Indicators on linking resource use to the economy

Environmental Data Centres on Natural Resources and Products

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Executive summary

This report provides a brief and focused analysis of the macroeconomic indicators that are able to explain and describe the link between resource use and economic activities. The “main questions” of the report are:

- What existing indicators are relevant to understand the link between the economy and resource use?
- Are there dimensions of the link between the economy and resource use that are not sufficiently covered?
- In this case, what are the solutions to better monitor these dimensions?

A preliminary list of thirty-two economic indicators was established which could potentially help in understanding the links between the economy and resource use. These indicators were classified into following 9 categories:

- Measures of economic activity;
- Measures of welfare and/or socioeconomic development;
- Measures of the sustainability of economic activities;
- Measures of the inputs to production;
- Measures of scarcity of natural resources;
- Market values;
- Information on EU material dependency with respect to the rest of the world;
- Measures of economic efficiency; and
- Other economic indicators.

Based on an analysis of these indicators, four major links between the economy and resource use were identified. Firstly, resources can be used as inputs to production and generate value added. On the other hand, it is possible to use resources more efficiently in order to create value added. However, there are short-run economic concerns with resource use, mainly price volatility and resource shortages. These short run economic concerns are partly linked to long-run economic issues associated with resource use, mainly resource depletion and waste production.

Among the identified indicators, fourteen were then selected as the most interesting with regard to their ability to summarise the economic issue at stake, their ability to provide information about resource efficiency or resource use and data availability.

Based on the thorough analysis of the most relevant indicators, it was possible to assess what dimensions of the links between the economy and resource use are insufficiently monitored. Five propositions were then developed to compensate for insufficient coverage of these dimensions:
Proposition 1: in cooperation with EU Member States, complement the growth accounting exercise of EU KLEMS with national data on intermediate inputs with a breakdown by category (materials, energy, business services).

Proposition 2: develop and test an indicator on resource stocks with a breakdown by type of resource.

Proposition 3: analyse price movements with monthly or weekly data for a few resources.

Proposition 4: analyse the concentration of the origin of EU imports

Proposition 5: analyse the market structure in the extractive sector and assess its economic impact.
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Introduction

Resource pressures and scarcity are likely to rise due to increasing population and affluence. Given EU dependency on imported resources and the price volatility, such trends in resource consumption are likely to have a damaging effect on EU economy, welfare and well-being. Conversely, using fewer resources could reduce costs, enhance economic growth and improve EU competitiveness. Furthermore, reducing EU dependency on imported resources could shield the EU from the increasing prices of raw materials and their volatility.

This is why transforming the economy is one of the main axes of the Roadmap to a Resource Efficient Europe (COM (2011) 571), looking at eco-innovation, environmental taxes, environmentally harmful subsidies, sustainable consumption and production, and waste management. This path is often referred to as greening the economy. To measure progress to a resource efficient Europe, the Roadmap proposes to monitor initially materials, land, water and carbon. These indicators rather look at environmental and physical resource issues. However, good indicators on linking resource use to the economy and that cover the transformation of the economy are still lacking. Potential links with the economy include: resource prices and their volatility; resource availability, including sustainable management of renewable resources, geographical concentration, and market structures; expenditures of business and economies for resources; markets for RE/green innovations/products; substitutability for key uses; overall benefits for companies, workers, economies and the nationals and global society as a whole.

In this context, this document provides a brief and focused analysis of the indicators that are able to describe the link between resource use and the economy. The “driving questions” are:

- What existing indicators are relevant to understand the link between the economy and resource use?
- Are there dimensions of the link between the economy and resource use that are not sufficiently covered?
- In this case, what are the solutions to better monitor these dimensions?
- What adaptations could be made to existing indicators in order to better take into account resource use?
- Are there any alternative ways to measure the positive and negative links between resource efficiency and the economy?

The selection and description of the indicators follows the following approach:

1. Mapping of existing economic indicators and their link with resource use;
2. Assessment of existing indicators and selection of the most relevant indicators;
3. Analysis of the most relevant indicators and provision of time-series;
4. Identification of the dimensions of the link between the economy and resource use that are not sufficiently monitored; and
5. Proposition for adaptations and ways to complement the current set of indicators.
Chapter 1: Identification of existing economic indicators and their link to resource use

1.1 Methodology

In order to identify existing economic indicators, the publications of international organisations were consulted, including the European Commission, World Bank, UNDP, UNEP, OECD, International Energy Agency, and the European Environment Agency. Furthermore, the documents published by some specific institutions concerning research projects on economic indicators were reviewed, such as the "Beyond GDP" Initiative¹, the portal of the European System of Social Indicators (www.gesis.org), the "EU KLEMS" Project², and the Groningen Institute for Development and Growth.

1.2 Existing economic indicators

1.2.1 Definition of eight categories

A preliminary list of thirty-two economic indicators was established which could potentially help in understanding the links between the economy and resource use. These economic indicators were classified into the following 8 categories:

1. Measures of economic activity
2. Measures of welfare and/or socioeconomic development
3. Measures of the sustainability of economic activities
4. Measures of the inputs to production
5. Measures of scarcity of natural resources
6. Information on EU material dependency with respect to the rest of the world
7. Measures of economic efficiency
8. Other economic indicators

Figure 1 shows in a very simplified way how the different categories of indicators are related to each other. Natural resources are extracted and used as inputs to production. Efficiency is the relationship between the inputs and outputs of production. Welfare is based on economic output.

¹ The Beyond GDP initiative is about developing indicators that are as clear and appealing as GDP, but more inclusive of environmental and social aspects of progress. Link to the website: http://www.beyond-gdp.eu/

² The EU KLEMS Project aims to create a database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states from 1970 onwards. Link to the website: http://www.euklems.net/
and growth, but also includes other dimensions such as the sustainability of natural resources. Economies are dependent on certain resources that are needed as inputs to production. Scarcity occurs when the natural resources in the environment are not sufficient to fulfil the demand for production.

The theoretical background for the economic chain represented in Figure 1 partly relies on the growth accounting framework. Developed by Solow, growth accounting initially focused on the share of value added growth that could not be explained by growth in labour and capital. Therefore, it tried to understand the way inputs can be used to produce a valuable output. Solow’s framework provides a measure of efficiency, generally called total factor or multi-factor productivity. However, this measure of efficiency did not take into account the environment in Solow’s initial work.

A different field of research tried to provide measures of economic efficiency that could account for environmental damages. Born in the 1970s, the concept of eco-efficiency was popularized by the World Business Council for Sustainable Development in 1992. It incorporates both concepts of resource efficiency (minimising the resource used and the wastes generated in producing a unit of output) and resource productivity (maximising the efficiency of economic activities in generating added value from the use of resources). At a company level, eco-efficiency indicators show the link between environmental and financial performance. They can be used in a systematic and consistent manner to improve the quality of environmental reporting. As pointed out by UNACT, the main problem with constructing eco-efficiency indicators is the lack of harmonised rules for measurement and disclosure of environmental information either within an industry or across industries and countries.

A different option would be to resort to an adapted Solow framework: today’s accounting exercises could take into account environmental concerns by including natural resources as an intermediate input to production. More generally, it could be said that output growth is not only

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determined by traditional factors such as labour and capital, but also by the use of the environment. Using an econometric model, Tzouvelekas et al. (2007) showed that the use of the environmental accounts (proxied in their study by CO₂ emissions) is a statistically significant factor in explaining output growth.

With a policy-oriented viewpoint, Brock (1973) emphasised that as long as the external costs associated with environmental damages (e.g. biodiversity loss, pollution, etc.) are not internalised through accurate environmental policies, output and value added growth will be biased towards an overuse of the environment. Therefore, output only creates welfare to the extent that the use of natural resources is sustainable.

Research in the field of external costs is wide and developing fast in Europe. External costs are unintentional side effects of an activity affecting people other than those directly involved in the activity. Many methods allow evaluating in monetary terms the external costs associated with resource use. In Europe, most of them have been investigated in the past twenty years through the ExternE projects (Externalities of Energy). More recently, the EXIOPOL project updated and detailed external costs associated with damages from emissions into air and water. Monetary values are presented in a database by type of emission, industry sector and country, as well as for a range of themes, namely health, agriculture, biodiversity, forestry and wastes.

The concept of external costs is of utmost interest in the context of resource efficiency because it allows measuring unaccounted costs of economic activities by putting a price on natural resources that are used in the economy (but rarely accounted for in economic balances). Thus, further integrating environmental externalities into national accounting and developing composite indices on environmental pressure is one of the milestones of the Commission’s Roadmap to a Resource Efficient Europe.

Necessarily, these indicators would have to take into account the amount of natural resources that are used as inputs to production and their worldwide availability or scarcity. Indeed, the economic activity of a country may be more or less dependent on specific resources.

The following references provide more detailed discussion on growth accounting, external effects and eco-efficiency indicators in the context of resource use:


Mailbach et al. (2008) Handbook on estimation of external costs in the transport sector, Produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT), Version 1.1, Commissioned by the European Commission DG TREN.


The Conference Board Total Economy Database™ (2011) *Methodological Notes*

The research project EXIOPOL⁴ (2007-2011) *A new environmental accounting framework using Externality data and Input-Output tools for policy analysis and the Multi-regional Environmentally Extended Supply and Use database developed through this project: EXIOBASE⁵*


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⁴ [http://www.feem-project.net/exiopol/scheda.php?id=45](http://www.feem-project.net/exiopol/scheda.php?id=45)

⁵ [http://www.exiobase.eu/](http://www.exiobase.eu/)

⁶ [http://www.needs-project.org/](http://www.needs-project.org/)
1.2.2 Presentation of the indicators in each category

A presentation of the indicators that are included in each category is provided below, with a short description of the links between the indicators and resource use. A definition of each indicator is included in Annex 1.

- **Measures of economic activity**
  - **Indicators**
    - Gross Domestic Product (GDP)
    - Gross Value Added (GVA)
    - Economic Output
    - Gross National Income (GNI)
  - **Link to resource use**

At the level of an individual producer, industry or sector, the gross value added (GVA) is a measure of the value of their output. The output is based on different inputs, including raw materials and energy. Therefore, GVA specifies, all things being equal, a level of value added based on a given level of resource use. At an aggregate level, GDP constitutes the sum of all the gross values added, corresponding to a given level of resource use by all the sectors of the economy. Gross national income is very similar to GDP, but takes into account transfers with non-residents located abroad.

- **Measures of welfare and/or socioeconomic development**
  - **Indicators**
    - Genuine Progress Indicator (GPI)
    - Canadian Index of Wellbeing
    - Human Development Index (HDI)
    - Index of Sustainable Economic Welfare (ISEW)
    - Japan for Sustainability (JFS) Indicators
    - Millennium Development Goals Dashboard of Sustainability
    - Sustainable Society Index
    - Index of Individual Living Conditions
  - **Link to resource use**

The use of gross added-value and GDP to describe development or welfare has been criticised by economists because they do not cover many aspects of development and welfare, such as health, education, violence, or impact on the environment. It is possible to construct indicators that are more comprehensive of welfare by aggregating different indicators into indices. Those composite indicators may present some advantages with respect to GDP as they are more inclusive of different dimensions of socioeconomic life. However, they also present...
disadvantages as the weighting of the different dimensions (health, education, wealth, the environment, etc.) is somehow arbitrary.

Therefore, the indices of welfare may sometimes include environmental indicators (e.g. Genuine Progress Indicator, Canadian Index of Wellbeing, Index of Sustainable Economic Welfare, Sustainable Society Index, JFS indicators) or not (e.g. Human development Index, Index of Individual Living Conditions). The first kind of indices (including environmental issues) provides a more comprehensive overview of welfare and development than the second one (not including environmental issues). However, the latter are also relevant because their increase or decrease can be analysed in parallel with the use of natural resources (as this is not calculated based on the evolution of resource efficiency).

▶ Measures of the sustainability of economic activities
  ▶ Indicators
    ■ Sustainable National Income (SNI)
    ■ Adjusted Net Savings (ANS)
  ▶ Link to resource use

The measures of sustainability of economic activities are neither a measure of welfare nor a measure of the increase or decrease of the economic activity. Their aim is to describe, at a macroeconomic level, the degree of sustainability of current economic activities. This degree of sustainability is directly dependent upon a moderate use of resources.

▶ Measures of the inputs to production
  ▶ Indicators
    ■ Intermediate inputs
    ■ Employment in environmental goods and services sector
    ■ Commodity prices
    ■ Secondary Material Price Indicator (per waste material)
  ▶ Link to resource use

Resources are used in combination with other inputs to create value added. The use of some resources with respect to other resources or with respect to labour is a good indicator of the “resource intensity” of the economy. The increase in commodity prices and their volatility are likely to have a negative impact on economic activities that currently use these commodities. Secondary materials sometimes provide an alternative that can moderate the impact of the rate of increase in the price of raw materials.

▶ Measures of scarcity of natural resources
  ▶ Indicators
    ■ Reserve-to-production ratio
    ■ Resources-to-production ratio
    ■ Renewable internal freshwater resources
Chapter 2: Analysis of the most relevant economic indicators

- Ratio between current catch weight and stock biomass

  Link to resource use

For non-renewable resources, the lifetime of proven energy resources and reserves provides an indication about the time-frame in which the current use of non-renewable energy resources becomes unsustainable. For renewable resources, such as water, wood and fisheries, indicators about resource scarcity are also very important, because an intense use of renewable resources has a negative impact on the rate of regeneration of those resources.

Information on EU material dependency with respect to the rest of the world

  Indicators

- Total Imports (Exports) of raw materials
- Extra EU-27 Imports (Exports) of raw materials
- Economic importance of a raw material for the EU

  Link to resource use

The European Union is dependent upon materials that are extracted in non-EU member countries, which intensifies the risks of shortage and price volatility for EU firms. Furthermore, data on EU-27 trade of raw materials provides information on the changes needed to achieve a sustainable supply of raw materials from global markets.

Measures of economic efficiency

  Indicators

- Multi-factor Productivity (MFP)
- Contribution of Multi-Factor Productivity to output growth
- Contribution of intermediate material and energy inputs to output growth
- Labour productivity

  Link to resource use

The increase in multi-factor productivity measures to what extent output can increase without any increase in the amount of inputs. It is usually interpreted as overall efficiency increases in production.

On the other hand, the contribution of intermediate material and energy inputs to output growth is a measure of the dependency of economic growth to material and energy use. Finally, labour productivity provides a good measure of the added value that can be created per unit of hours worked.

Other economic indicators

  Indicators

- Revenues from environmentally related taxes
- Amount of generated waste
■ Amount of treated waste

Link to resource use

Statistics on waste provide information about the externalities of resource use that society may face. Statistics on waste treatment provides information about the capacity of society to deal with these externalities. Information on the revenues from environmental taxes describes the involvement of EU Member States to mitigate the environmental damages linked to the economic activities, including unsustainable resource use.
Chapter 2: Analysis of the most relevant economic indicators

2.1 Selection of the most relevant indicators

For each of the different categories of indicators that were identified previously, a selection of the most interesting indicators was performed based on the following criteria:

- Ability to provide information about resource efficiency or resource use;
- Ability to summarise the economic issue referred to within a category of indicators; and
- Data availability.

The reason for such a selection was to reduce the amount of indicators to a subset that would cover the most important issues relating to the link between resource use and the EU economy.

Grades were then attributed to each indicator for each of the criteria (see Annex 2). Based on these grades, the economic indicators identified as the most relevant in the context of resource use are:

- The Gross Domestic Product;
- Economic Output;
- The Human Development Index;
- Adjusted Net Savings;
- Intermediate inputs;
- The reserve-to-production ratio;
- Commodity price indices;
- Secondary Material Price Indicators;
- Extra EU-27 imports and exports of raw materials;
- Economic importance of a raw material for the EU;
- Multi-factor productivity;
- The contribution of multi-factor productivity to output growth;
- The contribution of material and energy inputs to output growth; and
- Labour productivity.

Time series for all the selected indicators along with information on data availability are provided in Annex 3.
2.2 Links to resource use

The following four different links between the economy and resource use were explored in the analysis of the economic indicators performed in Annex 2:

1. Resources are inputs to production and are used to generate value added;
2. Resource efficiency is producing, processing and consuming natural resources in a more environmentally sustainable way;
3. Price volatility and resource dependency are short-run economic concerns related to resource use; and,
4. Resource depletion and waste production are long-run economic concerns related to resource use.

Table 1 below identifies the links of selected economic indicators with resource use.

<table>
<thead>
<tr>
<th>Name of indicator</th>
<th>Resources are input to create value added</th>
<th>Towards a more efficient use of resources</th>
<th>There are short-run economic concerns linked to resource use</th>
<th>There are long-run economic concerns linked to resource use</th>
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</thead>
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<tr>
<td>Gross Domestic Product</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Output</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Development Index</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Adjusted net savings</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Intermediate inputs</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources-to-production ratio</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Commodity prices</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Secondary Material Price Indicator (per waste materials)</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Economic importance of a raw material for the EU</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Extra EU 27 imports (exports) of raw materials</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-factor productivity</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution of multi-factor productivity to output growth</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contribution of material and energy inputs to output growth</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour productivity</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
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</table>
A description of the interaction of all the selected indicators in the framework of their link to resource use is presented below.

- Resources are inputs to production and are used to generate value added.

The *Gross Domestic Product* corresponds to the sum of the Gross Values Added (GVA) of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs). At the same time, the Gross Value Added of a firm or a sector corresponds to the value of its own production minus the value of *intermediate inputs*.

Within this framework, growth accounting allows representing *output* growth or value added "*growth as a weighted sum of the growth rates of the inputs*". The difference between output (or value added growth) and the growth rate of the inputs is commonly referred to as total factor productivity or *multi-factor productivity (MFP)*. When it is calculated based on value added, the inputs to production are labour and capital. When it is calculated based on gross output, the inputs to production also include all the intermediate inputs, such as material, energy and business services.

In the context of resource use, growth accounting exercises allows comparing:

- The contribution of multi-factor productivity to value added growth with *the contribution of multi-factor productivity to output growth*. The calculation of MFP based on gross output instead of value added allows accounting for changes in the use of materials, energy and business services. Therefore, by withdrawing changes in intermediate inputs affecting the creation of added value, it provides a more comprehensive calculation of multi-factor productivity.

- The *contribution of material (and energy) inputs to output growth* with the contribution of multi-factor productivity to output growth. The first corresponds to the increase in output that is imputable to a more (or less) intensive use of materials and energy. On the other hand, the second corresponds to the increase in output which is imputable to a more efficient use of all the inputs employed in production. A more efficient economy will rely more on MFP and less on resource use to foster economic growth.

Another measure of the creation of added value from resource use corresponds to *labour productivity*: the latter corresponds to the value added that is created by a single worker based on all the other inputs that were used in production.

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Resource efficiency is producing, processing and consuming natural resources in a more environmentally sustainable way.

With efficiency increases, it should be possible to sustain economic growth without depleting natural resources (estimated based on multi-factor productivity and the contribution of inputs and multi-factor productivity to output growth).

Furthermore, the price of secondary materials is an important indicator about the way society provides economic incentives towards a better management of resources through waste reduction.

Price volatility and resource dependency are short-run economic concerns related to resource use.

In the short run, EU production and consumption are dependent on the global price of commodities. Price indices for commodities provided by the World Bank and other institutions allow the estimation of short-term risks to resources. To do so, it is necessary to calculate the volatility associated with the price of each commodity.

At the same time, the co-evolution of prices for secondary raw materials is a good indication of the substitutability between primary and secondary raw materials. It is likely that a high substitutability between the two (leading to a zero difference in market price) may reduce the risk of price volatility.

The risks of shortage are all the more important as the EU imports large quantities of raw materials from the rest of the world. The calculation of net imports (imports minus exports) to the EU provides a good overview of the way the EU economy might be affected by the volatility of world commodity prices. This indicator is however a bit different from the economic importance of a raw material for the EU, which is calculated based on the value added of production linked to the use of a raw material (independent of whether it was extracted in the EU or somewhere else in the world).

Resource depletion and waste production are long-run economic concerns related to resource use.

In the long run, a reduction of net imports of raw materials to the EU is a good indicator for the sustainability of the EU economy, in the context of resource depletion. The reserve-to-production ratio estimates the lifetime of non-renewable energy resources before depletion. It is one of the main drivers of the energy price index of the World Bank, as it is known that as long as resources are depleting, commodity prices will rise.

Within this framework, Adjusted Net Savings provide an overview of the way an intensive use of resources is equivalent to borrowing resources from future generations. This may positively affect welfare (estimated based on the Human Development Index) in the short run at the expense of negative impacts in the long run. At the level of each raw material, the economic importance of a raw material for the EU provides an indication about the dependency of EU production on specific materials.
2.3 Strengths and weaknesses of selected indicators

The strengths and weaknesses of each of the selected economic indicators are presented below.

- **Gross Domestic Product**
  
  **Strengths**: there have been many developments in national accounting with a process of international harmonisation and inclusion of many products and services since the 1940s: "after a long emphasis on the relationship between production, income and expenditure, national accounting concerns have in recent decades been extended to the full set of relations between production, income, accumulation and wealth".\(^8\)
  
  **Weaknesses**: GDP is not capable of taking into account non-market or non-monetary flows and stocks. More generally, it is not a good indicator of welfare, as it only measures the value added of production and does not take into account social and environmental issues. Moreover, in some industries (agriculture, mining) the value added is relatively small due to high subsidies and hence does not reflect the production output of the industry. On the same lines, an environmentally adjusted GDP gives rise to much debate. Up to now, there is no consensus about the method that could be used to integrate environmental damages to GDP among economists.

- **Economic Output**
  
  **Strengths**: economic output embeds the overall productive activities of a firm, sector or country, including potential subsidies and excluding taxes. It takes into account the use of intermediate inputs in production and can therefore be employed to calculate multi-factor productivity based on the use of intermediate inputs (mostly materials, energy and business services).
  
  **Weaknesses**: output constitutes a poor representation of the value of economic activities, which is better accounted for in GVA and GDP.

- **Human Development Index**
  
  **Strengths**: due to the wide range of factors that it takes into account (longevity, knowledge, income), the HDI is a powerful indicator allowing comparing living standards across countries on an annual basis. Its main strength lies in its capacity to reflect the human condition in a more appropriate way than most conventional economic indicators such as economic growth. It can also be used "to question national policy choices, \(^8\)".

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asking how two countries with the same level of Gross National Income per capita can end up with such different human development outcomes”

**Weaknesses:** the Human Development Index only captures welfare in terms of health, education and standard of living. Therefore, it leaves out many other elements that constitute welfare: freedom, protection against violence, environmental safety, etc. In the context of resource use, the HDI does not take into account resource depletion for the measurement of welfare.

**Adjusted Net Savings**

**Strengths:** “the measurement of saving effort is complicated by the fact that depletion of natural resources is not visible in standard national accounts”

**Weaknesses:** Adjusted Net Savings is relevant with static populations but does not provide information on the sustainability of economies when there is a growing population. Therefore, for countries with a growing population, Adjusted Net Savings can be positive while wealth per capita is declining. Furthermore, some important data are lacking in the estimation of natural resources depletion (e.g. data on underground water, land degradation, fish stocks or diamonds) which may tend to overestimate the value of the indicator.

**Intermediate inputs**

**Strengths:** the constitution of aggregates of intermediate inputs allows calculating their contribution to economic growth. The separation of intermediate inputs into broad categories (mainly material, energy and business services) allows making comparisons between the relative contributions of each input (including labour and capital as direct inputs) to economic growth.

**Weaknesses:** within each intermediate or direct input, there is high to very high heterogeneity, which may create measurement errors. This restriction is true in general for all aggregate inputs to production. It has been discussed in the case of capital inputs. In fact, the quality of inputs may vary within a same year (different kinds of products) or between years (a computer produced in 2012 is different from a computer produced in 2013).

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Chapter 2: Analysis of the most relevant economic indicators

2011). As a result, there is a presumption that the growth rate of the capital stock, for example, is often understated.

**Reserve-to-production ratio**

*Strengths:* by estimating the rate of resource exhaustion, the Reserve-to-Production Ratio provides a straightforward basis for assessing possible future energy supplies with respect to the current availability of energy resources and levels of production.

*Weaknesses:* the ratio focuses only on energy use. Moreover, “the rate of use of energy reserves depends on many factors, including economic conditions, prices, technological progress and exploration efforts”\(^{12}\). Therefore, the reserve-to-production ratio represents only a measure of resource availability among others.

**Commodity prices**

*Strengths:* yearly (and sometimes monthly) data is available from the World Bank for the world price of major raw materials. Price indices are calculated for specific goods, such as energy or metals.

*Weaknesses:* there are many reasons why a price can increase or decrease on a market. Shifts in demand or production may have an impact on price, but speculation on raw materials may also explain changes in prices.

**Secondary material price indicator**

*Strengths:* the presentation of this indicator is similar to other market-price related indicators, such as energy prices or commodity prices. Therefore, it is easily comparable to other conventional price indicators. Furthermore, the index aims to monitor the specific price for a fixed set of materials, not just an average price\(^{13}\). It is based on EU trade and monitors both the intra-EU and extra-EU cross-country trade which makes it a particularly relevant indicator for European stakeholders.

*Weaknesses:* the secondary material price indicator is only available for glass, plastic and paper and board wastes. Moreover, as mentioned earlier, many different factors can explain variations in secondary material prices, which explains why conclusions drawn from the analysis of this indicator have to be interpreted with caution.

**Labour productivity**

*Strengths:* "labour productivity is a revealing indicator of several economic indicators as it offers a dynamic measure of economic growth,

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\(^{12}\) IAEA et al. (2005), Energy Indicators for Sustainable Development: Guidelines and Methodologies.

\(^{13}\) Eurostat (2010), Statistical books, Environmental statistics and accounts in Europe.
competitiveness, and living standards within an economy”\textsuperscript{14}. Therefore, one of its main strengths is that it helps explain both economic growth and social development.

- **Weaknesses**: labour productivity is computed based on the amount of hours worked or the number of persons employed. Both measures have limitations. When estimated by a simple headcount of employed persons, the number of persons employed does not account for changes in average hours worked due to e.g. the evolution of part-time work. Conversely, when the unit of labour is based on the amount of hours worked, the quality of hours-worked estimates is not always clear.

- **Extra EU 27 imports and exports of raw materials**
  - **Strengths**: Data on Extra EU-27 trade of raw materials provides some insight into the EU-27 material dependency with respect to the rest of the world.
  - **Weaknesses**: Extra EU-27 does not take into account any sustainability criterion in the way raw materials are extracted. Moreover, EU data are compiled according to community guidelines and may, therefore, differ from national data published by Member States\textsuperscript{15}.

- **Economic importance of raw materials for the EU**
  - **Strengths**: the indicator of the economic importance of raw materials assesses the potential impact on the economy in case of supply restrictions for one raw material. It is a way of measuring the dependency of the EU economy to some specific materials.
  - **Weaknesses**: the methodology adopted to compute the value-added chains of ‘mega-sectors’ is based on a breakdown of NACE sectors that can be confusing (e.g. some indicators are compared with their own end products such as bauxite-aluminium). Further statistical information and analysis are therefore required to better assess the concept of the value-added chain\textsuperscript{16}. Moreover, the indicator does not take into account the socio-economic impacts generated by the extraction of raw materials.

- **Multi-factor productivity**

\textsuperscript{14} OECD (2008), Labour productivity indicators: Comparison of two OECD databases, Productivity differentials and the Balassa-Samuelson effect.

\textsuperscript{15} Eurostat (2010), Statistical books, Environmental statistics and accounts in Europe.

\textsuperscript{16} Fraunhofer ISI (2010) Critical raw materials for the EU.
Chapter 2: Analysis of the most relevant economic indicators

- **Strengths**: multi-factor productivity can be interpreted as a proxy for the economic impact of R&D externalities\(^7\). In other words, multi-factor productivity is a measure of the increase in efficiency that arises due to knowledge spill overs stemming from R&D activities.

- **Weaknesses**: the private returns from R&D activities are not captured by multi-factor productivity. This is because the effect of technical change is embodied in the contributions of the other inputs to production (e.g. researchers are included in labour). Therefore, it is not a measure of technical change as such. Furthermore, multi-factor productivity is calculated as a residual. It is the share of output or value added growth that cannot be imputable to input growth. Therefore, it is subject to estimation errors and dependent on the way inputs are measured and included in a production function. This is why MFP calculated based on value added or based on output will be different.

- **Contribution of multi-factor productivity to output growth**

  The strengths and weaknesses of this indicator are identical to the ones of multi-factor productivity. Mainly, this indicator does not account for the impact of technical change in economic growth, but may capture the contribution of knowledge spill overs to increasing efficiency in the use of all inputs.

- **Contribution of material and energy inputs to output growth**

  The strengths and weaknesses of this indicator are identical to the ones of intermediate inputs: the contribution that is calculated from material and energy is subject to measurement errors and to difficulties associated with aggregating heterogeneous assets.

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Chapter 3: Possible adaptation of indicators to better suit the resource efficiency context

3.1 What is missing in the resource efficiency context

Based on the identification and analysis of the most relevant existing indicators, the dimensions of the links between the economy and resource use were assessed with regards to whether they were sufficiently monitored by existing indicators. In particular, it would be of great interest to better monitor and assess the following elements:

1. **The use of materials as inputs to production**: data on the contribution of materials to economic growth was not available for all EU countries. In the framework of the EU KLEMS Project\(^8\), it could only be calculated for 9 EU countries. Strengthening data availability in order to better understand the economic impact of resource use seems necessary.

2. **The scarcity of resources**: the reserve-to-production ratio focuses only on energy resources and is not gathered by a single institution for EU Member States, which limits the use of this indicator for resource scarcity. A broader indicator could be constructed in order to assess the availability of a large scope of natural resources used in the EU.

3. **Commodity price movements**: there is no identified indicator which measures uncertainty related to commodity price movements. This limit reduces current ability to understand the impact of commodity price movements on welfare.

4. **The concentration of resource extraction in some countries**: there is no indicator that informs on the manner the EU economy depends on resource extraction which originate from only a few countries.

5. **The market concentration of the extractive industry**: indicators on market concentration are largely used throughout the world to monitor the market structure of economic sectors. However, it would be useful to have an indicator of market concentration by type of resource extracted in order to assess the degree of competition within the extractive sector and anticipate potential risks of collusion. Such an indicator could be telling about the way prices do (or do not) reflect extraction costs.

To address the above issues, some recommendations are proposed in the next section.

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\(^8\) [http://www.euklems.net/](http://www.euklems.net/)
3.2 Proposition for adaptations and new indicators

Proposition 1: in cooperation with EU Member States, complement the growth accounting exercise of EU KLEMS with national data on intermediate inputs with a breakdown by category (materials, energy, business services).

The indicator on the intermediate inputs to production developed within the EU KLEMS project is a powerful indicator since it allows clarifying the contribution of each category of input (labour, capital, material, energy, services, etc.) to economic growth. A more complete description of the time series available for this indicator is provided in Annex 3.

In fact, the indicator is still limited due to the lack of data for more than half of the EU Member States. Complementing the growth accounting exercise of EU KLEMS would allow calculations to be made on the multi-factor productivity on gross output for the EU, and on the contribution of each intermediate input to EU growth, at the sector level and for all sectors.

To do so, cooperation with Member States is necessary to create the relevant statistics on material, energy and services inputs.

Proposition 2: develop and test an indicator on resource stocks with a breakdown by type of resource.

Data on reserve-to-production ratios are only available for some countries and strictly focus on energy resources. Consolidating this information in order to get a broader overview of non-renewable resource stocks would be beneficial in order to better understand the link between resource use and the economy. This is in line with the Integrated Raw Materials Strategy called for under the Raw Materials Initiative. The Strategy sets out to improve the knowledge base of mineral deposits globally and within the EU in order to safeguard the supply of raw materials. The Roadmap for a Resource Efficient Europe further states that the Commission will continue working on improving indicators on resource availability.

Extended to all the non-renewable natural resources used in the economy, a reserve-to-extraction ratio could be used to assess the sustainability of resources consumption. In line with the definition of the reserve-to-production ratio, the reserve-to-extraction ratio could be defined as the ratio of a natural resource (e.g. mineral reserve) remaining at the end of a year to the extraction of the resource in that year.

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21 According to the European Commission’s Ad-hoc Working Group on defining critical raw materials, a ‘mineral reserve’ is the part of the resource which has been fully geologically evaluated and is commercially and legally mineable. Reserves may be regarded as ‘working inventories’, which are continually revised in the light of various ‘modifying factors’ related to mining, metallurgy, economics, marketing, law, the environment, communities, government, etc.
Chapter 3: Possible adaptation of indicators to better suit the resource efficiency context

Expressed in years and computed at the country level, the purpose of this indicator would be to measure the availability of natural resources with respect to corresponding extraction levels. It would provide a relative measure of the number of remaining years of the resource stock, if extraction was the same in the future as in the base year.

The ratio could first be computed for the following natural resources: oil, natural gas, coal, aluminium, bentonite, clays, diatomite, feldspar, gypsum, limestone, magnesite, and glass sand. The main limit of this indicator is that it would not take into account the many other factors likely to influence the use of natural resources in the future, including demographic growth, price volatility, technological progress, exploration efforts, etc. However, it would provide some useful information with regard to the future availability of natural resources in the EU, which is a key aspect to take into consideration when building the way to a resource efficient Europe.

Proposition 3: analyse price movements with monthly or weekly data for a few resources

In the framework of resource use, higher price fluctuations are linked with higher supply risks for the users of a given commodity. This element is not directly captured by the indicator of commodity prices, but can be accounted for by constructing an indicator of price movements. However, the choice and construction of such an indicator is difficult because it is based on an assumption about price trends. In principle, the indicator would be associated with the changes in prices that occurred a few months before. It could be representative of the economic agents’ expectations about the risk of price changes. The required data would be monthly (or even weekly) data on commodity prices. This data is already available for a few commodities from the World Bank, including oil and gas (Figure 2). Indicators on price movements would allow the Commission to better monitor commodity markets and critical raw materials, and support them in developing responses to securing access to these resources.

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22 These materials were considered as the most important ones to the EU economy as calculated with the indicator on the economic importance of a raw material (Fraunhofer ISI, 2010, Critical raw materials for the EU).

However, there are many statistical ways of representing the intensity of price fluctuations. One of the possibilities is calculating the variance of price with respect to a constantly updated price average:

- Note $P_m$ is the price $P$ during month $m$. The average price of $P$ over the past 12 months can be estimated as:
  \[
  \bar{P}_{m-11,m} = \frac{\sum_{m-11}^{m} P_m}{12}
  \]

- It is possible to measure $V$ price movements for month $M$, as the variance of prices with respect to the average price over the past 12 months:
  \[
  V_M = \frac{\sum_{m=M-11}^{M} (P_m - \bar{P}_{M-11,M})^2}{11 \cdot \bar{P}_{M-11,M}}
  \]

With such an indicator, it is possible to compare the intensity of the fluctuations in price between crude oil and gas (Figure 3).
Even though relevant to understand price changes, such an indicator is a bit biased, because it assumes no trend (downwards or upwards) for commodity prices over the period that is employed to calculate price fluctuations (12 months in this case). Ways of compensating for this bias exist but still assumptions must be made on the nature of the trend.

In any case, the assessment of the economic effect of commodity price volatility is complex and cannot be directly inferred from an indicator of price volatility. It may depend upon many other variables, such as the economic importance of the commodity for world production. An assessment of those elements could surely enhance current knowledge about the link between the economy and resource use.

Proposition 4: analyse the concentration of the origin of EU imports

For some commodities, the EU is dependent upon a very small number of countries, which have those resources in their territory. This element may have important consequences as a small number of exporting countries may increase short run risks of shortage and long run risks in terms of price increases.

The COMEXT data from Eurostat provides detailed information on the country of origin of imported products. An indicator of concentration about the origin of imported raw materials could be constructed with Eurostat data on trade.

- Principle: determine if the EU imports raw materials from a small or a large number of countries.
- Data required: data on the origin of imported resources.
- Calculations to be made to construct the indicator: in analogy with the Herfindahl-Hirschmann index of firm concentration, an indicator of concentration of the origin of raw materials can be constructed as follows:
  - Consider a material imported by the EU from a number $N$ of countries, noted $n$. Each country provides the EU with a quantity $Q_n$ of imports. Total imports $Q$ are the sum of the quantities imported from commercial partners:
    \[
    Q = \sum_{n=1}^{N} Q_n
    \]
  - The $S$ share of imports coming from country $n$, noted $S_n$, is calculated as:
    \[
    S_n = \frac{Q_n}{Q}
    \]
  - Calculate the indicator of concentration of origin of imports COI as:
    \[
    COI = \sum_{n=1}^{N} (S_n \times 100)^2
    \]
    The maximum value of the indicator is 10000 (one provider of all imports) and the indicator soon
 decreases to lower values with more commercial partners exporting raw materials to the EU.

Example

Data source: Eurostat – Adjusted EU-EXTRA imports by tariff regime, by CN8 (DS_041691). Materials used in example are “zinc oxide and peroxide” and “iron oxides and hydroxides”.

The Eurostat data provides information on the value of extra EU imports of zinc and iron between 2000 and 2010 (Figure 4).

Figure 4: Extra EU imports of zinc and iron (current million euros)

At the same time and based on the origin of imports, it is possible to calculate the indicator of concentration of origin of imported raw materials (Figure 5).

Figure 5: Concentration of origin of imported raw materials (zinc and iron)

In 2000, imports of zinc mainly came from China and the EU has constantly reduced its Chinese imports of zinc from 2001 and onwards. This is the main reason explaining the decrease in the concentration of the origin of imports. Conversely, the EU has increased its dependence on
Chinese iron, which explains the increase of the concentration of the origin of imports for this material.

Surely, this information may be meaningful from an economic or a political perspective. However, measuring the concentration of the origin of raw materials is not self-explanatory about its main drivers. In the example above, not much is said about the reasons why imports of iron and zinc from China have changed? Further research about the link between the concentration of the origin of providers, resource depletion and price fluctuations could be particularly interesting.

Proposition 5: analyse the market structure in the extractive sector and assess its economic impact

In line with the reflection of concentration about the origin of imported products developed in Proposition 4, it could also be useful to monitor the market concentration of firms in the extractive sector and assess its economic relevance in the resource efficiency context.

Market concentration is a useful indicator because it reflects the degree of competition in the market. For some commodities, the EU is dependent upon a very small number of firms involved in the extraction of these resources, either outside or inside the EU. High market concentration may have important consequences as a small number of firms reduces competition in a sector and tends to result in higher prices and lower consumer welfare. Thus, monitoring market structure in the extractive sector could also provide some information on the way prices do or do not reflect extraction costs.

The market concentration of the extractive industry could be systematically monitored, using the Herfindahl-Hirschmann index of firm concentration. Furthermore and based on such an indicator, assessing the economic impact of firm concentration on commodity prices and on the risks of shortages for the EU could be particularly important to better understand the link between the EU and resource use. Such an assessment would surely require to gather the relevant data for different commodities and comparing the price changes for those commodities based on the structure of supply in the extractive sector.
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Annex 1: Definition of economic indicators

> Measures of economic activity

- **Gross Domestic Product (GDP):** the OECD glossary defines GDP as “an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)”.
  
  Unit: monetary unit (e.g. euros) or in volume.

- **Gross Value Added (GVA):** the OECD glossary defines GVA as “the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector”.
  
  Unit: monetary unit (e.g. euros) or in volume.

- **Output:** the OECD glossary defines output as “those goods or services that are produced within an establishment that become available for use outside that establishment, plus any goods and services produced for own final use”. It is possible to aggregate output at the sector level or at the country level.
  
  Unit: monetary unit (e.g. euros) or in volume.

- **Gross national income (GNI):** the OECD glossary defines GNI as “GDP less net taxes on production and imports, less compensation of employees and property income payable to the rest of the world plus the corresponding items receivable from the rest of the world (in other words, GDP less primary incomes payable to non-resident units plus primary incomes receivable from non-resident units))”.
  
  Unit: monetary unit (e.g. euros) or in volume.

> Measures of welfare and/or socioeconomic development

- **Genuine Progress Indicator (GPI):** The GPI is a measure of socioeconomic progress that corrects GDP according to the negative effects linked to economic activity. There exist many ways of calculating a "Genuine Progress Indicator". Most of them take into account natural resource depletion as a negative effect of the creation of added-value.
  
  Unit: indexed values.

- **Canadian Index of Wellbeing:** the Canadian Index of Wellbeing adds up the added-value of the economic activities that are considered beneficial to citizens (e.g. education) and subtracts the added-value of harmful ones. It
tries to take into account damages to the environment or a degradation of working conditions\textsuperscript{24}.

Unit: indexed values.

- **Human Development Index (HDI):** developed by the UNPD, the HDI is a way of measuring development by combining indicators of life expectancy, educational attainment and income into a composite index. The breakthrough for the HDI was the creation of a single statistic which was to serve as a frame of reference for both social and economic development. The HDI sets a minimum and a maximum for each dimension, called goalposts, and then shows where each country stands in relation to these goalposts, expressed as a value between 0 and 1.

  Unit: index between 0 (worse) and 1 (best)

- **Index of Sustainable Economic Welfare (ISEW):** according to the Institute for Environmental Studies (IVM at VU University Amsterdam), ISEW is calculated by adjusting conventional national income accounts by various factors, such as pollution and the distribution of wealth. It is partly based on a reclassification of expenditures and partly on the valuation of income distribution and environmental damages.

  Unit: monetary unit (e.g. euros) corresponding to adjusted GDP.

- **Japan for Sustainability (JFS) Indicators:** the JFS indicators correspond to 20 indicators accounting for Nature, Economy, Society and Wellbeing.

- **Millennium Development Goals Dashboard of Sustainability:** The Dashboard of Sustainability is both a software tool for displaying complex indicator sets, and the application of this tool to one particularly important indicator set, i.e. the United Nations Commission on Sustainable Development (UN CSD) indicators, aggregating the 60 UN CSD indicators into a "Global Sustainability Index". Aggregation is used as a means to enhance communication with non-expert audiences\textsuperscript{25}.

- **Sustainable Society Index:** the Sustainable Society Index is a composite indicator made of 22 indicators encompassing three dimensions (economy, society and the environment)\textsuperscript{26}.

  Unit: indexed values.

- **Index of Individual Living Conditions:** the research project “Beyond GDP” defines the index as "a composite index aiming to give a summary view of the quality of living conditions in a single measure. The Index allows to easily and unequivocally assess the living conditions of a population – which are

\textsuperscript{24} More information at [http://ciw.ca](http://ciw.ca).

\textsuperscript{25} More information at [http://esl.jrc.it/dc/](http://esl.jrc.it/dc/).

\textsuperscript{26} More information available on the website of the Sustainable Society Foundation: [http://www.ssfindex.com/](http://www.ssfindex.com/).
multidimensional by nature – and to compare them across countries and across time. It measures progress in the improvement of living conditions of the European citizens beyond GDP. Since this index, contrary to others, is based on microdata on personal and household level, the Living Conditions Index can be broken further down and thus allows to compare the situation of subgroups (e.g. age groups, men and women, educational level) within a population”. The index is part of the European System of Social Indicators (EUSI).

Unit: indexed values.

▸ Measures of the sustainability of economic activities

- **Sustainable National Income (SNI):** according to the Institute for Environmental Studies (IVM at VU University Amsterdam), SNI represents the maximum level of economic activity that can be developed within an accounting period that respects the sustainability standards. All the costs that need to be made to meet the standards of pollution and resource use in order to prevent the sustainability standards to be exceeded, irrespective whether they are to be made by industry, government or households, are considered to be intermediary expenditures and should therefore not count as income. To put it simply, SNI is the difference between standard national income and the expenditures that need to be made to respect the sustainability standards.

  Unit: monetary unit (e.g. euros)

- **Adjusted Net Savings:** according to the World Bank, “adjusted net saving, (also known as genuine saving), is a sustainability indicator building on the concepts of green national accounts. Adjusted net savings measure the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution”.

  Unit: monetary unit (e.g. euros)

▸ Measures of the inputs to production

- **Intermediate inputs:** the “EU KLEMS project“ states that “intermediate inputs are divided into various groups, such as energy (E), materials (M) and services (S). This breakdown of intermediate inputs can be used for extending the growth accounting exercises, but also convey interesting information about changing patterns in intermediate consumption”.

- **Employment in environmental goods and services sector:** The employment in environmental goods and services sector is measured by the full-time equivalent employment which is the number of full-time equivalent jobs, defined as total hours worked divided by average annual hours worked in full-time jobs in the environmental goods and services sector (EGSS). The EGSS consists of two main sets of activities:
Activities to 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 the supply of ‘cleaner’ technologies, goods and services that prevent or minimise pollution (Environmental protection activities).

Activities to measure, control, restore, prevent, minimise, research and sensitise resource depletion. This results mainly in the supply of resource-efficient technologies, goods and services that minimise the use of natural resources (Resource management activities).

Commodity prices: the World Bank provides monthly and/or yearly world market prices for specific commodities (Aluminium, Bananas, Barley, Meat, Coal, Cocoa, Coconut oil, Coffee, Copper, Copra, Cotton, Crude oil, Fishmeal, Gold, Groundnut oil, Iron ore, Meat, Lead, Logs, Maize, Natural gas, Nickel, Oranges, Palm oil, Phosphate rock, Palm kernel oil, Plywood, Potassium Chloride, Rice, Rubber, Sawn wood, Shrimp, Silver, Sorghum, Soybeans, Steel, Sugar, Tea, Tin, Tobacco, Wheat, Wood pulp, Zinc) and commodity price indices (for energy, agriculture, fertilisers, metals and minerals, base metals) and a manufactured unit value index. Note that other commodity indices are available from other sources (e.g. Dow Jones-AIG Commodity Index).

Unit: monetary unit (e.g. euros) or indexed values.

Secondary Material Price Indicator (per waste materials): for each waste material (e.g. glass, paper and board, plastics), Eurostat identifies the corresponding codes in the Foreign Trade Statistics (FTS) and calculates a specific price for the sum of the value and volume of all codes.

Unit: monetary unit (e.g. euros) or indexed values.

Measures of scarcity of natural resources

Reserve-to-production ratio: according to the International Atomic Energy Agency (IAEA), ratio of energy reserves remaining at the end of a year to the production of energy in that year. The purpose of this indicator is to measure the availability of national energy reserves with respect to corresponding fuel production. Reserves are generally defined as identified (demonstrated and inferred) resources that are economically recoverable at the time of assessment. Reserves are also defined as those quantities that geologic and engineering information indicates can be recovered with reasonable certainty in the future from known or identified energy resources under existing economic and technical conditions. The indicator considers fuels such as oil, natural gas, coal and uranium, and provides a relative measure of the length of time that proven reserves would last if production were to continue at current levels.
Indicators on linking resource use to the economy

- **Resources-to-production ratio**: according to the International Atomic Energy Agency (IAEA), ratio of the energy resources remaining at the end of a year to the production of energy in that year. The purpose of this indicator is to measure the availability of national energy resources with respect to corresponding fuel production. Resources are generally defined as concentrations of naturally occurring solid, liquid or gaseous material in or on the Earth’s crust in a form that makes economic extraction potentially feasible. Total resources include reserves, and hypothetical and speculative undiscovered resources. This indicator considers fuels such as oil, natural gas, coal and uranium. It provides a relative measure of the length of time that resources would last if production were to continue at current levels.

  Unit: years (of lifetime of proven energy resources).

- **Renewable internal freshwater resources**: the World Bank defines renewable internal freshwater resources as the sum of internal renewable resources (internal river flows and groundwater from rainfall) in a country.

  Unit: cubic meters of freshwater.

- **Ratio between current catch weight and stock biomass**: the European Commission defines this indicator as the ratio of current catch weight of (fish) species and the estimated biomass of the stock exploited attributed to fleet segments according to their share of total allowable catch. This indicator provides trends in catch/biomass ratio over time that reflects exploitation of a given stock of fish.

  Unit: percentage of estimated biomass for a stock of fish.

Information on EU material dependency with respect to the rest of the world

- **Total Imports (Exports) of raw materials**: total imports (exports) of raw materials correspond to the value of the imports (exports) of raw materials by EU Member States from (to) all countries.

  Unit: monetary unit (e.g. euros) or in volume.

- **Extra EU-27 Imports (Exports) of raw materials**: Extra EU-27 imports (exports) of raw materials indicate the value of the imports (exports) of raw materials by the Community and its Member States from (to) non-member countries.

  Unit: monetary unit (e.g. euros) or in volume.

- **Economic importance of a raw material for the EU**: in a recent report for the European Commission, Fraunhofer ISI calculated the economic importance of a raw material as an indicator in order to define, together with

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27 Fraunhofer ISI (2010) Critical raw materials for the EU.
supply and environmental risks, critical raw materials. The economic importance of a raw material is calculated by “breaking down its main uses and attributing to each of them the value added of the economic sector that has this material as input”. The concept of value added chains is used to break down the economy in sectors which would be affected by a shortage of the material upstream. The economic importance of a raw material is then calculated “as the weighted sum of the individual sectors (expressed as gross value added), divided by the European gross domestic product (GDP)”.

Unit: share of GDP.

Measures of economic efficiency

- Multi-factor Productivity (MFP): according to the OECD definition, multi-factor productivity “relates a change in output to several types of inputs. MFP is often measured residually, as that change in production that cannot be accounted for by the change in combined inputs”. Multi-factor productivity can be calculated from value-added (excluding the analysis of intermediate inputs) or from gross output (including the analysis of intermediate inputs).

  Unit: change in added value or in output (including intermediate goods and services).

- Contribution of Multi-Factor Productivity to output growth: the contribution of multi-factor productivity to output growth is the residual increase in value added growth that is not directly imputable to any specific input.

  Unit: share of output growth.

- Contribution of intermediate material and energy inputs to output growth: in the EU KELMS Database, these indicators (one for materials and one for energy) calculate the share of the increase in output growth that is imputable to using materials and energy.

  Unit: share of output growth.

- Labour productivity: labour productivity is defined as output (in constant prices) per unit of labour. The indicator can be reported for the total economy as well as for different sectors. Both hours worked and number of persons employed can be used as unit of labour. Positive changes in labour productivity measure the part of economic growth due to more effective work by those who are employed. The driving forces behind labour productivity include the accumulation of machinery and equipment, improvements in organization as well as physical and institutional infrastructures, improved health and skills of workers (“human capital”) and the generation of new technologies.

  Unit: monetary unit (e.g. euros) per worker or per hour worked.

Other economic indicators
- **Revenues from environmentally related taxes**: according to the OECD, this indicator corresponds to environmentally related taxes as any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance. Taxes are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments.

  Unit: monetary unit (e.g. euros) or as a share of GDP

- **Amount of generated waste**: amount of waste produced in a country.

  Unit: tonnes

- **Amount of treated waste**: amount of waste that is treated (through energy conversion or recycling) in a country.

  Unit: tonnes
Annex 2: Assessment and selection of the most relevant indicators

For each of the 32 economic indicators that were identified in Chapter 1: a selection of the most interesting indicators was performed based on the following criteria:

- Data availability;
- Ability to summarize the economic issue referred to within a category of indicators; and
- Ability to provide information about resource efficiency or resource use.

The reason for such a selection was to reduce the amount of indicators to a subset that would cover the most important issues relating to the link between resource use and the EU economy.

The method used to select the most relevant indicators consisted then to attribute grades to each indicator for each of the criteria:

- (+++) was attributed when the indicator fully satisfied the criterion;
- (+++) was attributed when the indicator mostly satisfied the criterion;
- (+) was attributed when the indicator only partly satisfied the criterion;
- (-) was attributed when the indicator did not really satisfy the criterion; and
- (--) was attributed when the indicator did not satisfy the criterion at all.

Grades attributed to each indicator are presented in the following tables. They are complemented by a short paragraph justifying the reasoning for selection.

**Measures of economic activity**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Domestic Product</td>
<td>(+++) Eurostat provides time series for all EU Member States</td>
<td>(+++) Gross domestic product is an aggregate measure of production for resident institutional units. It can also be obtained as the sum of all final uses of goods and services.</td>
<td>(++) Resources can be considered as an intermediate input that explains production, on which value added is calculated</td>
<td></td>
</tr>
<tr>
<td>Gross Value Added</td>
<td>(+++) Eurostat provides time series for EU countries and at the sectoral level</td>
<td>(-) The breakdown by sector level may be helpful in some circumstances, but will not be useful at the aggregate level</td>
<td>(++) Resources can be considered as an intermediate input that explains production at the sectoral level, on which value added is calculated</td>
<td></td>
</tr>
</tbody>
</table>
### Indicators on linking resource use to the economy

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>► Economic Output</td>
<td>Economic Output</td>
<td>(+++) Eurostat provides statistics on production value with a breakdown by NACE sectors of activity</td>
<td>(-) This indicator can be relevant at the sector level, but GDP is usually preferred at the aggregate level because it gives a more precise information about the added value that is created out of production</td>
<td>(+++) Resources usually are an input to production, not to added value. Therefore, this indicator may be more closely linked to resource use than GDP or GVA</td>
</tr>
<tr>
<td></td>
<td>Gross National Income</td>
<td>(+++) Eurostat provides time series for EU countries</td>
<td>(+) Gross national income is an aggregate measure of production for resident institutional units that takes into account transfers with non-residents.</td>
<td>(+) As it takes into account transfers with non-residents, the link between GNI and resources used at the national level is less clear than with GDP</td>
</tr>
</tbody>
</table>

Growth Domestic Product (GDP) was selected because it is the most representative indicator of the value that is obtained out of nationwide economic activities. Eurostat provides time series for all EU countries and it is able to make a link between factor endowments and the economy. However, the use of output in growth accounting makes it also a very important indicator to understand the link between resource use and economic activity. This is the reason why economic output was also selected.

### Measures of welfare and socio-economic development

**Table 3: Assessment of indicators measuring welfare and/or socio-economic development**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>► Genuine Progress Indicator</td>
<td>Genuine Progress Indicator</td>
<td>(-) Some data are available for a few countries (US, Australia) but different methodologies were applied</td>
<td>(+++) The genuine progress indicator aims to correct GDP in order to provide an accurate information on development</td>
<td>(-) There are many ways to calculate this indicator, some of them may include indicators on resource use</td>
</tr>
<tr>
<td></td>
<td>Canadian Index of Wellbeing</td>
<td>(--) Data is available for Canada only from 1984 onwards</td>
<td>(+++) The Canadian Index of Wellbeing takes into account many dimensions of wellbeing</td>
<td>(+++) The CIW takes into account the following indicators: Primary energy production (peta joules), Water yield in Southern Canada (cubic meters), Viable Non-Renewable Energy Reserves Index, Viable Metal Reserves Index, Canadian Living Planet Index, Marine Trophic Index.</td>
</tr>
<tr>
<td>► Human Development Index</td>
<td>Human Development Index</td>
<td>(+++) Data available from the UNDP website for all countries from 1980 onwards</td>
<td>(+++) The Human Development Index is a commonly agreed indicator of development and wellbeing.</td>
<td>(-) The index does not take into account environmental issues, but focuses on health-related and social issues.</td>
</tr>
<tr>
<td></td>
<td>Index of Sustainable Economic Welfare</td>
<td>(--) Daly and Cobb (1989) made estimates for the US between 1954</td>
<td>(+++) ISEW is calculated by adjusting conventional national income accounts by various factors, such as pollution and the distribution of wealth, to provide a</td>
<td>(+) In the original study by Daly and Cobb (1989), changes in environmental pollution and resource stocks were valued with &quot;off-the-shelf&quot; values from</td>
</tr>
</tbody>
</table>

---

*Indicators on linking resource use to the economy* | 43
The Human Development Index (HDI) was selected as representative of measures of welfare and socio-economic development. Its main advantages are its recognition by professionals as a useful indicator of welfare and data availability. On the other hand, this indicator does not include the environmental dimension (only social). Therefore, it is not directly linked to resource use, but can be used to analyse its co-evolution with resource use and/or resource efficiency.

Among the most interesting indicators of welfare and development, the Sustainable Society Index is a composite indicator that encompasses three dimensions (economic, social, environmental), and includes statistics about resource use. However, a time series for this indicator is not available (data points for 2006, 2008 and 2010 only). As regards the Millennium Development Goals Dashboard, it provides a very comprehensive overview of welfare and takes into account environmental issues. However, it is based on sixty indicators, which makes this index more difficult to interpret.

### Measures of the sustainability of economic activities

#### Table 4: Assessment of indicators measuring the sustainability of economic activities

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Capacity to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable National Income</td>
<td>(-) A calculation was done for the Netherlands</td>
<td>(+++) The indicator assesses the distance between the present and the sustainable level of production</td>
<td>(+) Resource use is included as a cost</td>
<td></td>
</tr>
</tbody>
</table>
Adjusted Net Savings and Sustainable National Income would be two equally relevant measures of the degree of sustainability of an economy. However, Sustainable National Income seems more complicated to measure and no data is available for all EU countries. On the other hand, the World Bank provides statistics on Adjusted Net Savings. This is the reason why the latter has been selected.

Measures of the inputs to production

Table 5: Assessment of indicators measuring the inputs to production

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Capacity to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶</td>
<td>Adjusted Net Savings</td>
<td>(+++) Data available from the World Bank website (from 1970 onwards, for various countries)</td>
<td>(+++) Adjusted Net Saving, known informally as Genuine Saving, is an indicator aiming at assessing an economy’s sustainability based on the concepts of extended national accounts</td>
<td>(+++) Mineral, energy and forest depletion are taken into account in Adjusted Net Savings</td>
</tr>
</tbody>
</table>

Intermediate inputs were selected as the most relevant indicator. In particular, materials and energy are the most relevant intermediate inputs for this study. As prices are essential to understand the link between resource use and the economy, both commodity price and secondary material indices were selected.
Measures of scarcity of natural resources

**Table 6: Assessment of indicators measuring the scarcity of natural resources**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserve-to-production ratio</td>
<td>(-) Data may exist but is not gathered into a same database</td>
<td>(-) This indicator is relevant in the context of energy only</td>
<td>(++) Provides an overview of the rate of resource depletion for known extraction sites</td>
<td></td>
</tr>
<tr>
<td>Resources-to-production ratio</td>
<td>(-) Data may exist but is not gathered into a same databank</td>
<td>(-) This indicator is relevant in the context of energy only</td>
<td>(++) Provides an overview of the rate of resource depletion for known extraction sites and unknown ones, based on the assumption of future resource discoveries</td>
<td></td>
</tr>
<tr>
<td>Renewable internal freshwater resources</td>
<td>(+++) Data available from the World Bank</td>
<td>(-) This indicator is relevant in the context of water only</td>
<td>(++) Provides a limit to the sustainable use of water</td>
<td></td>
</tr>
<tr>
<td>Ratio between current catch weight and stock biomass</td>
<td>(--)) Data is not directly available</td>
<td>(-) This indicator is relevant in the context of fish only</td>
<td>(++) Provides a limit to sustainable fishing</td>
<td></td>
</tr>
</tbody>
</table>

The reserve-to-production ratio was preferred to the resources-to-production ratio because it excludes extrapolations about future discoveries and is therefore relatively more robust. The scarcity of energy resources appeared to be a good indicator of the depletion of resources, even though a more comprehensive view about resource stocks should include other kinds of resources, such as water and fish stocks.

**Information on EU material dependency with respect to the rest of the world**

**Table 7: Assessment of indicators measuring EU resource dependency**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total imports (exports) of raw materials</td>
<td>(+++) Available from Eurostat</td>
<td>(-) These indicators provide information at the country level about the dependency of each EU country on other EU Member States and non-EU countries. The information at the EU level cannot be inferred from these indicators</td>
<td>(++) Data on trade of raw materials provides information on the changes needed to achieve a sustainable supply of raw materials from EU and non-EU partners</td>
<td></td>
</tr>
<tr>
<td>Extra EU 27 imports (exports) of raw materials</td>
<td>(+++) Available from Eurostat</td>
<td>(++) These indicators provide information about the needs in resources that the EU is importing from non-EU countries</td>
<td>(++) Data on EU-27 trade of raw materials provides information on the changes needed to achieve a sustainable supply of raw materials from global markets</td>
<td></td>
</tr>
</tbody>
</table>
### Measures of economic efficiency

**Tableau 8: Assessment of indicators measuring economic efficiency**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise economic issue at stake</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>► Multi-factor productivity</td>
<td>(+++) Available from EU KLEMS database</td>
<td>(+++) The increase in total factor (or multi-factor) productivity allows increasing output without increasing the amount of inputs. It is usually interpreted as the effect of innovation on the economic activity</td>
<td>(+) In the EU KLEMS database, multi-factor productivity is calculated with material use as an input to output growth</td>
<td></td>
</tr>
<tr>
<td>► Contribution of multi-factor productivity to output growth</td>
<td>(+++) Available from EU KLEMS database</td>
<td>(+++) The contribution to growth imputable to MFP should correspond to an increase in efficiency</td>
<td>(+++) The more important is the contribution of MFP to economic growth, the less economic growth was sustained by traditional inputs, including material consumption.</td>
<td></td>
</tr>
<tr>
<td>► Contribution of material and energy inputs to output growth</td>
<td>(+++) Available from EU KLEMS database</td>
<td>(-) This indicator is not an indicator of economic efficiency</td>
<td>(+++) The contribution of material and energy inputs to output growth relates a change in the use of resources to a change in production.</td>
<td></td>
</tr>
<tr>
<td>► Labour productivity</td>
<td>(+++) Available from Eurostat</td>
<td>(+++) Labour productivity provides a good measure of the value added that can be created out of economic activities per unit of hours worked</td>
<td>(+++) Labour productivity provides a good measure of the value added that can be created out of used materials, per unit of hours worked.</td>
<td></td>
</tr>
</tbody>
</table>

As it provides information at the EU-27 level that takes into account exchanges with non-EU countries, the extra EU-27 imports and exports of raw materials were selected as indicators of the EU material dependency with respect to the rest of the world. In parallel, the indicator on the economic importance of a raw material for the EU accounts for the overall use of materials in the EU, independent on whether they were imported from the rest of the world or extracted in the EU. This is complementary information that may be useful to understand long-term trends and short run needs in material use in the EU.
Considering the amount of available data and the close relationship of those indicators with respect to resource efficiency and economic growth, all those indicators were considered as very relevant to this study.

Other economic indicators

<table>
<thead>
<tr>
<th>Selection</th>
<th>Name of indicator</th>
<th>Data availability</th>
<th>Ability to summarise an economic issue</th>
<th>Link with resource use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues from environmentally related taxes</td>
<td>(+++) Available from the OECD/EEA database on instruments used for environmental policy and natural resources management</td>
<td>(-) This indicator provides information about the stringency of the policies that are implemented in Member States</td>
<td>(+++) The tax-bases covered include among others the management of water, land, soil, forests, biodiversity, wildlife and fish stocks</td>
<td></td>
</tr>
<tr>
<td>Amount of generated waste</td>
<td>(+++) Available from Eurostat</td>
<td>(-) The indicator provides information about a negative externality linked to resource use and inefficiency: waste</td>
<td>(+++) The indicator is directly linked with the inefficient use of resources</td>
<td></td>
</tr>
<tr>
<td>Amount of treated waste</td>
<td>(+++) Available from Eurostat</td>
<td>(-) The indicator provides information about waste management</td>
<td>(+++) A better treatment of waste can increase resource efficiency thanks to recycling or energy conversion</td>
<td></td>
</tr>
</tbody>
</table>

Summary

The most relevant economic indicators in the context of resource use that were identified in this section are:

- The Gross Domestic Product;
- Economic Output;
- The Human Development Index;
- Adjusted Net Savings;
- Intermediate inputs;
- The reserve-to-production ratio;
- Commodity price indices;
- Secondary Material Price Indicators;
- Extra EU-27 imports and exports of raw materials;
- Economic importance of a raw material for the EU;
- Multi-factor productivity;
- The contribution of multi-factor productivity to output growth;
- The contribution of material and energy inputs to output growth; and
- Labour productivity.
Annex 3: Times series of selected indicators

- **Gross Domestic Product**
  - Data source: Eurostat – GDP and main components, with current prices (code: nama_gdp_c) or in volume (code: nama_gdp_k)

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU 27</td>
<td>1995-2013 (est.)</td>
</tr>
</tbody>
</table>

- **Trends for Member States (current prices)**

- **Trends at the EU level (current prices)**
Data source: Eurostat. Output statistics are gathered into different datasets for the different NACE sectors of activity. Data for total manufacturing is presented below as an example. Time series of “Production Value” for total manufacturing are available in Annual detailed enterprise statistics on manufacturing subsections DA-DE and total manufacturing (NACE Rev. 1.1 D) (sbs_na_2a_dade).

Trends for Member States: EU production of Manufacturing sector (current euros – no data available for Malta)

Trends at the EU level: production of manufacturing sector (current euros – no data available for Malta)
Human Development Index

Data source: Human Development Report Office

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>1980-2011</td>
</tr>
</tbody>
</table>

There are missing values for some countries and some years, above all before 1995. Dataset is complete for EU 27 countries from 1995 onwards.

Trends for Member States

Own calculations based on Human Development Report Office values for the HDI. Weights attributed to the HDI of Member States according to total population (source: Eurostat).
Adjusted Net Savings

Data source: Green Accounting – Adjusted Net Saving, including PM10 damage – World Bank data.

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>1990-2010</td>
</tr>
</tbody>
</table>

Data on ANS excluding PM10 damage is available from 1970 to 2008. There are missing values for some countries and some years, above all before 1995. Dataset is complete for EU 27 countries from 1995 to 2007 except for Malta.

Trends for Member States

Trends at the EU level

http://databank.worldbank.org/ddp/home.do
Intermediate inputs

Data source: EU KLEMS Database – Sum of intermediate inputs to production by country (unit: index 2005=100 or in national currency)

<table>
<thead>
<tr>
<th>Geographic Coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU 25</td>
<td>1995-2007</td>
</tr>
</tbody>
</table>

The classification into energy, material and services as separable inputs is not available for all countries.

<table>
<thead>
<tr>
<th>Geographic Coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain</td>
<td>1980-2005</td>
</tr>
</tbody>
</table>

Trends for Member States (index, 2005 = 100, current prices – all intermediate inputs together)

Trends at EU level (all intermediate inputs – current euros)
Share of each type of input in the consumption of intermediate inputs at the EU level (includes Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands and Spain only, using PPP-converted euros).
Reserve-to-production ratio

Data source: No data is directly available for this indicator. The World Energy Council provides data on fossil fuel resources from some countries in its annual Survey of Energy Resources. However, data are subject to frequent revision. Some publications of the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) provide data on uranium resources. Another potential source of data is the national and international oil and gas companies that publish data both on resources and production.

The British Petroleum Company publishes Reserve-to-Production ratios in its annual Statistical Review of World Energy. Data is available for oil, natural gas, and coal and cover 14 European countries.29

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria, Czech Republic, Denmark, Germany, Greece, Hungary, Italy, Netherland, Norway, Poland, Romania, Spain, United Kingdom</td>
<td>2010</td>
</tr>
</tbody>
</table>

Proved reserves are defined as “generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions”. The Reserve-to-Production ratio shows therefore the length of time that those remaining reserves would last if production was to continue on its current pace.

Commodity prices

Data source: Global Economic Monitor (GEM) Commodities – World Bank data

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>1960-2012</td>
</tr>
</tbody>
</table>

Commodities covered by the World Bank are Aluminium, Bananas, Barley, Meat, Coal, Cocoa, Coconut oil, Coffee, Copper, Copra, Cotton, Crude oil, DAP, Fishmeal, Gold, Groundnut oil, Iron ore, Meat, Lead, Logs, Maize, Natural gas, Nickel, Oranges, Palm oil, Phosphate rock, Palm kernel oil, Plywood, Potassium Chloride, Rice, Rubber, Sawn wood, Shrimp, Silver, Sorghum, Soybeans, Steel, Sugar, Tea, Tin, Tobacco, TSP, Wheat, Wood pulp, Zinc

Commodity price indices from the World Bank are energy, agriculture, fertilisers, metals and minerals, base metals or manufactured unit value index.

World Bank price indices for "energy" and "metals and minerals"

World Bank price indices for base metals
Secondary material price indicator

- Data source: Eurostat – Waste Management Tables\(^{30}\) (Yearly Prices)

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU27</td>
<td>2000 - 2010</td>
</tr>
</tbody>
</table>

Additional monthly prices are available starting from January 2006.

- Trends at the EU level

Labour productivity

Data source: Eurostat – Real labour productivity per person employed\[31\] (code: nama_aux_lp)

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU27</td>
<td>1995 - 2013</td>
</tr>
</tbody>
</table>

It should be noted that “persons employed” does not distinguish between full-time and part-time employment. Data for Malta and Romania is missing from 1995 to 2000.

Trends for Member States and at the EU27 level (€/person employed)

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http://epp eurostat ec europa eu/portal/page/portal/national_accounts/data/database

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Extra EU-27 imports and exports of raw materials

- Data source: Eurostat – Intra and Extra-EU trade by Member State and by product group (ext_it_intratrd)

<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU-27</td>
<td>1999-2010</td>
</tr>
</tbody>
</table>

The dataset is complete for all EU-27 countries.

Trends for Member States

Trends at the EU level
Multi-factor productivity

Data source: EU KLEMS Database\(^3\) – Multi-factor productivity on value added

<table>
<thead>
<tr>
<th>Geographic Coverage</th>
<th>Period</th>
<th>15 EU Countries: Austria, Czech Republic, Denmark, Spain, Finland, France, Ireland, Italy, United Kingdom, Belgium, Germany, Hungary, Netherlands, Slovenia, Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1995-2007. For some countries, anterior periods are also covered.</td>
<td></td>
</tr>
</tbody>
</table>

The calculation of multi-factor productivity on value added is done by taking aggregated values for labour and capital as inputs. The evolution of intermediate inputs is not taken into account in the calculations (they are neither in the input nor in the output).

Data source: EU KLEMS Database – Multi-factor productivity on production (breakdown between material, energy and services)

<table>
<thead>
<tr>
<th>Geographic Coverage</th>
<th>Period</th>
<th>Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain</td>
<td>1980-2005</td>
<td>Available at the sector level for 30 sectors</td>
</tr>
</tbody>
</table>

The calculation of multi-factor productivity on gross output (total production, including intermediate goods and services) takes into account intermediate inputs (material, energy and business services). The growth accounting framework is more complex and the results for MFP are net of changes in resource use.

Multi-factor productivity on value added of Member States

\(^3\) [http://www.euklems.net/](http://www.euklems.net/)
Difference in multi-factor productivity on value added and on gross output for a few sectors of activity at the EU level (includes Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands and Spain only)

The calculation of multi-factor productivity on gross output systematically gives lower results in terms of MFP growth. This is because the evolution of intermediate inputs is a supplementary
Indicators on linking resource use to the economy

Explanation given to overall changes in output (included in added value). Three examples are provided below.

- Contribution of intermediate inputs and multi-factor productivity to output growth
  - Data source: EU KLEMS Database – Multi-factor productivity on production (breakdown between material, energy and services)

<table>
<thead>
<tr>
<th>Geographic Coverage</th>
<th>Period</th>
<th>Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain</td>
<td>1980-2005</td>
<td>Available at the sector level for 30 sectors</td>
</tr>
</tbody>
</table>

The time-series include the contribution of material and energy inputs along with the contribution of multi-factor productivity. Other contributions calculated in the EU KLEMS project include:

- The contribution of business services to output growth;
- The contribution of hours worked to output growth;
- The contribution of labour composition change to output growth;
- The contribution of ICT capital services to output growth;
- The contribution of non-ICT capital services to output growth;
- Share of each input to output growth for some sectors at the EU level (includes Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands and Spain only)

![Graph showing contributions to output growth over time](image-url)
> Economic importance of raw materials


<table>
<thead>
<tr>
<th>Geographic coverage</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU 27</td>
<td>Not specified.</td>
</tr>
</tbody>
</table>

The large scope of sources used to compute this indicator makes it difficult to define a specific period for which the indicator can be considered as representative. For instance, material production data were compiled for the year 2008 whereas value-added per sectors stem from 2006.

> Trends at the EU level

In theory, the economic performance of raw materials should be expressed in percentage of GDP. However, values in % of GDP are not presented in the Fraunhofer ISI’s report. For presentation purposes, the values for economic importance of each material were scaled to fit in the range from 0 to 10, with higher scores indicating higher economic importance.

The graph presented here reflects the positioning of the material in relation to its importance to the economy. Therefore, it suggests that in case of a supply shortage in chromium, the potential impact could affect a larger part of the economic value chain in terms of value added than other materials.

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