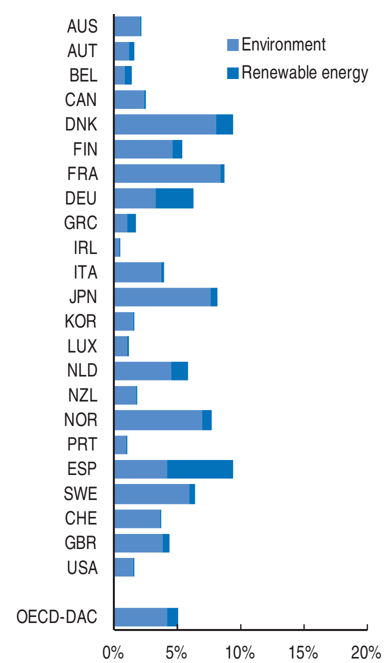
As % of GNI



Source: OECD-DAC Development Aid database

ODA to the environment and renewable energy, OECD-DAC members, 2008-09

% of total ODA



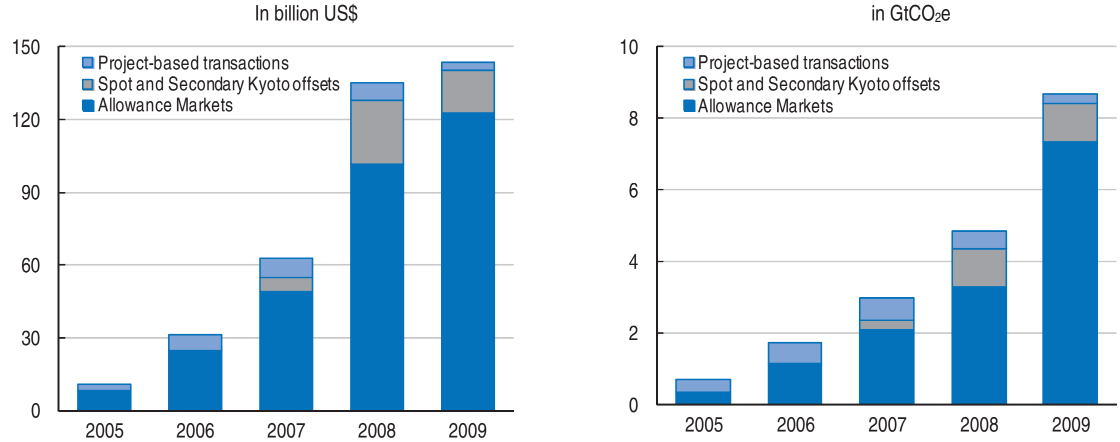
OECD DAC members: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States and European Union Institutions.

StatLink http://dx.doi.org/10.1787/888932425802

IV.3 INTERNATIONAL FINANCIAL FLOWS: CARBON MARKETS

CARBON MARKET FINANCING

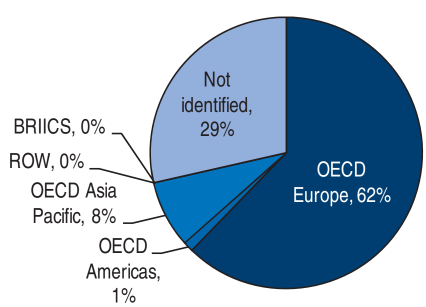
Total carbon market in terms of traded carbon allowances, 2005-2009



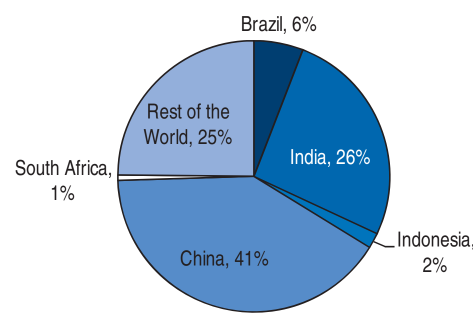
Source: World Bank.

StatLink http://dx.doi.org/10.1787/888932425821

Buyers of Clean Development Mechanism credits in the pipeline, 2010
As a % of total number of projects, by region



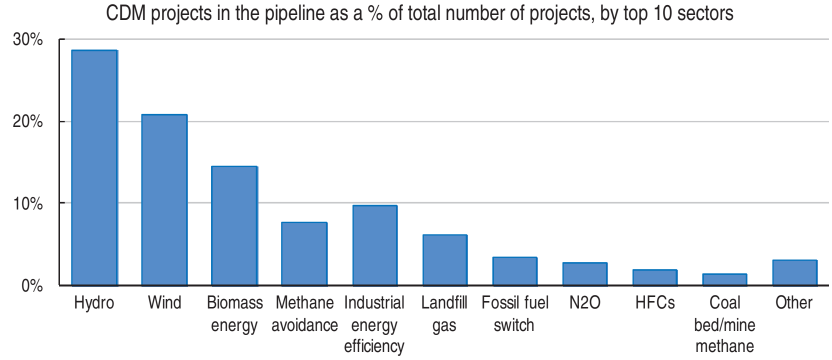
Sellers of Clean Development Mechanism credits in the pipeline, 2010
As a % of total number of projects, by region



Source: UNEP Riso CDM/JI Pipeline Analysis and Database.

StatLink http://dx.doi.org/10.1787/888932425840

Clean Development Mechanism projects with CERs issued, 2010
CDM projects in the pipeline as a % of total number of projects, by top 10 sectors



Source: UNEP Riso CDM/JI Pipeline Analysis and Database.

StatLink http://dx.doi.org/10.1787/888932425859

IV.3 INTERNATIONAL FINANCIAL FLOWS

Notes and definitions

Environmentally related ODA

The OECD's Development Assistance Committee (DAC) has established a comprehensive system for measuring aid targeting the objectives of the Rio Conventions, environment and renewable energy.

Official Development Assistance targeting the objectives of the **Rio Conventions** is identified using the so-called "Rio Markers", which screen for policy objectives that have a cross-sectoral nature and include climate change, biodiversity, and desertification. Data cover Members of the OECD's Development Assistance Committee (DAC); they refer to commitments expressed in US dollars at constant 2008 prices, and to two-year averages.

Biodiversity-related aid is defined as activities that promote conservation of bio-diversity, sustainable use of its components, or fair and equitable sharing of the benefits of the utilisation of genetic resources.

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

Climate change-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.

Total ODA: data refer to annual average disbursements as a share of total sector-allocable aid.

ODA for environment and renewable energy: data refer to commitments at constant 2008 prices. Renewable and energy-related aid defined as activities that promote the development and deployment of energy generation facilities with reduced pressure on the environment.

Carbon market financing

Trading of carbon allowance in terms of value of offset transactions is based on known volumes of sales of units and estimates of average offset prices, expressed in US dollars and $GtCO_2$.

The structure of supply and demand of CER credits issued by the CDM projects in the pipeline, expressed in % of all projects by regions and sectors.

Total carbon markets: The figures refer 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. Allowance markets include European Union Emissions Trading Scheme (accounting for 96% of total allowances value in 2009), Assigned Amount Units, Regional Greenhouse Gas Initiative, New South Wales Greenhouse Gas Reduction Scheme, and Chicago Climate Exchange. Project-based primary transactions include Clean Development Mechanism (79% of value in 2009), Joint Implementation and, where data are available, Voluntary Market transactions.

CDM projects: The shares are based on the number of CDM projects in the pipeline. Total number of CDM projects includes registered projects and the projects at validation and requested registration. Rejected projects are excluded as well as the projects where validation has been terminated. The distribution of projects is not representative of the volume of credits issued, because approximately 70% of all CERs issued to date are for industrial HFC and N_2O.

CDM projects with CERs issued: CDM comprise registered projects, projects at validation and requested registration. Excluded are rejected projects and projects where validation has been terminated. Industrial energy efficiency relates to energy efficiency in industry and power generation from waste gas and waste heat recovery.

Sources

- OECD-DAC: CRS Aid Activity database
- OECD-CCXG (2010), Personal communication, E. Haites, S. Seres, G. Kirkman.
- UNEP (2011), Riso CDM/JI Pipeline Analysis and Database
- UNFCCC (2011), CDM Registry, http://cdm.unfccc.int/Registry/index.html
- World Bank (2005-2010), State and Trends of the Carbon Market

Further information

- The OECD-DAC Secretariat of the OECD
- The CCXG Secretariat of the OECD
- OECD-DAC (2009), "Measuring Aid to Water Supply and Sanitation", www.oecd.org/dac/stats/crs/water.
- OECD (2010a), Defining and Measuring Green FDI: Preliminary Findings and Issues for Discussion. Working Party of the Investment Committee. DAF/INV/WP/WD(2010)1. Paris: OECD.
- OECD (2010b), Arrangement on officially supported export credits, January 2010 REVISION, TAD/PG(2010)2. OECD: Paris.
- OECD (2011a) Financing Climate Change Action and Boosting Technology Change, flyer updated December.
- OECD (2011b), Development Perspectives for a Post-2012 Climate Financing Architecture, available at: http://www.oecd.org/dataoecd/47/52/47115936.pdf
- Corfee-Morlot, J., B. Guay and K.M. Larsen (2009), Financing for Climate Change Mitigation: Towards a Framework for Measurement, Reporting and Verification, OECD/IEA Information Paper, http://www.oecd.org/dataoecd/0/60/44019962.pdf
- UNEP (2010), Bilateral Finance Institutions and Climate Change: a Mapping of 2009 Climate Financial Flows to Developing Countries, United Nations Environment Programme, 2010.
- UNFCCC (2007) Investment and financial flows to address climate change. http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/background_paper.pdf

IV.4 PRICES AND TRANSFERS

POLICY CONTEXT

The issue

Market signals influence the behaviour of producers and consumers and hence provide a vehicle for addressing environmental externalities of economic activity. Environmentally-related taxes are an important instrument for governments to shape relative prices. Changes in relative prices affect substitution between different types of energy inputs and also between energy and other inputs into production. For instance the level of taxation of energy relative to the level of taxation of labour can influence the relative price of inputs and affect demand for labour and energy. Energy end-use prices influence overall energy demand and their composition influences the fuel mix which in turn largely determines environmental pressures caused by energy activities.

Main challenges

The main challenge is to provide clear, stable and transparent market signals. This requires appropriate policies to incentivise innovation and new technology adoption by firms and to facilitate environmentally efficient consumption patterns, while demonstrating a clear policy commitment of governments to move towards greener growth. For instance, the level of taxation of energy relative to the level of taxation of labour can influence the relative price of inputs and affect demand for labour and stimulate the use of energy from cleaner sources.

MONITORING PROGRESS THROUGH INDICATORS

Progress towards green growth can be assessed against the evolution of tax structures and price signals.

Indicators of progress

The indicators presented here relate to:

- Environmentally related tax revenues expressed in % of total tax revenues, compared to labour tax revenues in % of total tax revenues.
- Taxes and prices for road fuels (diesel, unleaded petrol) and end-use prices for light fuel oil, electricity and natural gas and for industry and households.

Interpretation

When interpreting the indicator on environmentally-related taxes, it should be noted that the figures alone do not provide sufficient information to judge the "environmental friendliness" of the tax systems in the countries concerned. For such analyses, additional information describing the economic and taxation structure of each country is required. It should also be kept in mind that revenues from fees and charges – and from any levies related to resource management – are generally not included. However, charges whose benefits are in proportion with their payment are classified as taxes (e.g. wastewater or effluent charges).

When interpreting the indicators on energy prices and taxes, it should be noted that comparisons among countries should be made with caution, in particular as regards electricity prices for households for which a variety of tariff structures exist.

These indicators reflect only one type of policy instruments (economic instruments). They should be complemented with indicators reflecting regulatory measures put in place by governments. The construction of such indicators is however constrained by data gaps and conceptual issues.

Measurability and data quality

Information on environmentally-related taxes is available from the OECD-EEA database on on instruments used for environmental policy and natural resources management. The data are more complete for taxes, and further efforts are needed to cover other instruments, e.g. fees and charges, tradable permits, deposit refund systems, and environmentally motivated subsidies.

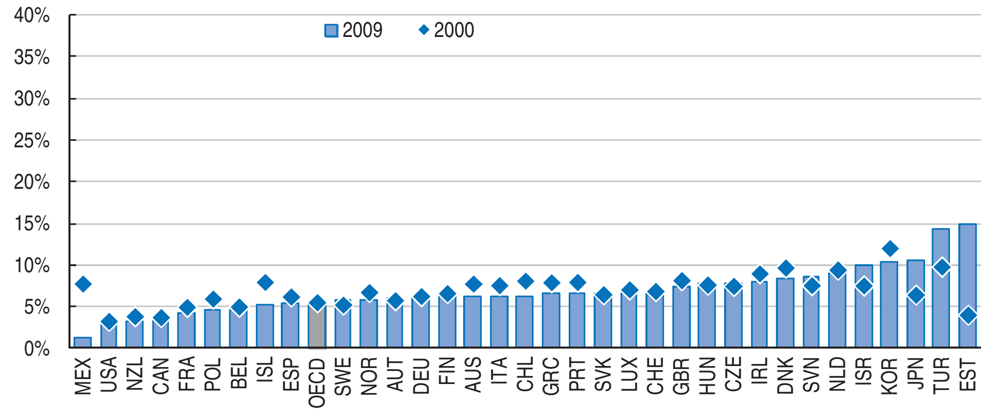
Information on energy prices and taxes is available from the IEA, but its compilation has become a challenge. Deregulation of energy markets has led to an exponential increase in the number of market players – and to more and more difficulties in collecting price data on an equivalent basis.

IV.4 PRICES AND TRANSFERS: ENVIRONMENT RELATED TAXES

ENVIRONMENT RELATED TAXES

Revenues from environmentally related taxes, OECD countries, 2000 and 2009

In % of total tax revenues

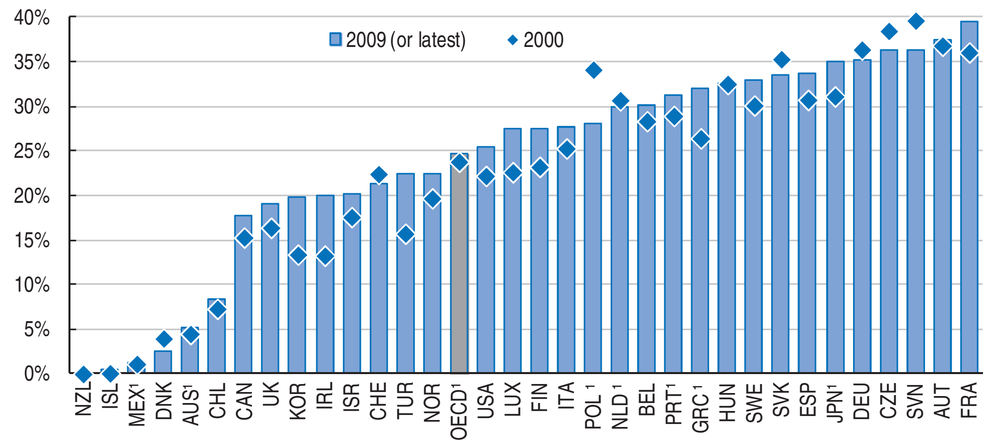


Source: OECD/EEA database on instruments used for environmental policy and natural resource management.

StatLink http://dx.doi.org/10.1787/888932425878

Revenues from labour taxes, OECD countries, 2000 and 2009 (or latest)

In % of total tax revenues

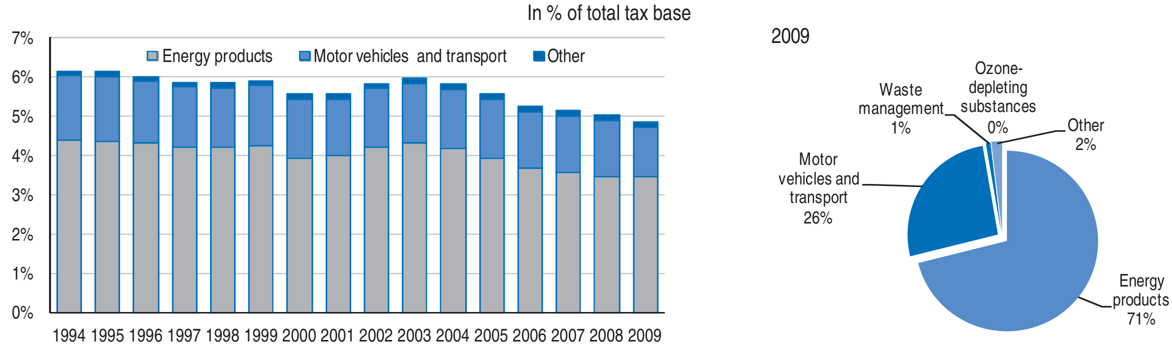


Source: OECD Revenues statistics database.

StatLink http://dx.doi.org/10.1787/888932425897

Structure of environmentally related tax revenues, OECD, 1994-2009

In % of total tax base



Source: OECD/EEA database on instruments used for environmental policy and natural resource management.

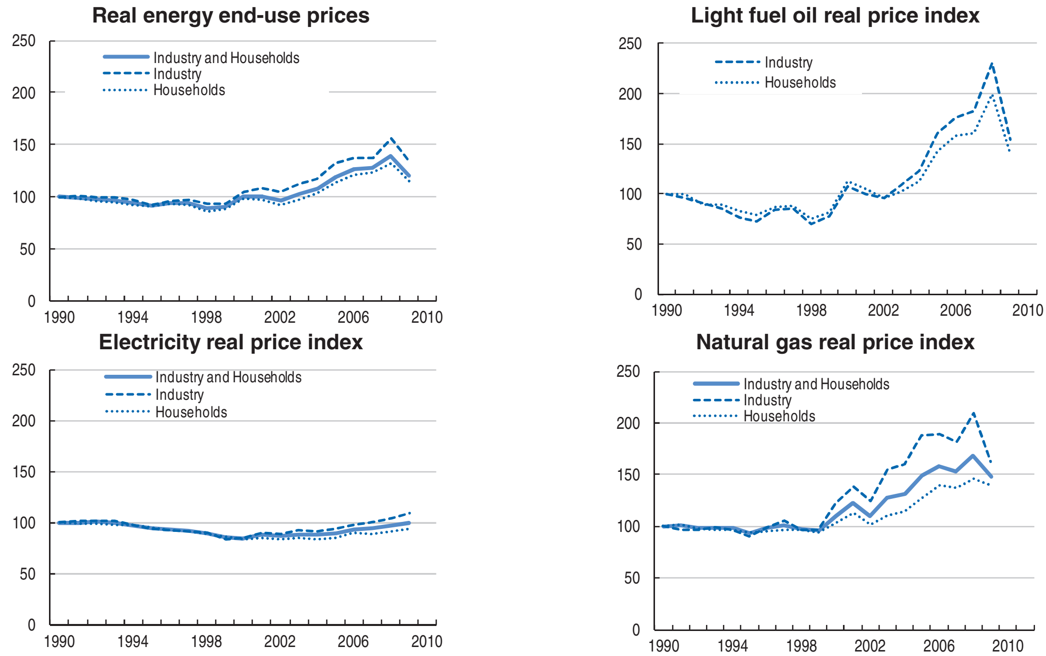
StatLink http://dx.doi.org/10.1787/888932425916

IV.4 PRICES AND TRANSFERS: ENERGY TAXES AND PRICES

ENERGY END-USE PRICES

Trends in real energy end-use prices, OECD, 1990-2009

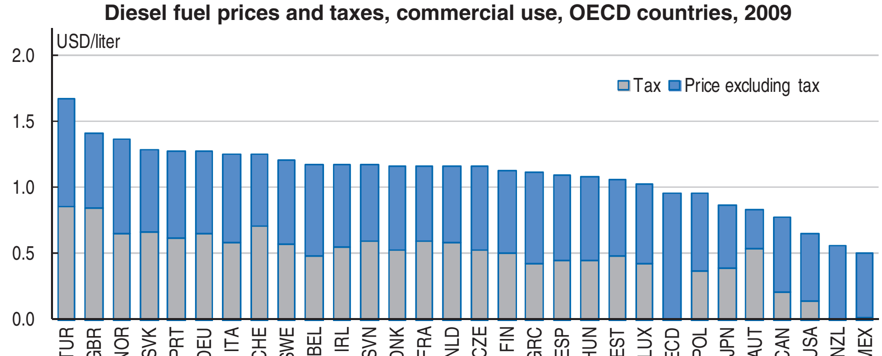
Index 1990=100



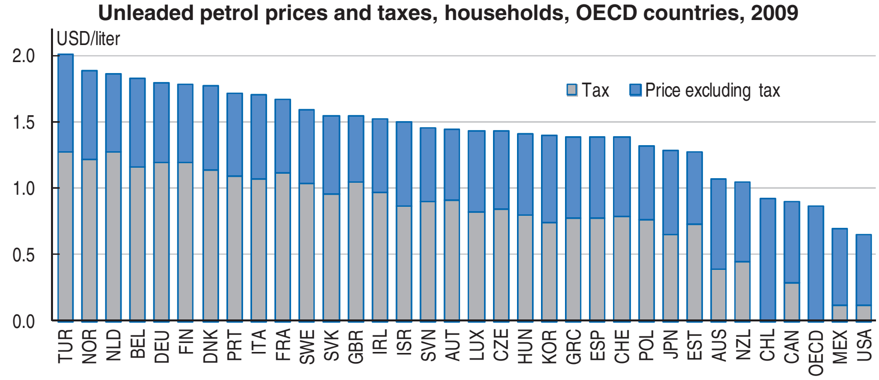
Source: OECD-IEA (2011), Energy Prices Database.

ENERGY TAXES – ROAD FUELS

Diesel fuel prices and taxes, commercial use, OECD countries, 2009



Unleaded petrol prices and taxes, households, OECD countries, 2009



Source: OECD-IEA (2011), Energy Prices Database.

IV.4 PRICES AND TRANSFERS: ENVIRONMENT RELATED TAXES

MAIN TRENDS

Rise in real energy prices since the early 2000s…

Real end-use energy prices have increased in most OECD countries up to 2008, mainly due to a rise in crude oil prices, and since then, have been decreasing mainly due to the economic crisis.

Energy prices and related taxes, whether for industry or households, and rates of change vary widely among countries for all types of energy. This is due to different fuel taxation policies that vary widely, regardless of whether countries are energy producers, exporters, importers or consumers.

…but large variations in levels between countries

Electricity prices and light fuel oil prices vary widely across OECD countries for both industry and households. Prices tend to be higher for households than for industry. Deregulation of electricity supply has led to increased price volatility over the last 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. Another driver of pricing is found in the fuel mix, which varies considerably across OECD countries (see Section II).

… due to differences in the policy mix and in energy endowments.

Differences in road fuel prices across OECD countries can be mostly attributed to differences in taxes, which account for the bulk share of the fuel price in oil-importing countries. Taxes on unleaded petrol prices are systematically higher than taxes on diesel fuel prices, suggesting higher price elasticity of demand for the former type of fuel.

Notes and definitions

Environmentally related taxes

Environmentally-related tax revenues expressed in % of total tax revenues, compared to labour tax revenues in % of total tax revenues. Environmentally related taxes include taxes on energy products (for transport and stationary purposes including electricity, petrol, diesel and fossil fuels), motor vehicles and transport (one-off import or sales taxes, recurrent taxes on registration or road use, other transport taxes), waste management (final disposal, packaging, other waste-related product taxes), ozone-depleting substances and other environmentally related taxes. The OECD weighted average includes 34 OECD countries. In Mexico, fluctuations of consumer prices on motor vehicle fuels are smoothed out; since 2009, the government is implementing a phase-out policy on fossil fuel subsidies.

Labour taxes

Labour taxation includes employees taxation, employers taxation and taxes on payroll and workforce. The OECD weighted average includes 34 OECD countries.

Energy taxes and prices

Road fuel prices and taxes for diesel and unleaded petrol: USD at current prices and exchange rates. Unleaded petrol: Premium unleaded, except Japan. Prices for end-use energy, light fuel oil, electricity and natural gas for industry and households. The OECD average excludes Iceland. The trend is expressed as an index number (1990=100).

Sources

- OECD/EEA (2011) database on instruments used for environmental policy and natural resource management: http://www2.oecd.org/ecoinst/queries/index.htm
- OECD (2011), Revenues statistics database.
- OECD-IEA (2011), Energy Prices database.

Further information

- IEA Scoreboard 2009 – 35 Key Energy Trends over 35 years.
- IEA World Energy Outlook 2010.
- Energy Prices and Taxes: Methodological notes : http://wds.iea.org/wds/pdf/EPT_documentation_4Q2010.pdf.
- OECD (2010) Taxation, Innovation and the Environment.
- OECD (2006) The Political Economy of Environmentally Related Taxes.

Glossary of terms and definitions

This glossary includes a list of terms and definitions from OECD and other international sources. It provides a basis for a common language on the measurement of green growth at international level.

Please note that:

- The glossary makes no claim for completeness.
- In some cases, it is appropriate to refer to several definitions depending on the context in which the term is used. Some terms have for example a general (user-friendly) definition, as well as a more specific, technical definition when used in the context of environmental-economic accounting. In this case, keeping the two kinds of definitions is essential to make the underlying concepts understandable to a broader audience.
- Terms and definitions already agreed upon elsewhere and compiled from existing and glossaries and publications have been kept as they are, but are accompanied with further specifications when appropriate.
- As new international references become available, in particular the SEEA, the glossary will be adjusted as required.

Consumption

Final consumption

An activity in which institutional units use up goods or services; consumption can be either intermediate or final.
Source: SNA

Intermediate consumption

Intermediate consumption consists of goods and services used up in the course of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital.
Source: SNA

Decoupling

The term decoupling refers to breaking the link between "**environmental bads**" and "**economic goods**."

In practice, the **measurement** of decoupling refers to the relative growth rates of a direct pressure on the environment and of an economically relevant variable to which it is causally linked. Decoupling occurs when the growth rate of the environmental pressure (EP) is less than that of its economic driving force (DF) over a given period. One distinguishes between **absolute and relative** decoupling. Decoupling is said to be absolute when the environmental variable is stable or decreasing while the economic variable is growing. Decoupling is said to be relative when the environmental variable is increasing, but at a lower rate than the economic variable.

The decoupling concept has however no automatic link to the environment's capacity to sustain, absorb or resist pressures of various kinds (deposition, discharges, harvests). A meaningful **interpretation** of the relationship of EP to economic DF will require additional information. Also, the relationship between economic DF and EP, more often than not, is complex. Most DF have multiple environmental effects, and most EP are generated by multiple DF, which, in turn, are affected by societal responses. Changes in decoupling may thus be **decomposed** in a number of intermediate steps. These may include changes in the scale of the economy, in consumption patterns, and in economic structure — including the extent to which demand is satisfied by domestic production or by imports. Other mechanisms in the causal chain include the adoption of cleaner technology, the use of higher-quality inputs, and the post-facto clean-up of pollution and treatment of waste.
Source: OECD (2002) Indicators to measure decoupling of environmental pressure from economic growth; OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

Disposable income

Disposable income is derived from the balance of primary incomes of an institutional unit or sector by adding all current transfers, except social transfers in kind, receivable by that unit or sector and subtracting all current transfers, except social transfers in kind, payable by that unit or sector.
Source: SNA

Domestic Material Consumption (DMC)

Domestic Material Consumption (DMC) is a variable used in material flow accounting. DMC measures the mass (weight) of the materials that are physically used in the production and consumption activities of the domestic economic system (i.e. the direct apparent consumption of materials, excluding indirect flows). In economy–wide material flow accounting DMC equals domestic extraction plus imports minus exports.
Source: OECD (2008) Measuring material flows and resource productivity: The OECD Guide, and Eurostat(2001)

Economic assets

Assets are entities functioning as stores of value and over which ownership rights are enforced by institutional units, individually or collectively, and from which economic benefits may be derived by their owners by holding them, or using them, over a period of time (the economic benefits consist of primary incomes derived from the use of the asset and the value, including possible holding gains/losses, that could be realised by disposing of the asset or terminating it).
Source: SNA

Ecosystem services

See functions of natural capital

Efficiency

Efficiency (of production processes)

Efficiency refers to the degree to which a production process reflects 'best practice', either in an engineering sense ('technical efficiency') or in an economic sense ('allocative efficiency').
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Resource efficiency

There is no commonly agreed upon definition of resource efficiency. It is understood to refer to the economic efficiency and the environmental effectiveness with which an economy or a production process is using natural resources. It is also understood to contain both a *quantitative* dimension (e.g. the quantity of output produced with a given input of natural resources) and a *qualitative* dimension (e.g. the environmental impacts per unit of output produced with a given natural resource input).
Source: based on OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

Environmental goods and services (sector)

The environmental goods and services sector consists of a heterogeneous set of producers of technologies, goods and services that:

– Measure, control, restore, prevent, treat, minimise, research and sensitise environmental damages to air, water and soil as well as problems related to waste, noise, biodiversity and landscapes. This includes 'cleaner' technologies, goods and services that prevent or minimise pollution.
– Measure, control, restore, prevent, minimise, research and sensitise resource depletion. This results mainly in resource-efficient technologies, goods and services that minimise the use of natural resources.

These technologies and products (i.e. goods and services) must satisfy the end purpose criterion, i.e. they must have an environmental protection or resource management purpose (hereinafter 'environmental purpose') as their prime objective.

Following the nomenclature used in the SERIEE and SEEA, environmental technologies and products comprise environmentally -specific services, connected products, adapted goods, end-of-pipe technologies and integrated technologies. Following the SERIEE, the SEEA and the OECD/Eurostat environmental industry manual, these environmental technologies and products can be classified in two main groups:

– **Environmental protection** (EP), which includes technologies and products of both a preventive or remedial nature for the prevention, reduction, elimination and treatment of air emissions, waste and wastewater, soil and groundwater contamination, noise and vibration as well as radiation, the prevention, reduction and elimination of soil erosion and salinity as well as other kinds of degradation, the preservation of biodiversity and landscapes as well as the monitoring and control of the quality of environmental media and waste.
– **Resource management** (RM), which comprises technologies and products to manage and/or conserve the stock of natural resources against depletion phenomena including both preventive and restoration activities as well as the monitoring and control of the levels and uses of natural resource stocks.

Both groups include administrative activities, education, training, information and communication activities as well as research and development activities. They include activities carried out by General Government and by Corporations, ranging from, for example, manufacturing enterprises to consulting, from public administration to educational institutions.

Source: (Eurostat (2009), The environmental goods and services sector - A data collection handbook)

Environmental protection activities

Environmental protection (EP) activities include all purposeful activities directly aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment resulting from the production process or from the use of goods and services.
Source: OECD/Eurostat, Questionnaire on the state of the environment – Section on environmental protection expenditure and revenues

Environmental services (or services from natural assets)

See functions of natural capital.

Functions of natural capital (or environmental functions)

For the purpose of this report the concept of 'environmental functions or services' is defined in a broad sense. It encompasses all functions or services provided by natural assets, and which contribute directly and indirectly to human well-being. This includes the provision of water, energy, raw materials, land and ecosystem inputs to produce goods and services, the regulatory capacity of the environment, and its roles in supporting life and biodiversity, and in providing amenities and cultural benefits.

Environmental functions or services are also referred to as 'ecosystem services' or as 'ecosystem goods and services'. Three main types of functions are distinguished: resource functions, sink functions and service functions.

Resource functions

Resource functions provide productive or provisioning services. They refer to the capacity of natural assets to provide:

– Natural resources (water, energy, and other raw materials including medicinal resources) and space (land) for use as inputs in the economy where they are used in the production of goods and services. Examples are mineral deposits, timber from natural forests, deep sea fish and land.

– Ecosystem inputs, such as as water and other natural inputs (e.g. nutrients, carbon dioxide) required by plants and animals for growth, and oxygen and other gases needed for combustion and production processes.

Sink functions

Sink functions provide regulating services. They refer to the capacity of natural assets to absorb the unwanted by-products of production and consumption and to regulate air, water and soil quality and natural processes. This includes:

– the absorption of pollution and waste, and the sequestration and storage of carbon;
– the provision of flood and disease control, and the moderation of extreme natural events;
– the provision of other functions such as pollination support.

Service functions

Service functions provide supporting services, i.e. services that underpin almost all other services. They refer to the capacity of natural assets to provide living spaces (habitats) for plants, animals and man, and to maintain biological diversity (genetic diversity). This includes:

– functions that are essential to life, such as the provision of clean air or clean water or protection against UV rays (survival functions).
– functions that are less essential but improve the quality of life, i.e. the non-material benefits that people obtain from contact with ecosystems, for example recreational, aesthetic and leisure benefits (amenity functions), or spiritual and psychological benefits (cultural functions).

Source: OECD based on SEEA 2003 and TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, Conclusions and recommendations of TEEB.

Green growth

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. To do this, it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities.
Source: OECD.

Green economy

UNEP defines a green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.
Source: UNEP (2011) Towards a Green Economy – Pathways to Sustainable Development and Poverty Eradication, A synthesis for Policy Makers.

Indicator

A parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/area, with a significance extending beyond that directly associated with a parameter value. This definition points to two major functions of indicators:

– they reduce the number of measurements and parameters that normally would be required to give an exact presentation of a situation.
As a consequence, the size of an indicator set and the level of detail contained in the set need to be limited. A set with a large number of indicators will tend to clutter the overview it is meant to provide.
– they simplify the communication process by which the results of measurement are provided to the user.
Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of "the best knowledge available".

Source: OECD, 1993

Innovation

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.
Source: OECD, 2005, "The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data: Oslo Manual, Third Edition"

Technological innovations comprise new products and processes and significant technological changes of products and processes. An innovation has been implemented if it has been introduced on the market (product innovation).
Source: OECD Frascati Manual, Fifth edition, 1993, Annex 2, para. 29, page 116

Inputs

Economic inputs

Labour, capital services, and intermediate goods and services that are used in a process of economic production, i.e., production within the general production boundary as described in the System of National Accounts
Source: SNA

Ecosystem inputs

Ecosystem inputs cover the substances originating from ecosystems that are used in production and consumption processes. Examples include water and other natural inputs (e.g. nutrients, carbon dioxide) required by plants and animals for growth, and oxygen and other gases needed for combustion and production processes.
Source: OECD based on SEEA

Intermediate inputs

Those factors of production that are produced and transformed or used up by the production process within an accounting period.
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Natural inputs

Materials and energy that flow from the environment to the economy. Natural inputs include (i) direct material inputs, i.e. resources which are incorporated into products in the economy (such as timber, crops, livestock, fish, water, mineral and energy resources); (ii) other energy inputs such as geothermal energy and solar energy; (iii) unused extraction such as soil excavated during mining operations which are natural inputs that are impacted by economic activity but are never incorporated into products; and (iv) ecosystem inputs, such as oxygen, nutrients and CO_2 for the respiration of cultivated crops.
Source: OECD based on SEEA.

Primary inputs

Those factors of production that are treated as exogenous in the framework of production analysis. In a static framework primary inputs comprise capital and labour.
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Materials or material resources

The term "materials" or "material resources" designates the usable materials or substances (raw materials, energy) produced from natural resources. These usable "materials" include energy carriers (gas, oil, coal), metal ores and metals, construction minerals and other minerals, soil and biomass.

In the context of Material Flow Analysis and Accounting, the term "materials" is used in a very broad sense so as to record all material related flows at all relevant stages of the material cycle. It designates materials from renewable and non-renewable natural resource stocks that are used as material inputs into human activities and the products that embody them, as well as the residuals arising from their extraction, production and use (such as waste or pollutant emissions to air, land, water) and the ecosystem inputs required for their extraction, production and use (such as nutrients, carbon dioxide required by plants and animals for growth and the oxygen necessary for combustion).
Source: OECD.

Material extraction

The extraction of materials from the environment (i.e. from natural resources) on purpose and by means of technology for use in human activities.

Gross material extraction refers to all materials extracted, moved or disturbed by economic activities on purpose and by means of technology, including those materials that remain unused in the environment or return to the environment immediately after removal from their natural site. In material flow accounting, gross material extraction comprises "used" extraction and "unused" extraction.

Net material extraction refers to the materials extracted that physically enter the economic system as inputs for further processing or consumption. In material flow accounting, net material extraction is called "used extraction".
Source: OECD.

Material Flow Analysis (MFA)

Material flow analysis (MFA) refers to the monitoring and analysis of physical flows of materials into, through and out of a given system (usually the economy) through the process chains, through extraction, production, use, recycling and final disposal. MFA is generally based on methodically organised **accounts** in physical units (Material flow accounts). It uses the principle of **mass balancing** to analyse the relationships between material flows (including energy), human activities (including economic and trade developments) and environmental changes.

The term MFA designates a **family of tools** encompassing a variety of analytical approaches and measurement tools, including different types of accounts, indicators and evaluation methods at different levels of ambition, detail and completeness. MFA can be applied at various scales and with different instruments depending on the issue of concern and on the objects of interest of the study. It can be applied to a wide range of economic, administrative or natural entities at various levels of scale (world regions, whole economy, industries, firms, plants, territories, cities, river basins, eco-zones, etc.) and can be applied to materials at various levels of detail (individual materials or substances, groups of materials, all materials).
Source: OECD.

Natural assets (or natural capital)

Assets that occur in nature and that provide environmental "functions" or services. Natural assets are also referred to as natural capital. They comprise three principal categories: natural resource stocks, land and ecosystems.
See also functions of natural capital or environmental functions.
Source: OECD

Natural resources

The term "natural resources" designates renewable and non-renewable resource stocks that are found in nature (mineral resources, energy resources, soil resources, water resources and biological resources).

Renewable natural resources

Renewable natural resources are resources from renewable natural stocks that, after exploitation, can return to their previous stock levels by natural processes of growth or replenishment. Examples of renewable resources include timber from forest resources, freshwater resources, land resources, wildlife resources such as fish, agricultural resources.

Non-renewable natural resources

Non-renewable natural resources are exhaustible natural resources whose natural stocks cannot be regenerated after exploitation or that can only be regenerated or replenished by natural cycles that are relatively slow at human scale. Examples include metals and other minerals such as industrial and construction minerals, and fossil energy carriers.
Source: OECD (2008), Measuring material flows and resource productivity – OECD guide; SEEA; UNSD.

Output

Goods or services that are produced within a producer unit and that become available for use outside the unit plus any goods and services for own final use.
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Economic outputs

Goods and services that result from a process of economic production, i.e., production within the general production boundary as described in the System of National Accounts.
Source: SNA

Material outputs

Material outputs refer to the flows of materials leaving a system. When applied to the economic system, material outputs refer to the material outflows related to production and consumption activities of a given country or entity. They account for those materials that have been used in the economy or the system and are subsequently leaving it either in the form of emissions and waste, or in the form of exports to other systems.
Source: OECD.

Production function

The maximum set of output(s) that can be produced with a given set of inputs. Use of a production function implies technical efficiency. Synonym for production frontier, the technically efficiency part of a feasible production set, the set of all input-output combinations that are feasible (but not necessarily efficient).
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Productivity

Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use. While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals that there is neither a unique purpose for measuring productivity nor a single measure. Productivity is generally measured within the SNA production boundary.

The terms productivity and efficiency refer to different but related concepts. Productivity relates the quantity of output produced to one or more inputs used in the production of the output, irrespective of the efficiency of their use.

Overview of the main productivity measures

Type of output measure \ Type of input measure	*Labour*	*Capital*	*Capital and labour*	*Capital, labour & intermediate inputs (energy, materials, services)*
Gross output	Labour productivity (based on gross output)	Capital productivity (based on gross output)	Capital-labour MFP (based on gross output)	KLEMS multi-factor productivity
Value-added	Labour productivity (based on value-added)	Capital productivity (based on value-added)	Capital-labour MFP (based on value-added)	–
	Single factor productivity measures		***Multi factor productivity (MFP) measures***	

Single-factor productivity

Synonym for partial productivity measure. It relates output to one particular type of input.

Multifactor productivity (MFP)

Relates a change in output to several types of inputs. MFP is often measured residually as that change in output that cannot be accounted for by the change in combined inputs. The term Total Factor Productivity is sometimes used as a synonym for multifactor productivity.
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Environmental and resource productivity

For the purpose of this report, environmental and resource productivity is defined in a broad sense.
It refers to a partial productivity measure that relates economic output to an environmental input (whether in the form of natural resource inputs, of ecosystem inputs, or in the form of regulating services).

Environmental productivity

A partial productivity measure that relates economic output to the input of regulating services.
Alternatively, emissions could be treated as undesirable or negative output rather than as environmental inputs. This is a matter of convenience and labelling but has no implication for measurement.

Material productivity

Material productivity designates an indicator that measures the output or value added generated per unit of materials used, i.e. energy carriers and other raw materials, excluding water and ecosystem inputs.

Resource productivity

Resource productivity designates an indicator that measures the output or value added generated per unit of natural resources used. This is typically a macro-economic concept that can be presented alongside labour or capital productivity. Resource productivity would ideally encompass all natural resource and ecosystem inputs that are used as factors of production in the economy. The term is however often used as a synonym for material productivity.
Source: OECD.

Water productivity

The level of economic output (in physical or in monetary terms) achieved from one unit volume of gross water inflows, or for one unit volume of waste water outflows.

Energy productivity

The level of economic output (in physical or in monetary terms) achieved from one unit of energy used/consumed.

Carbon productivity:

The level of economic output (in physical or in monetary terms) achieved for one unit of emissions, i.e. from one unit of regulating service used.

Products or Commodities

Products, also called "goods and services", are the result of production; they are exchanged and used for various purposes: as inputs in the production of other goods and services, as final consumption or for investment. The term "commodities" can be used as a synonym for "products".
Source: SNA

Residuals

"Residuals" is a generic term used to designate all unwanted waste materials in solid, liquid and gaseous form resulting from economic activity. Residuals encompass (solid) waste and pollutants. Residuals generally have no economic value and may be recycled, stored within the economy or released into the environment.

Source: OECD, based on SEEA

Unused (material) flows

Unused (material) flows mainly consist of unused extraction, i.e. materials that (i) are extracted, moved or disturbed by economic activities on purpose and by means of technology, (ii) are not fit or not intended for use in further processing, and (iii) remain unused in the environment. This is the case when material must be extracted from the natural environment, along with the desired material, to obtain the desired material, or when material is moved or disturbed to obtain the natural resource, or to create and maintain an infrastructure. These materials are not incorporated in products at any stage and are usually without economic value. Examples of unused extraction are soil and rock excavated during construction and not used elsewhere, dredged sediments from harbours, overburden from mining and quarrying and unused biomass from harvest.

Source: Source: OECD (2008), Measuring material flows and resource productivity – OECD guide.

List of acronyms and abbreviations

Signs

The following signs are used in Figures:

.. : not available

– : nil or negligible

. : decimal point

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 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
G8	Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom, the United States

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

Country aggregates may include Secretariat estimates.

Country Codes

AUS	- Australia	GBR	- United Kingdom	NOR	- Norway
AUT	- Austria	GRC	- Greece	POL	- Poland
BEL	- Belgium	HUN	- Hungary	PRT	- Portugal
BRA	- Brazil	IND	- India	RUS	- Russian Fed.
CAN	- Canada	IDN	- Indonesia	SVK	- Slovak Rep.
CHE	- Switzerland	ISL	- Iceland	SVN	- Slovenia
CHL	- Chile	IRL	- Ireland	SWE	- Sweden
CHN	- China	ITA	- Italy	TUR	- Turkey
CZE	- Czech Republic	ISR	- Israel	USA	- United States
DEU	- Germany	JPN	- Japan	ZAF	- South Africa
DNK	- Denmark	KOR	- Korea, Rep.		
ESP	- Spain	LUX	- Luxembourg	EU	- European Union
EST	- Estonia	MEX	- Mexico		
FIN	- Finland	NLD	- Netherlands		
FRA	- France	NZL	- New Zealand	G8	- G8 countries

Abbreviations

ABS	Australian Bureau of Statistics
BIP	Biodiversity Indicators Partnership
cap	Capita
CBD	Convention on Biological Diversity
CDM / JI	Clean Development Mechanism / Joint Implementation
CER	Certified Emission Reduction
CFCs	Chlorofluorocarbons
CF_4	Tetrafluorocarbon
C_2F_6	Hexafluoroethane
CH_4	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CPI	Consumer price index
CRS	Creditor Reporting System
CSTAT	OECD Committee on Statistics
DAC	Development Assistance Committee, OECD
DEU	Domestic Extraction Used
DMC	Domestic Material Consumption
EEA	European Environment Agency
EGSS	Environmental goods and services sector
ETS	Emission Trading Scheme
EU	European Union
Exp	Exports
FAO	Food and Agriculture Organisation of the UN
FDI	Foreign direct investment
GBAORD	Government budget appropriations or outlays on research and development
GDP	Gross domestic product
GEF	Global Environment Facility
GG	Green growth
GHG	Greenhouse gas
GL	Gigalitre (10^9 litre)
GNI	Gross national income
HWWI	Hamburg Institute of International Economics; Hamburgisches WeltWirtschafts Institut
ICES	International Council for the Exploration of the Sea
IEA	International Energy Agency
ILO	International Labour Organisation
IMF-IFS	International Monetary Fund – International Financial Statistics
IMO	International Maritime Organisation
Imp	Imports
IPCC	International Panel on Climate Change
ISIC	International Standard Industrial Classification
IUCN	International Union for Conservation of Nature
IUU	Illegal, unreported and unregulated (fishing)
kL	Kilolitre (1,000 litres)
kt	Kilotonne (1,000 tonnes)
MCM	Ministerial Council Meeting
MFA	Material flow analysis
MFP	Multifactor productivity
MJ	Megajoule
Mt	Million tonnes
Mtoe	Million tonnes of oil equivalent
N	Nitrogen
NGO	Non-governmental organisation
NH_3	Ammonia
NMVOCs	Non-methane volatile organic compounds
NO_x	Nitrogen oxides
NO_3^-	Nitrates
NO_x	Nitrogen oxides
ODA	Official development assistance
ODS	Ozone depleting substance
OECD	Organisation for Economic Co-operation and Development
OSPAR	Convention for the Protection of the Marine Environment of the East Atlantic
P	Phosphorous
PCT	Patent Co-operation Treaty
PFC	Private final consumption
PM	Particulate matter
PPP	Purchasing power parities
REDD	Reducing Emissions from Deforestation and Degradation
SDBS	Structural and Demographic Business Statistics (OECD)
SF_6	Sulphur hexafluoride
SEEA	System of integrated environmental economic accounting
SNA	System of National Accounts
STAN	Structural Analysis Database (OECD)
TPES	Total primary energy supply
Toe	Tonnes of oil equivalent
TWh	Terawatt hour
UN CED	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
UNEP WCMC	UNEP World Conservation Monitoring Centre
USD	United States dollar
VA	Value added
WBI	Wild bird index
WHO	World Health Organisation
WMO	World Meteorological Organisation
WPEI	Working Party on Environmental Information (OECD)
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation
WWF	World Wildlife Fund

Annex. Proposed list of OECD indicators: Overview by group and by theme

The proposed list of indicators presented below 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

The proposed indicators are to be accompanied with contextual information or additional indicators to accompany the message conveyed.

Each indicator is accompanied with a first evaluation of its relevance for green growth (R), its analytical soundness (S), and the measurability of the underlying data (M). The classifications used for evaluating the indicators are as follows:

Criteria	Classification
Relevance (R)	1= high 2= medium 3= be further reviewed
Analytical soundness (S)	1= good 2= average 3= to be further reviewed
Measurability (M)	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.

Proposed list of indicators

The socio-economic context and characteristics of growth				
Economic growth, productivity and competitiveness	**Economic growth and structure** GDP growth and structure; Net disposable income	M		
	Productivity and trade Labour productivity; multi-factor productivity Trade weighted unit labour costs Relative importance of trade: (exports + imports)/GDP **Inflation and commodity prices**	M		
Labour markets, education and income	**Labour markets** Labour force participation & unemployment rates	M		
	Socio-demographic patterns Population growth, structure & density Life expectancy: years of healthy life at birth Income inequality: GINI coefficient Educational attainment: Level of and access to education	M		

Group/theme	Proposed indicators	Type	R	S	M
Environmental and resource productivity					
Carbon & energy productivity	**1. CO_2 productivity**				
	1.1. Production-based CO_2 productivity GDP per unit of energy-related CO_2 emitted	M	1	1	S
	1.2. Demand-based CO_2 productivity Real income per unit of energy-related CO_2 emitted	M	1	2	S/M
	2. Energy productivity				
	2.1. Energy productivity (GDP per unit of TPES)	M	2	1	S
	2.2. Energy intensity by sector (manufacturing, transport, households, services)	M	2	1	S/M
	2.3. Share of renewable energy in TPES, in electricity production	M	1	1	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	1	3	M/L
	• Domestic material productivity (GDP/DMC) - Biotic materials (food, other biomass) - Abiotic materials (metallic minerals, industrial minerals)	P	1	2	S/M
	3.2. Waste generation intensities and recovery ratios By sector, per unit of GDP or VA, per capita	M	1	1	M/L
	3.3. Nutrient flows and balances (N,P)	M	1	3	L
	• Nutrient balances in agriculture (N, P) per agricultural land area and change in agricultural output	P	2	1	S/M
	4. Water productivity VA per unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated)	M	1	1	M
Multi-factor productivity	**5. Multi-factor productivity reflecting environmental services** (comprehensive measure; original units in monetary terms)	M	1	2	M/L
Natural asset base					
Renewable stocks	**6. Freshwater resources** Available renewable resources (groundwater, surface water, national, territorial) and related abstraction rates	M	1	1	S/M
	7. Forest resources Area and volume of forests; stock changes over time	M	1	1	S/M
	8. Fish resources Proportion of fish stocks within safe biological limits (global)	M	1	1	S
Non-renewable stocks	**9. Mineral resources** Available (global) stocks or reserves of selected minerals (tbd): metallic minerals, industrial minerals, fossil fuels, critical raw materials; and related extraction rates	M	1	2	M/L
Biodiversity and ecosystems	**10. Land resources** Land cover types, conversions and cover changes State and changes from natural state to artificial or man-made state	M	1	1	M/L
	• Land use: state and changes	P	1	2	S/M
	11. Soil resources Degree of top soil losses on agricultural land, other land	M	1	2	M/L
	• Agricultural land area affected by water erosion by class of erosion	P	1	2	S/M
	12. Wildlife resources (tbd)				
	• Trends in farmland or forest bird populations or in breeding bird populations	P	1	2	S/M
	• Species threat status: mammals, birds, fish, vascular plants in % species assessed or known	P	2	2	S
	• Trends in species abundance	P	1	2	S/M

Group/theme	Proposed indicators	Type	R	S	M
Environmental quality of life					
Environmental health and risks	**13. Environmentally induced health problems & related costs** (e.g. years of healthy life lost from degraded environmental conditions)	M	1	3	L
	• Population exposure to air pollution	P	2	2	S/M
	14. Exposure to natural or industrial risks and related economic losses	M	1	2	L
Environmental services and amenities	**15. Access to sewage treatment and drinking water**	M			
	15.1. Population connected to sewage treatment (at least secondary, in relation to optimal connection rate)		2	2	S/M
	15.2. Population with sustainable access to safe drinking water	–	1	2	S/M
Economic opportunities and policy responses					
Technology and innovation	**16. R&D expenditure of importance to GG**	M	1	1	S/M
	- Renewable energy (in % of energy related R&D)		1	1	S
	- Environmental technologies (in % of total R&D, by type)		1	1	S
	- All purpose business R&D (in % of total R&D)		1	1	S
	17. Patents of importance to GG in % of country applications under the Patent Cooperation Treaty	M	1	1	S/M
	- Environmentally related and all-purpose patents		1	1	S/M
	- Structure of environmentally related patents		1	1	S/M
	18. Environment-related innovation in all sectors	M			
Environmental goods and services	**19. Production of environmental goods and services (EGS)**	M	1	2	S/M
	19.1. Gross value added in the EGS sector (in % of GDP)				
	19.2. Employment in the EGS sector (in % of total employment)				
International financial flows	**20. International financial flows of importance to GG** (in % of total flows; in % of GNI)	M	2	1	L
	20.1. Official Development Assistance		2	1	S
	20.2. Carbon market financing		2	1	S
	20.3. Foreign Direct Investment (tbd)		3	3	L
Prices and transfers	**21. Environmentally related taxation**	M	2	2	S/M
	- Level of environmentally related tax revenues (in % of total tax revenues, in relation to labour related taxes)				
	- Structure of environmentally related taxes (by type of tax base)		2	2	S/M
	22. Energy pricing (share of taxes in end-use prices)	M	1	1	S
	23. Water pricing and cost recovery (tbd)	M	1	2	S/M
	<u>*To be complemented with indicators on:*</u>				
	• *Environmentally related subsidies (tbd)*		1	3	M/L
	• *Environmental expenditure: level and structure (pollution abatement and control, biodiversity, natural resource use & management)*		2	1	L
Regulations and management approaches	*Indicators to be developed*				
Training and skill development	*Indicators to be developed*				

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where governments work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Union takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

OECD PUBLISHING, 2, rue André-Pascal, 75775 PARIS CEDEX 16
(97 2011 07 1 P) ISBN 978-92-64-11134-9 – No. 58167 2011-07

Towards Green Growth: Monitoring Progress

OECD INDICATORS

The OECD Green Growth Strategy aims to provide concrete recommendations and measurement tools, including indicators, to support countries' efforts to achieve economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which well-being relies. The strategy proposes a flexible policy framework that can be tailored to different country circumstances and stages of development. This report accompanies the synthesis report *Towards Green Growth*.

Please cite this publication as:

OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD Publishing.
http://dx.doi.org/10.1787/9789264111356-en

This work is published on the *OECD iLibrary,* which gathers all OECD books, periodicals and statistical databases. Visit ***www.oecd-ilibrary.org***, and do not hesitate to contact us for more information.

2011

OECD*publishing*
www.oecd.org/publishing

ISBN 978-92-64-11134-9
97 2011 07 1 P