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Resource Efficiency Indicators

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Resource Efficiency Indicators

Contents

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EXECUTIVE SUMMARY

Resource Efficiency Indicators

Resource efficiency is one of the most important challenges faced today by the European Union (EU), and the wider global community. It forms a central pillar of Europe 2020, the EU's growth strategy for the coming decade towards a smart, sustainable and inclusive economy. Under the Europe 2020 strategy, the Flagship initiative for a resource-efficient Europe points the way towards sustainable growth and supports a shift towards a resource-efficient, low-carbon economy.

This In-depth Report from Science for Environment Policy takes a closer look at progress in resource efficiency indicators, building on the EU's Resource Efficiency Roadmap.

Robust and easily understandable indicators are needed to provide signals and measure progress in improving resource efficiency. Resource efficiency needs a consistent definition, between nations, disciplines and business sectors. Definitions or guidelines for Member States regarding what resource efficiency encompasses are an important policy consideration.

EU material use is increasing, yet resource productivity in Europe has improved over the past 20 years. Initiatives such as 'Beyond GDP' focus on decoupling. This means both decoupling economic growth from resource use, and decoupling negative environmental impacts from economic output. For now, the European Commission is using Resource Productivity as the lead indicator on resource efficiency. However, this only describes the material resource aspects of resource efficiency.

Policymakers and business leaders are keen to speed up the process from indicator selection through to their validation and widespread use. Since the 1990s, the path from indicator proposal to implementation has typically taken over a decade. Current initiatives are looking to significantly cut that lead time.

There is a plethora of indicators already available to choose from. These include indicators overseen by Eurostat, and being developed or improved by the Joint Research Centre (JRC) and European Environment Agency (EEA) within the European context. Accounting methodologies are increasingly international. Results show that Europe is making good progress towards resource efficiency, but is having less success with ensuring ecosystem resilience. Today's environmental indicators are heavily biased towards describing where we are, with a notable shortage of indicators measuring policy effectiveness and none covering total welfare.

Life-cycle approaches are important to ensure that impacts are not shifted - in accounting and accountability terms - between nations or between different categories of environmental or health consideration. The concept of measuring product life cycles is increasingly well accepted and supported by moves towards standardised methodologies.

Work is underway to catalogue EU consumption, production and waste management using life-cycle approaches. Progress has been made, but this indicator framework is not yet ready to roll out. Social and natural capital are areas where better indicators are needed.

Recent research from Asia highlights the shift in production from relatively resource-efficient nations, such as Japan, to less efficient ones, such as China and India. The Japanese government is currently preparing for the third policy round in its Sound Material Cycle Society towards 2013, to include more resource efficiency indicators. Meanwhile, preliminary data have begun to emerge in 2012 from China's unique 'Circular Economy' indicator system. Policies are being trialled on a large scale at regional and local levels, implementing national circular economy indicators based on 3R principles (reduce, reuse and recycle).

Industry is a key driving force behind resource efficiency. As well as offering the technical and technological innovation to improve sustainability, businesses are well aware of issues such as cost savings, environmental regulation, greater competitiveness and corporate social responsibility. However, there is a shortage of true measurement of resource efficiency at company level in the EU - some corporate indicators are not as useful at the policy level.

With a number of indicator and accounting frameworks at varying levels of academic and international acceptance, even indicator selection is a daunting task. Standardisation across business sectors or nations may seem desirable for purposes of comparison, but remains challenging in real terms. The reality on the ground is that decisive action will be needed, as our resource use today is shifting the burden of scarcity and the weight of environmental remediation to future generations.

Introduction

A web of factors, including pressure from the expanding global population, increased globalisation and growth and industrialisation in emerging economies, all contribute to greater competition over our natural resources. Exports of some raw materials are now restricted, some have become depleted, and others may be difficult to extract. Scarcity is an economic reality in the 21st century.

Following directly from raw materials' increasing scarcity are considerations of how efficiently we use and re-use the materials available to us. Resource efficiency is one of the most important challenges faced today by the EU, and the wider global community.

Our use of ecosystems and our impact on biodiversity, air, land and water are another dimension of resource efficiency. Economic activity uses materials, energy and land, and creates wastes and emissions. Building and construction, agriculture and food, and metals and manufacturing are industries highlighted for their considerable impact on resources and the environment (UNEP, 2010).

Governments, businesses and communities all have a part to play in moves to improve our resource efficiency, at the local, national and international levels.

The EU's Resource Efficiency Roadmap

Europe 2020 is the EU's growth strategy for the coming decade, which is intended to push the EU to becoming a smart, sustainable and inclusive economy. Under the Europe 2020 strategy, the Flagship initiative for a resource-efficient Europe points the way towards sustainable growth and supports a shift towards a resource-efficient, low-carbon economy.

One of the building blocks of this initiative is the European Commission's Roadmap for a resource-efficient Europe (European Commission, 2011). The roadmap offers a vision of the EU economy in 2050, where the economy is competitive, inclusive and provides a high standard of living with much lower environmental impact. All resources are sustainably managed, climate change milestones are achieved, and biodiversity and ecosystem services have been both protected and restored.

The Roadmap provides a framework explaining how policies and actions will work together to move towards this vision. Robust and easily understandable indicators are needed to provide signals and measure progress in improving resource efficiency. Many resource indicators already exist, and more are still being developed. The European Commission aims to use a lead indicator, accompanied by a dashboard of complementary macro-indicators, to assess the current situation, and to communicate the objectives found in its Resource Efficiency Roadmap.

Two levels of indicator have been proposed:

1 - A provisional lead indicator - 'Resource Productivity' - to measure the principal objective of the Roadmap, of improving economic performance while reducing pressure on natural resources.

2 - A series of complementary indicators on key natural resources such as water, land, materials and carbon, that will take account of the EU's global consumption of these resources.

The goal is for the European Commission to agree on indicators and targets by the end of 2013.

This report

A great deal of work has already been completed - or is underway - regarding resource efficiency indicators. This report summarises just some of this valuable work.

It reviews some of the types of indicator currently available, and the environmental accounting approaches that they fit into. Areas where specific issues with our current indicators exist are highlighted, and the pros and cons of existing or proposed indicators are discussed.

In particular, information on new or forthcoming research, or on areas that have not received as much attention thus far, is highlighted. Examples include updates on a new set of indicators being trialled in China, and a look at indicator issues and contributions from businesses - major players in achieving our resource-efficient future. This overview of research is intended to contribute recent and relevant data that policymakers can draw upon to progress with the Resource Efficiency Roadmap.

1.0 Definition of 'resource efficiency'

According to the European Commission's recent Roadmap to a Resource Efficient Europe, resource efficiency allows the economy to create more with less, delivering greater value with less input, using resources in a sustainable way and minimising their impacts on the environment. In practice, this requires that the stocks of all environmental assets from which the EU benefits or sources of its global supplies are secure and managed within their maximum sustainable yields. It will also require that residual waste is close to zero and that ecosystems have been restored, and systemic risks to the economy from the environment have been understood and avoided. A new wave of innovation will be required (European Commission, 2011).

According to the United Nations Environment Programme (UNEP), resource efficiency is about ensuring that natural resources are produced, processed, and consumed in a more sustainable way, reducing the environmental impact from the consumption and production of products over their full life cycles. By producing more wellbeing with less material consumption, resource efficiency enhances the means to meet human needs while respecting the ecological carrying capacity of the Earth (UNEP, 2012).

In industry, resource efficiency is often defined in supply chain terms, highlighting a firm's material, natural resource and energy efficiencies, and the generation and impact of waste. In some cases, only the resource efficiency of non-energy carrying materials is considered. In this case, the term 'material productivity' is used. Indeed, the majority of firms are currently measuring the amount of resources they consume, but not their level of efficiency (ECORYS, 2011).

The EEA and its European Topic Centre on Sustainable Consumption and Production (ETC/SCP) recently carried out a survey of resource efficiency policies and instruments with 31 nations among its member and cooperating countries network (Eionet).

None of the countries provided an explicit definition of resource efficiency. Most (26) focused on raw materials or material resources when referring to resource efficiency. Terms like 'resource efficiency', 'resource productivity' and 'decoupling' are used interchangeably, to express how 'efficiently' the economy is using resources.

Only five countries formally defined the term 'resources' in their policies. The general understanding of 'resources' in most of the countries was based on classical environmental policies, often covering raw materials, such as metals, mineral and biomass, and energy sources. Energy carriers, including fossil fuels, are often dealt with separately under energy policies. The majority of countries now include waste as a resource, and so view recycling as a route to greater resource efficiency (EEA, 2011).

In addition to broad or vague definitions, there are also some translation difficulties around key terminology in some languages. Definitions or guidelines for Member States regarding what resource efficiency encompasses are an important policy consideration.

2.0 Where we are now

2.1 The case for resource efficiency

There are three key drivers of resource use: population, economic growth and resource productivity.

Material use in the EU is increasing, in line with global trends. From 1900 to 2005, material extraction globally has increased eightfold. Within this figure, the largest increases are for construction materials (which grew by a factor of 34), ore and industrial minerals (27 times) and fossil energy carriers (12 times). Biomass extraction increased 3.6 times in the same period (UNEP, 2011).

Meanwhile, increasing resource productivity means that we are creating more wealth from the resources we have. Resource productivity in Europe has improved over the past 20 years, thanks to more eco-efficient technologies, the transition to service-based economies and EU economies increasing their share of imports (EEA, 2010).

2.2 The EU 2020 Agenda

The Europe 2020 agenda is a ten-year strategy proposed by the European Commission in March 2010. Priorities include:

- Smart growth: developing an economy based on knowledge and innovation;
- Sustainable growth: promoting a more resource-efficient, greener and more competitive economy;
- Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

The EU has introduced seven flagship initiatives to work towards these priorities. Flagship initiative 4 is Resource Efficient Europe, a Communication adopted on 20 September 2011 that focuses on decoupling economic growth from resource use; supporting moves towards a low-carbon economy; increased use of renewable energy; transport sector modernisation; and promoting energy efficiency.

Some key components in meeting these goals include the use of financial and market-based instruments as well as reducing environmentally harmful subsidies.

Flagship initiative 5: 'An integrated industrial policy for the globalisation era' looks at how to improve the business environment for strong and sustainable growth. This initiative specifically highlights

- Greater energy and resource efficiency in manufacturing sectors;
- Reduced transaction costs of doing business in Europe;
- Affordable access to finance;
- Promoting the use of technologies and production methods that reduce natural resource use;
- Enabling access to the Single Market and the international market beyond;
- Supporting the transition of service and manufacturing sectors to greater resource efficiency.

Box 1: Definitions of 'decoupling'

Relative Decoupling

Both economic performance and resource use grow, but the resource use is growing at a lower rate than the economy. Resource productivity increases.

Absolute Decoupling

Economic growth is achieved, while resource use is falling in absolute terms.

Double decoupling

Double decoupling is a concept that has entered the policy debate in recent years. It makes a distinction between decoupling resource use from economic growth, i.e. fewer resources used per unit of GDP, as well as decoupling resource use from the environmental impacts it causes, i.e. lower impacts per unit of quantity.

Some experts argue that the increase in resource quantity is not the most significant problem because impacts can be reduced by closing material loops, recycling and recovery or the wider use of end-of-pipe measures. Others believe that the growth in quantities is a problem in itself, given finite amounts of non-renewables and potentially irreversible impacts on ecosystems. There are methodological difficulties in measuring decoupling of environmental impacts from quantities of resources used (European Environment Agency, 2010).

Resource and impact decoupling

Resource decoupling means reducing the rate of resource use per unit of economic activity, leading to 'dematerialisation'. Greater resource decoupling is indicated by increased economic output relative to resource input – also known as resource productivity (GDP/DMC). Impact decoupling refers to increasing economic output while reducing negative environmental impacts, for example, from over-extraction or pollution. These types of impacts can be measured using life cycle analysis (LCA) (Fischer-Kowalski, 2011) (Bolla, Lock, & Popova, 2011).

3.0 What indicators are we using now?

3.1 Resource productivity – interim lead indicator

For the near future, the European Commission is using resource productivity as its lead indicator. This is calculated by dividing gross domestic product (GDP)[1] by domestic material consumption (DMC)[2], which provides a figure in euros/tonne (European Commission, 2011). This indicates when less material is being used to provide the same economic output.

The strengths of DMC as an indicator largely concern the fact that it is an established method that fits well with current available datasets (such as official statistics), it incorporates minerals, metals, carbon-based fossil fuels and renewable biomass, and it allows for a breakdown of results by material, sector or industry.

However, when resource productivity increases, this does not signal a reduction in our use of resources in absolute terms. It simply means that the economy is growing faster than our resource use at any given time.

One of the core objectives of policies towards sustainability is to decouple environmental degradation and resource consumption from economic and social development. The current situation in most industrialised countries is relative decoupling of material use from economic growth. Absolute decoupling is the ultimate goal for resource efficiency initiatives in the longer term.

3.2 Resource productivity in the EU

Figures from Eurostat show that in terms of resource productivity, the EU is making good progress towards its goals. However, the headlines mask a more complex picture.

Resource productivity consumption in the EU increased from €1.21 per kg in 2000 to €1.30 per kg in 2007. The increase was particularly strong during the economic downturn between 2000 and 2003, when DMC experienced a declining trend.

However, material consumption began to grow again faster than GDP from 2004, reversing the trend. This was followed by a period of relative decoupling from 2005 to 2007, during which GDP grew at a slightly higher rate than DMC. The overall picture for the seven-year period is that increased resource productivity was a result of relative decoupling of resource use from economic growth.

Big differences are evident between EU Member States. In 2007, the resource productivity of Member States varied by a factor of more than 30. The overall trend was that where material consumption was stable or decreasing, GDP growth was also low. Not surprisingly, a higher GDP was associated with moderate or high increases in material consumption. Between 2000 and 2007, absolute decoupling only occurred in six Member States.

The picture also varied between different types of waste and resources. While larger quantities of raw materials and electricity were used and hazardous waste generation was still on the increase, final energy consumption and the amount of non-mineral waste generated in the EU declined. Recycling and composting are on an upward trend, and the EU has seen substantial reductions in the emissions of important air pollutants (Eurostat, 2011).

The Commission recognises that resource productivity only describes the material resource aspects of resource efficiency, and so for now it is a 'proxy' indicator. It plans to compensate for these limitations by complementing this lead indicator with a dashboard of macro indicators on water, land and carbon. New indicators on natural ecological capital and on environmental impacts of resource use will be added as soon as possible.

Experience with environmental indicator developments since the 1990s shows that there is a time lag of around 10-15 years from an indicator proposal to its implementation. This has been how long it takes to put in-situ monitoring, satellites and statistical surveys in place, and to obtain trends. More recent indicator requirements to support, for example, the Europe 2020 strategy or Roadmap to a Resource Efficient Europe require shorter delivery timeframes (EEA, 2012).

Other possible proxy indicators have been developed that are in theory ready for use. These include environmentally weighted material consumption (EMC) and the ecological footprint, and have been considered by the Commission.

[1] GDP = Gross Domestic Product – an aggregate measure of production, GDP is sum of the gross value added of industries engaged in production, plus any taxes, and minus any subsidies, on products not included in the value of their outputs.
[2] DMC = Domestic Material Consumption: The total amount of materials directly used by an economy: the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports.

3.3 Eurostat SDI Indicators

The EU already uses a set of Sustainable Development Indicators (SDIs), developed by Eurostat along with the Task Force on Sustainable Development Indicators (Adelle & Pallemaerts, 2010).

The EU currently has over 130 economic, social, environmental and institutional indicators to monitor its progress towards sustainable development.

Indicators are grouped into ten themes representing overall objectives. Each theme includes a hierarchy of indicators, as shown in the SDI pyramid (see Figure 1), with a lead indicator at the top of each pyramid.

Resource productivity is the current lead indicator for sustainable consumption and production.

As we might expect, other themes overlap with resource efficiency too. These include climate change and energy, sustainable transport, natural resources, and good governance.

Each sub-theme represents operational objectives and finally actions. These levels are complemented by contextual indicators, which provide relevant background information, but do not directly monitor progress towards the key objectives[3].

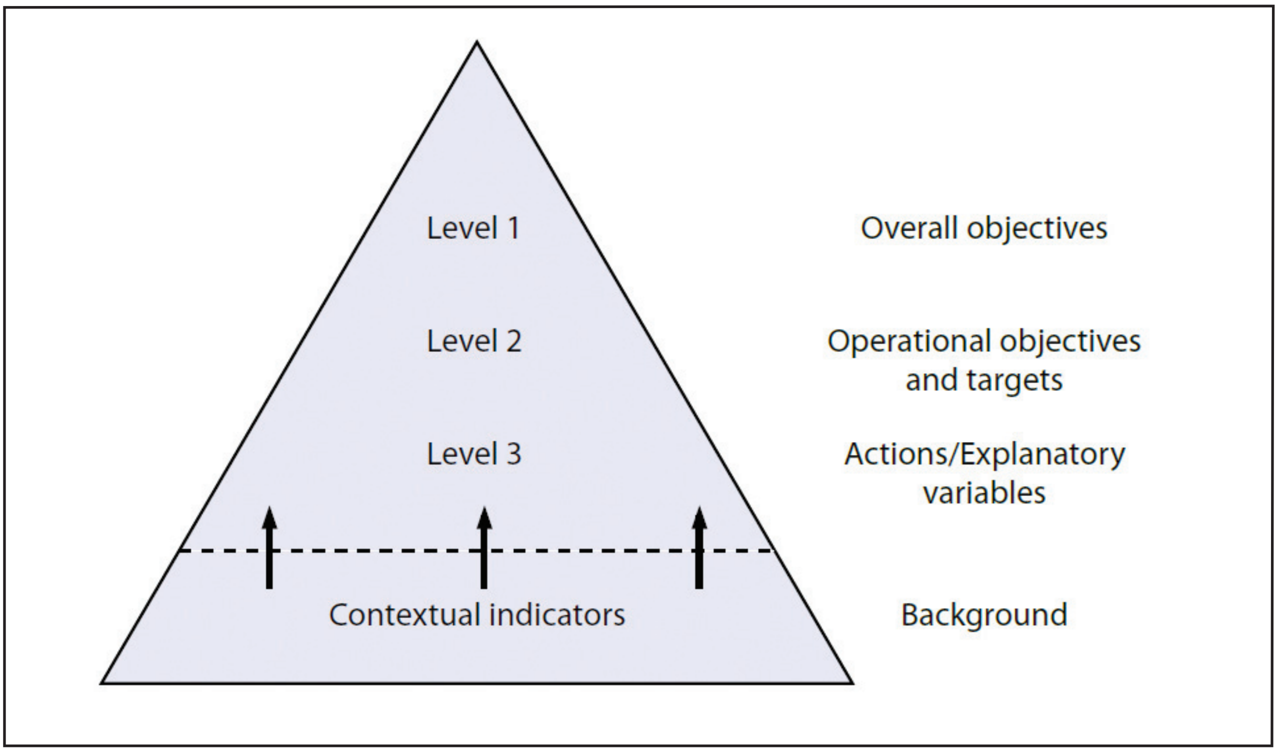


Figure 1: THE Sustainable Development Indicator (SDI) Pyramid.

[3] See http://epp.eurostat.ec.europa.eu/portal/page/portal/sdi/context

4.0 New indicators under development

4.1 Ecological capital indicators

Ecological capital indicators include Landscape Ecosystem Potential or Ecosystem Degradation indicators currently under development by the European Environment Agency (EEA).

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, soil, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits (EEA, 2007).

The EEA's current work in this area builds and elaborates on existing frameworks, such as the System of integrated Environmental and Economic Accounting (SEEA) methodology from the United Nations (UN, EC, IMF, OECD and World Bank, 2003). The aim is to find a small number of aggregated indicators that can be used to track progress. Sound aggregated indicators can help support decision making when used alongside other aggregates such as GDP.

Using the SEEA framework, the EEA proposed covering these elements:

1. Natural capital stocks of socio-ecosystems (stocks, internal flows, integrity/health/resilience, services) – are accounted in physical terms in a first step – by integrating monitoring, statistical and geographical data.

   However, giving natural capital a monetary value is more complicated, because it requires disentangling ecosystem services from market values of commodities. More research is needed, and so this would be a second step for future consideration.

2. Non-market benefits from ecosystem services need to be added to GDP to compute the Inclusive Domestic Product (IDP) which acts as a monetary measure of human wellbeing.

   Some ecosystem services have a monetary value, and are already incorporated into GDP. Those that are used for free are called non-market benefits, and can be calculated using physical units (e.g. number of persons x time spent x frequented area) and then valued with shadow or virtual prices. Adding this to GDP gives the IDP. Where GDP gives a measure of economic welfare, IDP tells us about human wellbeing in terms of ecosystems. For example, IDP can measure the fact that degradation of an ecosystem has negative consequences for the amount of goods and services available.

3. Non-financed costs necessary for maintaining and/or restoring the natural capital need to be added to GDP for calculating a Full Cost of Goods and Services (FCGS).

   When an ecosystem is degrading or not at a level decided by society, the full cost of its use is not covered by any economic expenditure. Extra maintenance and restoration costs need to be factored in to allow for natural capital depreciating, because these are not covered in GDP at the present time and so are a debt effectively being deferred for future generations to address. When these costs are added to the current value of goods and services, the new aggregate gives the true cost: FCGS (see below).

4. Full cost of imported goods and services is part of FCGS – it is a monetary measure of Europe's footprint on the global ecosystem.

   This means that the future costs associated with maintaining or restoring ecosystems in countries that export to the EU are also considered. The full cost of imports will reflect the global human footprint of the importing country.

5. Breakdowns by sectors/products with the national Accounts Matrix for Environmental Accounting (NAMEA) are important as they relate directly to the national accounts and policy action areas (e.g. energy, agriculture, industry, forestry).

   Ecosystem services and physical costs of maintenance/restoration can be analysed by sectors/products within NAMEA. The EEA recommends that the Input-Output analysis under NAMEA should be expanded to IDP and FCGS, because comparisons between either different industries in a country or between the same industries in different countries are very important for policies regarding globalisation. For example, CO_2 might be a candidate for a FCGS calculation, using carbon shadow prices.

6. The ratio IDP/FCC measures a 'Sustainable Development Gap' aggregate (SDG). When SDG is less than one, the costs of our current welfare are not covered and we are over-consuming.

According to the EEA, IDP and FCGS are straightforward indicators of sustainable development. The proposed adjustment generates no damages to GDP, which may help its acceptance by statisticians, in particular in the context of environmental accounting discussions. The neutrality of the framework can accommodate major positions in environmental accounting and environmental/ecological economics (ibid).

4.2 Environmental impacts of Land Use Indicators

Land and Ecosystem Accounts (LEAC) is a method developed and used by the EEA to account for the interactions between nature and society on the basis of a detailed grid (1km x 1km) for land use and land cover changes within the EU. It is based on CORINE land cover data and its goal is to provide information on land cover and related land use changes. Within LEAC, ecosystem accounts incorporate material and energy stocks and flows, health of ecosystems counts and ecosystem services measurements. The ultimate goal is to measure the resilience of natural capital, its services and maintenance costs.

An example of an indicator developed by EEA that uses LEAC is ecosystem coverage, which details the area of available habitats and ecosystems across Europe. This indicator uses photo-interpretation of satellite imagery to provide a rough picture of the trend in area and proportion of the major ecosystems in Europe since 1990. Data are available from 23 countries, and include changes that occurred between 1990 and 2000.

4.3 Progress

The EEA has revived its annual indicator report series in 2012 with the publication of its Environmental Indicator Report. The EEA has a set of over 200 environmental indicators, many of which are directly or indirectly relevant to resource efficiency[4].

The report defines the key challenge as improving resource efficiency whilst ensuring ecosystem resilience. It presents a set of environmental indicators to enable policymakers and the public to assess how Europe is meeting this challenge. There are some encouraging trends, but progress appears to have been greater for resource efficiency than for ecosystem resilience.

The EEA will publish a first set of experimental ecosystem accounts around March 2013, with the longer-term aim of establishing data assimilation and integration within the economic and social domains.

The Annex breaks down the indicators based on the following categories:

A – Descriptive indicators: 'What's happening?'

B – Performance indicators: 'Does it matter?'; 'Are we reaching targets?'

C – Efficiency indicators: 'Are we improving?'

D – Policy effectiveness indicators: 'Are the measures working?'

E – Total welfare indicators: 'Are we on the whole better off?'

It is worth noting that the vast majority (175) are descriptive indicators. A reasonable number can be used for target setting (35) and a few can be used to measure efficiency (12). Only three indicators measure policy effectiveness and there is currently no single indicator for total welfare.

4.4 Environmental impacts of resource use

EU actors are also involved in developing indicators of the environmental impacts of resource use. One key option for the Commission to consider is a set of life cycle based resource efficiency indicators under development by the Commission's Joint Research Centre (JRC)[5].

According to the JRC, Life Cycle Thinking (LCT) is essential to avoid 'shifting of burdens' of impacts among countries and among different types of environment and human health considerations.

LCT takes into consideration the environmental impacts along the whole 'lifecycle' of a product (both goods and services) in a single framework, irrespective of when or where they occur. The lifecycle ranges from resource extraction, material production, manufacturing, use (or service delivery), to re-use, recovery, end of life treatment, and disposal of remaining waste (Koneczny, Bersani, Wolf, & Pennington, 2007).

As with any methodology, a standardised approach to Life Cycle Analysis (LCA) is vital if it is to find broad application. In 2012, the JRC, in cooperation with the European Commission's Directorate General (DG) for the Environment, published the International Reference Life Cycle Data System (ILCD) Handbook, which provides governments and businesses with a basis for assuring quality and consistency of life cycle data, methods and assessments.

As well as offering standard tools for those carrying out LCAs, the document is intended to be used by a number of audiences. These include uses within industry to inform company policy, e.g. for product improvement or technology strategy.

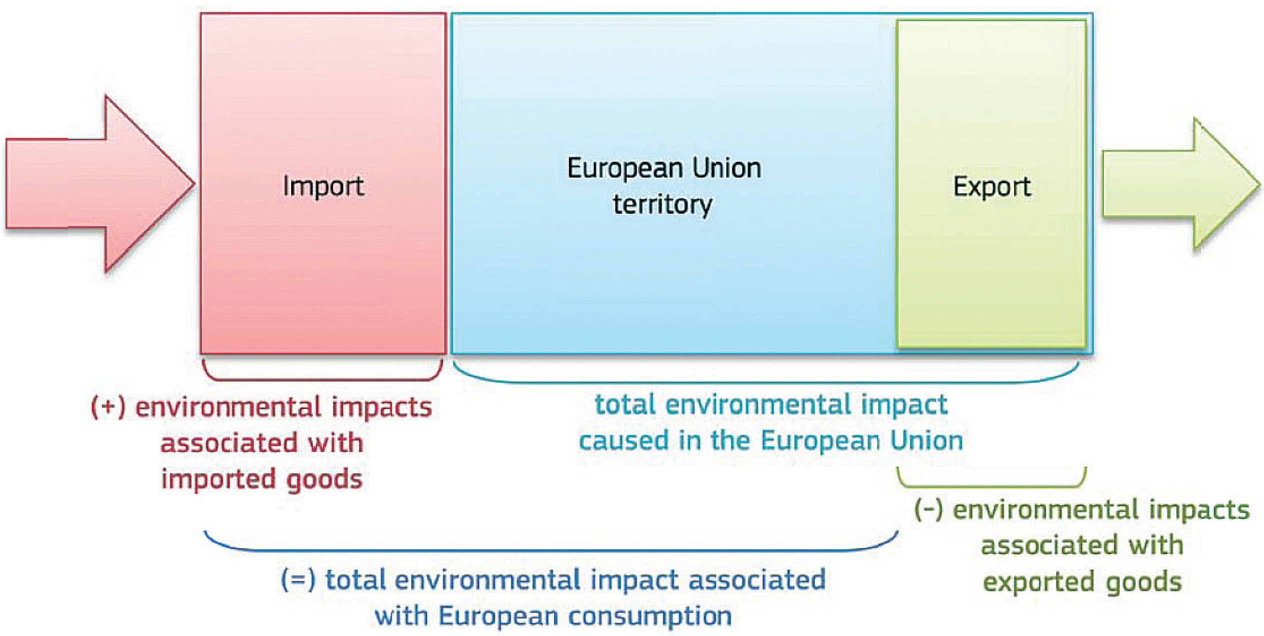


Figure 2: The life cycle perspective is a global perspective.

[4] *All 225 EEA indicators are accessible at: www.eea.europa.eu/data-and-maps/indicators. An exhaustive list is also given in the Annex of the Environmental Indicator Report 2012, giving their status as of March 2012.*

[5] *See http://lct.jrc.ec.europa.eu/assessment/projects*

For policymakers, the ILCD Handbook is intended to provide a reference to ensure coherence when developing, implementing and monitoring life-cycle related policies, research calls, or issuing standardisation mandates. For example, policymakers can request any work carried out must be 'ILCD compliant'. According to the JRC, life-cycle approaches are now being used in mainstream business and policy support. Now is the right time to also use these to support more informed monitoring and indicators. This is part of a move away from a domestic-only focus using mass-based approaches and other simplistic statistical insights.

With LCA approaches, we can now account for impacts also associated with imports, exports, as well as breaking down information to different product groups.

Some of the reasons why it has taken some time for life-cycle approaches to gain ground, and for why they have yet to achieve mainstream use in industry are detailed below (Wolf, Pant, Chomkhamsri, Sala, & Pennington, 2012).

- **Reproducibility**
  Reproducibility of LCA results and recommendations cannot be guaranteed because ISO standards leave too much room for interpretation.
- **Data availability and quality**
  There is a relative shortage of high-quality and consistent data to input into LCAs.
- **Uncertainty of impact assessment methods and factors**
  Uncertainty remains in some important impact areas, such as land use or water overuse. There are no robust and fully practice-tested methods yet.
- **Quality assurance**
  Clear requirements have not been available on how to select reviewers, how to run the review process, review methodology, etc.
- **Cost and complexity**
  Developing a reliable LCA is often perceived to be too resource- and time-consuming, requiring dedicated experts.

The ILCD Handbook aims to address these obstacles in detail.

One important limitation of the Environmental LCA approach outlined in the Handbook is that it does not address social and economic elements of the product life cycle. However, it can be complemented by other life-cycle instruments that do capture these aspects.

As with all indicators, including the statistics available, there remain gaps, expert choices, and opportunities for data quality improvement. For the life-cycle information (supply chains, use, end-of-life), this is equally valid. Nevertheless, the benefits of using available information to support decisions now outweigh the limitations.

Awareness and understanding form a key barrier. JRC scientists now have experience of using statistics for monitoring, and assumptions that this relates to realities are generally adopted. Introducing approaches that bridge the gap between micro/meso data used in business/policy support with macro scale monitoring is, however, novel. It will take time for a broad understanding and appreciation of the benefits to develop, as well as to address misconceptions.

Progress is being made to address some of the barriers to LCA approaches, for example, through the development of a common EU Environmental Footprint (life-cycle) approach, the existence of an associated European Platform on Life Cycle Assessment, an emerging International Life Cycle Data Network, an evolving European Reference Life Cycle Database (ELCD), and a Directory of information.

This is complemented by EC-business interactions, for example, such as the European Food SCP Round table, which is now in a test phase of its EnviFood Protocol for the environmental assessment of food and drink products and has life cycle as a mandatory requirement.

4.5 A framework for life cycle-based indicators

Following an evaluation of available approaches, the JRC has established a framework for life cycle-based indicators, and it will include:

- Decoupling indicators (resource efficiency indicators). The main focus is on the overall EU eco-efficiency indicator, which provides insights into decoupling environmental impacts from economic growth.
- Basket-of-products indicators. These monitor the environmental impact of consumption (including impacts related to imported products). The types of consumption include nutrition, shelter, mobility, consumer goods and services.
- Waste management indicators. These assess the environmental impacts related to the management of the most environmentally important waste streams. Waste management indicators address potential impacts and benefits related to the entire waste management chain, including the collection, transport, and treatment of waste, including secondary wastes (e.g. bottom ash from the incineration of household waste). The main challenges remain data availability and consistency (both statistical and life cycle data).

The life cycle indicators monitor the consumption, production and waste management in the EU and its Member States. In 2011, the JRC completed a pilot project to calculate a prototype indicator set for EU-27 as a whole, and for Germany as one example of a Member State. Indicators were calculated for the years 2004, 2005 and 2006. The JRC's Sustainability Assessment Unit is currently in the process of developing the indicators for more individual Member States, and for a longer time series. The pilot project proved the validity of the indicator framework, but JRC experts also identified some methodological issues that need further work.

The Commission has pledged to continue work on indicators, including the quality of the data, taking stock of existing assessment frameworks, such as iGrowGreen, with a view to inclusion in the mid-term review of the Europe 2020 strategy in 2013.

4.6 iGrowGreen

iGrowGreen is an indicator-based assessment framework tracking how structural reforms can contribute to a competitive, greener economy[6]. To date, it covers all 27 EU Member States since 2000, recording around 70 indicators, which systematically compare Member States' environmental performance with macroeconomic and fiscal implications across four green policy domains and nine policy areas.

By the end of 2013, the Commission aims to propose a new lead indicator on natural capital and environmental impacts of resource use. It will also continue work under the 'GDP and beyond' roadmap so that societal and economic progress are more comprehensively measured. This will involve continuing the development of the system of environmental accounts, further integrating environmental externalities into national accounting and developing a composite index on environmental pressures.

[6] *See http://ec.europa.eu/economy_finance/db_indicators/igrowgreen/index_en.htm*

5.0 International actors: resource efficiency in Asia

While the rest of the world has made resource efficiency gains, Asia Pacific has not: 1970-2005 saw material efficiency halve around most of the world from about 2.2 to 1.1kg per US$ of GDP. The exception was Asia and the Pacific, where material efficiency was stagnant at around 2.4kg per US$ of GDP until 1990. Since then, the region has lost efficiency, requiring 3.1kg of materials per US$ of GDP by 2005 (UNEP, 2011). This has happened because production has shifted from very material efficient producers (e.g. Japan), to less efficient ones (such as China or India). The EU is linked to this trend in less efficient nations, because production of many items destined for export to Europe has contributed to lower resource efficiency in producing nations.

5.1 China: circular economy

Economic growth in China has been achieved at the expense of its natural capital and environment. To address this problem, policymakers have chosen the circular economy (CE) as a national policy for sustainable development. China has enacted national laws and regulations to facilitate the implementation of CE and national CE demonstration projects have been initiated to complete benchmarking activities. Currently, 50 industrial parks exist which serve as national eco-industrial park (EIP) pilot projects.

China has national circular economy indicators based on 3R principles (reduce, reuse and recycle), which include macro level (regional) and local (industrial park) levels. Both indicator sets contain four categories: Resource output indicators; Resource consumption indicators; Integrated resource utilisation indicators; and Waste disposal indicators.

China is the first country to release nationally-focused CE indicators so that objective and credible information on the status of CE implementation can be recognized. This unique indicator system was not communicated to international communities until 2012, when details began to appear in journal articles (Geng, Fu, Sarkis, & Xue, 2012). These indicators are of interest to both developed and developing countries seeking to implement sustainable development measures within their regulatory policies.

China's resource efficiency experts say that, at present, substantive revision is still needed. China still lacks indicators in the following areas:

- Social
- Urban/industrial symbiosis
- Business
- Absolute material/energy reduction
- Prevention-oriented indicators[7]

Some barriers to implementation include a lack of direction regarding data collection, calculation and submission, which are tasks for local government. The indicator system is currently voluntary, and may be pursued with differing intentions by regions with differing agendas (Xue, Chen, Zhang, & Geng, 2010). The government has not yet offered specific goals or values to use as benchmarks against which to improve.

In terms of procedures for indicator selection and weighting, Yang *et al* (2010), writing on behalf of the Chinese Ministry of Urban and Rural Housing Development, propose a selection process that extends beyond the current project on energy-efficient buildings. China established various energy efficiency codes for its buildings since 2006. It aims to improve energy conservation by 50% over 1980s standards, with more ambitious targets of 65% lower energy use in four municipalities (Beijing, Shanghai, Tianjing, and Chongqing). As well as offering a method of identifying indicators, Yang *et al.* also show how researchers employ the Analytic Hierarchy Process (AHP) for weighting indicators, and addresses issues of choice and prioritisation in policymaking.

5.2 Japan: sound material cycle society

Japan was one of the first governments to encourage higher energy efficiency standards among its manufacturers. The Japanese Energy Conservation Laws enacted in 1979 led to product improvements in refrigerators, air conditioners and automobiles, among others, which in turn increased global market share for Japanese manufacturers. The significance in policy terms is that government leadership in energy efficiency in Japan influenced markets worldwide (Weizsacker, Hargroves, Smith, Desha, & Stasinopoulos, 2009).

Economists have noted that Japanese production of many products, ranging from rice to furniture has declined, with no complementary increase in demand for imported substitutes. A new generation of young people is more likely to choose against car ownership than older generations. Japan has effectively been 'downsizing' in many areas for some time (Cohen, 2011).

The decoupling concept has been explicitly incorporated into Japanese national policy for establishing a sound material cycle (SMC) society. The Japan Environment Agency created the term *Junkan-gata-shakai* (Sound Material Cycle Society) in the early 1990s. SMC is based on 3R (reduce, reuse, recycle) principles (Fischer-Kowalski, 2011). SMC policy was driven by issues with managing Japan's solid waste, and is now successfully coupled to resource input issues. Japan has enforced 3R policies through the national legislative framework, and has been active in sharing its concepts and experience globally.

Understanding how materials flow in the economy has been central to advancing SMC. Material flow accounts (MFA) are embedded in environmental policy. Under this policy, Japan has adopted material flow indicators, including resource productivity. The government has collected itemised data on flows of materials within the national economy and sets numerical targets for material flow indicators.

There has been more success in some areas than in others. CO_2 emissions have not been sufficiently decoupled from economic growth in Japan; energy use continues to climb, and waste management issues continue. However, voluntary initiatives in the business arena, such as the top runner approach for electric appliances, have led to efficiency gains.

The Fundamental Plan for Establishing a Sound Material Cycle Society was launched in 2003 followed by an update in 2008. The Japanese government is currently preparing for the third fundamental plan towards 2013 and it is likely that additional resource efficiency indicators will be included. The Institute for Global Environmental Strategies (IGES), based in Japan, has published a White Paper including research on resource efficiency indicators in July 2012 (IGES, 2012).

7. A full list of China's current CE indicators is described in (Geng, Fu, Sarkis, & Xue, 2012).

6.0 Industry

Industrial policy needs to incorporate resource efficiency, to balance Europe's need for growth and employment with the importance of protecting and managing the environment. In line with Europe 2020, the EU's strategy for smart, sustainable and inclusive growth, objectives of the European Commission's DG Enterprise and Industry include strengthening Europe's industrial base and promoting the transition to a low carbon economy.

Other key goals include promoting innovation as a means of generating new sources of growth and meeting societal needs. DG Enterprise and Industry has recently published two studies, funded by the European Commission under the Competitiveness and Innovation Framework Programme (CIP) on European progress, that highlight resource efficiency in the context of industrial environmental performance.

The study on the *Competitiveness of European Companies and Resource Efficiency* looked at resource efficiency performance, the obstacles businesses encounter and the opportunities that exist. The study on *EU industry in a sustainable growth context* meanwhile focused on the overall eco-performance of EU industry over the last 10 to 20 years. Both are summarised in a report (ECORYS, 2011).

The studies confirm that European industries have substantially increased their resource efficiency and environmental performance in recent years. This is evidenced by significant and continuing decoupling of economic growth and environmental impact. Industrial energy intensity, for example, has improved by more than 20% since 1995, and industrial greenhouse gas (GHG) emissions and waste generation have been reduced.

6.1 Industry drivers towards resource efficiency

A strong driver towards resource efficiency is industry's compliance with environmental regulations. However, resource efficiency also has other clear benefits for business, as it reduces costs, reduces businesses' exposure to resource scarcity, and can boost competitiveness.

Industry itself is a key driving force behind the technical and technological innovation required for greater sustainability and resource efficiency. Although eco-innovation remains underexploited, public and private investment in this area in the EU has continuously increased over the last 10 to 20 years, as has environmental protection expenditure, which totalled over €50 billion in 2006.

The eco-industries sector has grown (in employment terms) to equal the scale of the chemical or electrical and optical equipment sectors. Annual employment growth in this sector between 1999 and 2008 averaged approximately 180,000 jobs per year, representing over 7% annual growth, and in 2008 it was estimated to employ 3.4 million people across the EU.

Industry can further improve resource efficiency. There is potential to develop new sustainable products, use alternative materials, and develop new business models, such as chemical leasing. However, resource efficiency measures usually require large upfront investments, which may not be affordable to companies, particularly SMEs. The current difficult economic situation exacerbates this. Both reports call for more action to be taken at the EU level in this regard.

The studies are closely linked to the objectives laid out in the Europe 2020 Flagship Industrial Policy Communication, which set out a new framework to promote the modernisation of Europe's industrial base and the transition to a low-carbon, resource-efficient economy. The Resource Efficiency flagship also falls within the Europe 2020 strategy for sustainable, smart and inclusive growth.

The Industrial Policy Communication aims to mobilise the full range of EU and Member State policies to ensure that the EU remains an attractive place for business investment and job creation, not least in the green economy. It outlines a more focused industrial innovation policy to promote the wide deployment of new key enabling and environmental technologies and addresses access to essential raw materials. The EU is also working to promote growth and resource efficiency through the full cooperation and input of stakeholders.

Both reports underline the point that improved sustainability and resource efficiency are not only crucial to protecting the environment, but also beneficial to industry, given the fact that they open up new market opportunities. The reports highlight a series of challenges that need to be tackled in order to harness further potential for growth and resource efficiency, but if businesses are able to take on the challenge supported by appropriate policy, the reports suggest that Europe's resource-efficient future looks bright.

The *Study on the Competitiveness of European Companies and Resource Efficiency* looked at how companies monitor or measure their resource efficiency performance, and found a lack of comprehensive approaches to measuring resource efficiency at the company level. Measurements were often confined to those that companies adopted for their strategic resources. For example, in sectors with high energy consumption, measuring this took precedence over measuring other resources. At the company level, comparative indicators demonstrating progress were most relevant. These included results achieved compared to a previous performance or a baseline, or those relating to competitiveness, such as productivity or cost savings resulting from resource efficiency.

One notable finding among the EU industries examined was that companies adopted the measures that focused on optimising the use of the 'same' resources; i.e. they focused on using the resources 'right', which increased efficiency. However, companies rarely tried to improve effectiveness of resource use, or to use the 'right' materials. This is a short- to medium-term solution.

However, the EU vision of resource efficiency takes a longer-term view, which includes thinking beyond currently-used materials and introducing substitutes that may reduce heavy reliance on natural resources. Research, development and innovation are thus central to this longer-term vision for industry.

The Resource Efficiency Alliance is an initiative by European Partners for the Environment. The Alliance is moving towards the EU 2020 Agenda by working with business sectors using a voluntary, bottom-up approach along the value chain.

One important barrier to obtaining empirical data from companies is that they are unwilling to share confidential information on their investment in resource efficiency measures and the decision making process behind investments, because these are considered sensitive.

Other industry concerns include the impression of a shifting policy environment, creating difficulties with forward planning and giving contradicting signals to industry. In addition, tighter environmental legislation may be perceived as putting EU industry at a competitive disadvantage to less regulated industry elsewhere.

6.2 Definition

This report defined resource efficiency in supply chain terms, as 'the sum of material resource efficiency, natural resource efficiency, energy efficiency as well as waste generation and impact'. This approach highlighted firms' use of material resources (water, raw material and energy), and also included measures associated with natural resources (e.g. CO_2 emissions impacts) and waste management, where waste was also treated as a resource.

However, a significant result found through surveying companies from a wide range of European industries was that a comprehensive approach to resource efficiency at the industry level is lacking. Empirical data challenge the definition of resource efficiency given above and the concept of the summation of natural resources did not exist within these industries. The report also points out the need for a baseline against which to measure progress in resource efficiency within industries.

6.3 Issues with industry indicators

These indicators identified as commonly used within EU industries have some shortcomings. Not all of these indicators can demonstrate the level of efficiency for economic activities. Indicators need to show progress against a baseline or accrued benefits resulting from resource efficiency measures to achieve this.

As an example, an indicator that shows the rate of recycled material used in a certain production process only can reveal only so much about resource efficiency. If the recycled material could be substituted by another material that was less resource intensive, this might lead to greater gains in overall resource efficiency for that process. On the other hand, an indicator that measures materials saved against a baseline (e.g. 2010 levels) in the same process would be a useful indicator of resource efficiency.

Material Resources	Natural Resources	Energy	Waste	General
Consumption of material (amount)	CO_2 emission reduction/savings per unit of product	Annual energy consumption	% Recycled material to production	Expenditure of resource related R&D
Amount) Savings of input material (excl. Water)	(Amount) Emissions to air	Annual energy savings	Recycling rates	
(%) Savings of input material (excl. Water)	(%) Reduction of emissions to air	Amount of fossil fuels required	Waste collection rates (national levels)	
	(Amount) Emissions to water	Average thermal efficiency per unit of production		
	(Amount) Reduction of emissions to water	Substitution of conventional fuels by alternatives %		
	(%) Reduction of emissions to water	(Amount) Primary energy consumption		
		(% and amount) Savings on primary energy		

Table1: Thematic areas for resource efficiency indicators found in industry

Box 2: Key Policy Recommendations for Industry

ECORYS (2011) make several recommendations for industry policy as follows:

Policy solution 1: Support EU industries to increase resource effectiveness. By using the right material and by focusing on research development and innovation to introduce alternative materials, new products designs and products with more sustainable characteristics.

Policy solution 2: Increase support to material efficiency. Using the material right would entail adopting measures that maximise the use of the 'same material'. This would include recycling, industrial symbiosis, and measures towards cradle-to-cradle approaches.

Policy solution 3: Introduce economy-wide eco-efficiency indicators. Measuring resource efficiency at the firm level has given some indications on the consumption of resources, but has not given an indication of the 'level of efficiency' of firms. Therefore, setting efficiency indicators is an important policy tool to manage resources at the EU level.

Policy solution 4: Address the current barriers to resource efficiency, which leads to the following recommendations:

1. Enhance a circular economy and increase synergies among industries to address the misalignment of the incentives problem by enhancing the industrial symbiosis, reforming current waste legislation and introducing a single market for waste and recycling across the EU;
2. Consider Market Based Instruments (MBIs) to address the lack of incentives problem. Reforms of taxes and subsidies to support resource efficiency, green procurement and resource pricing are all market based instruments that can be used;
3. Improve access to finance to address the problem of lack of incentives;
4. Use benchmarks and performance levels to address the problem of lack of incentives, and to help the adoption of first order measures;
5. Adopt measures towards changing consumers' behaviour in order to address the lack of market demand problem through information campaigns, marketing (including control on green commercial claims), and labelling schemes;
6. Further support R&D for innovation to address the limits of the best available technology (BAT) problem and to enhance the use of second order measures;
7. R&D support for the development of green business models;
8. Disseminate good practices through industry platforms and networks to address the lack of access to information and knowledge problem through closer linkages between all actors including technology suppliers and enlarged industry platforms and networks;
9. Better define the term 'resource efficiency' (and thus improve communication on resource efficiency) and introduce an action plan to address the problem of unclear EU policies;
10. Improve the separation of waste at source for a better quality waste to address the horizontal barriers, through the installation of effective waste management systems and the appropriate infrastructure at municipal levels.

The ECORYS report (2011) suggests that eco-efficiency is a useful framework for addressing resource efficiency in an industry context, because it incorporates how efficiently economic value is generated from using resources, and it includes waste.

The UN Economic and Social Commission for Asia and the Pacific (ESCAP) suggested that Eco Efficiency indicators could also be used at the macro level, using GDP as the numerator. Eco Efficiency indicators could be adopted at the economy-wide, regional and sector level (ECORYS, 2011).

These indicators allow comparison between countries and regions, with the link to monetary value offering a standardised approach.

6.4 Economic instruments

Economic instruments, such as voluntary commitments from industry, environmental auditing and environmental management systems, have a role to play in resource efficiency. Within the business community, many of these come under the heading of Corporate Social Responsibility (CSR).

A wide array of industry sector programmes (such as Responsible Care in the Chemicals industry, for example) have helped to identify and remove harmful practices, stimulated innovation to address environmental and social issues, and improved resource efficiency in individual firms and along the supply chain.

However, CSR and individual company efforts will need to be bolstered by external signals and incentives for longer-term resource efficiency goals to be realised (Weizsacker, Hargroves, Smith, Desha, & Stasinopoulos, 2009).

Likewise, environmental management systems (EMS) and environmental auditing guidelines such as ISO 9011 and the voluntary ISO 14001 standards, only measure an individual company's environmental performance against its own criteria. It is not clear that these ISO standards, although widely adopted, will in practice help industry meet environmental goals (Clapp, 2005).

Table 2: Which indicators should business use?

Sector	Resource use intensity	Environmental impact intensity
Industry	Energy intensity (m^3/GDP) Water intensity (m^3/GDP) Material intensity (Direct Material Input[DMI]/GDP)	CO_2 Intensity (t/GDP) Solid waste intensity (t/GDP) Biological Oxygen Demand (BOD) intensity (t/GDP) Chemical Oxygen Demand (COD) (t/GDP)
Manufacturing	Energy intensity (m^3/GDP) Water intensity (m^3/GDP) Material intensity (DMI/GDP)	CO_2 Intensity (t/GDP) BOD intensity (t/GDP) COD intensity (t/GDP)
Household and other consumers	Energy intensity (m^3/GDP) Water intensity (m^3/GDP) Land use intensity (km^2/GDP)	CO_2 Intensity (t/GDP) Municipal solid waste intensity (t/GDP) Wastewater intensity (m^3/GDP)

6.5 Calls for indicator standardisation by businesses

In its 2010 report on moves towards a Sound Material Cycle Society, the Japanese Government notes that many businesses are using indicators to judge environmental performance, including those associated with resource use. However, as in the EU, there is a lack of standardisation between the indicators used by each company. The report also calls for a standardised calculation method to generate indicators that will be useful for consumers in selecting the most environmentally responsible products (Japan Ministry of the Environment, 2010).

An example from Toshiba Corporation (quoted in Japan Ministry of the Environment (2010)) illustrates how an eco-efficiency indicator can be introduced to product design. The indicator uses a benchmark product as a guide to measure the degree of improvement of the new product under consideration (see Figure 3).

Resource efficiency with respect to industry is currently addressed through EU policies, including the Eco-design Directive, Ecolabelling Directive and Raw Material Initiative.

In terms of product data, further work is needed in the EU to generate:

- data on product life cycle analysis (LCA)
- sound methodologies to assess resource efficiency implications, both at product level and from a supply chain perspective
- reliable collection, recycling and end-of-life data

There is a shortage of true measurement of resource efficiency at company level in the EU. Instead, industry measures consumption or savings in consumption. The efficiency embodied in these savings is not explicit. As a result, some of the indicators that companies are using are not as useful at the policy level.

To overcome these issues, indicators need to be sector and material specific, and they also need to be carefully selected to focus on materials that have strategic importance, at industry and EU levels.

6.6 Views from the business community

The 2012 UN Conference on Sustainable Development (Rio+20) aimed to set the sustainability agenda for the coming decade. The World Business Council for Sustainable Development (WBCSD), the International Chamber of Commerce (ICC), and the UN Global Compact formed Business Action for Sustainable Development 2012 (BASD 2012), an inclusive coalition that served as the United Nations Major Group coordinator of Business and Industry for the Rio+20 Conference.

BASD 2012's submission to the conference[8] highlighted efforts by companies to reduce their global environmental footprint, citing global and voluntary reporting initiatives as well as efforts to cut resource use and increase efficiency in production systems. BASD reiterated a willingness on the part of the business community to share its best practices and case studies with governments and other stakeholders.

In terms of policy, BASD called for more formalised, active engagement with the private sector, and stated that a lack of information on the effectiveness and profitability of voluntary initiatives is a challenge to international policy development. The business community calls for both systemic and macro-political change, urging policymakers to speed up the development of suitable indicators and measures beyond GDP.

The BASD submission also highlighted the lack of measures and standards to understand and benchmark the transition towards a green economy, pointing out that because no measurement system is in place, the cost of action and inaction cannot be evaluated.

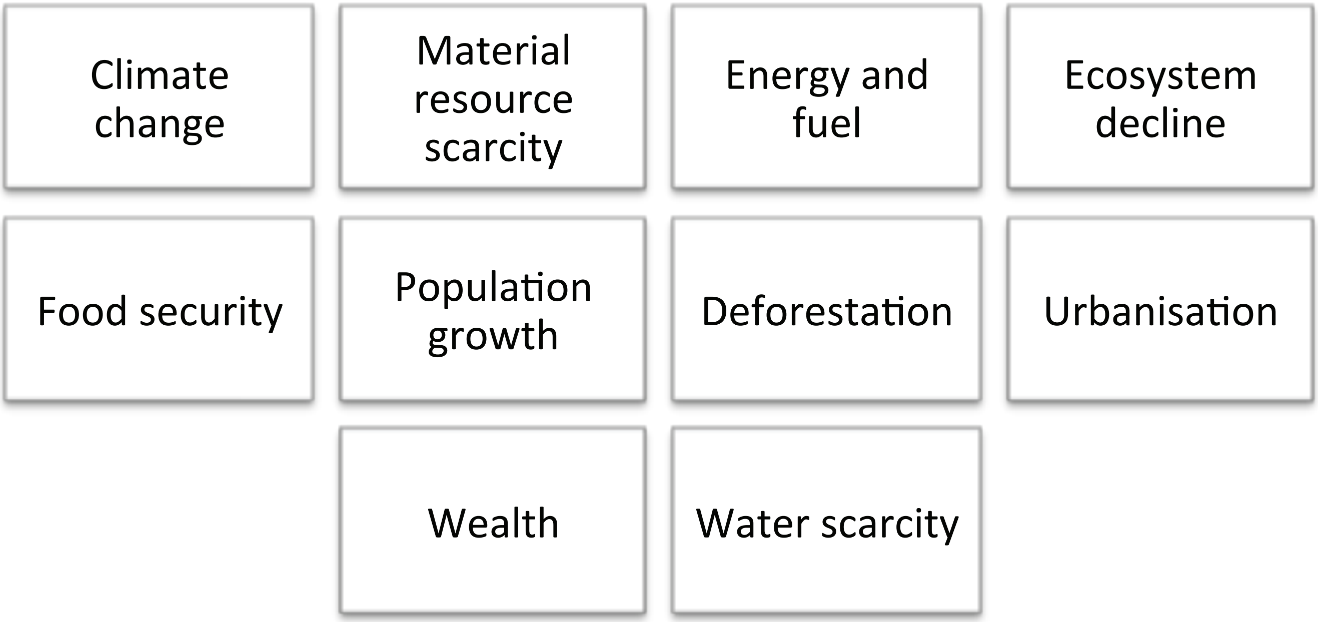
Business recognises the need for new cooperative efforts to integrate environmental externalities, specifically indicators and methodologies to appropriately evaluate these externalities. The business community proposes that the United Nations Environment Programme should be strengthened and enhanced, to stand as the 'authoritative and responsive voice' of the environment (BASD 2012).

Figure 3: Example of how an eco-efficiency indicator can be introduced to product design (Adapted from: Toshiba, 2010)

$$\text{Factor} = \frac{\text{Eco-efficiency of evaluated product}}{\text{Eco-efficiency of Benchmark product}} = \frac{\dfrac{\text{Value of evaluated product}}{\text{Environmental impact of evaluated product}}}{\dfrac{\text{Value of Benchmark product}}{\text{Environmental impact of benchmark product}}} = \text{Value factor x Environmental impact reduction factor}$$

[8] Updated BASD Positions can be viewed here: http://basd2012.org/our-positions

Figure 4: Ten global sustainability 'megaforces' that will affect businesses over the next two decades, according to KPMG (2012)



According to a recent report by KPMG (2012), the world's 3,000 largest public companies by market capitalisation in 2008 were estimated to be causing US$2.15 trillion of environmental damage, equivalent to 7% of their combined revenues and 50% of their combined earnings. Some 60% of these negative impacts were concentrated in the electricity, oil and gas, industrial metals and mining, food production and construction and materials sectors.

This report points out that not only is the way we do business affecting the world around us, but also that the state of the world around us affects the way we do business. It highlights ten global sustainability 'megaforces' that will influence every business over the next two decades.

The report suggests that business leaders seeking to manage risks and harness opportunities must understand how these megaforces function and might affect their organisations. A harmonised approach to resource efficiency indicators for business within the EU, and beyond, would support this goal.

The report uses the nexus approach widely used (e.g. by the World Economic Forum) to develop three nexuses that represent the challenges of sustainable growth in a business context:

1. **The footprint nexus**
The forces driving the escalating 'footprint' of mankind on the planet

2. **The erosion nexus**
The resulting changes in the natural systems on which we depend

3. **The innovation nexus**
The opportunity to address sustainability challenges through business innovation

It shows how the megaforces cluster and interact at each nexus, what this means for future business scenarios, and discusses which industry sectors are likely to be most affected, as well as where the opportunities lie.

7.0 Measuring Resource Efficiency: current approaches and limitations

7.1 What makes a good indicator?

To choose its current (proxy) lead indicator, the European Commission (2011) used the following criteria:

- Policy relevance
- Coverage of all relevant categories and resources
- Coherence and completeness
- Transparency of trade-offs and negative side effects such as burden shifting
- Link to a timeline for production of the data and calculation of the indicator
- Applicability to different levels of economic activities (EU, Member States, sectors, firms, products)
- Support by data that can be aggregated and disaggregated across scales, from products to sectors to countries

Other lists of criteria for selecting indicators have been put forward. For example, Giljum *et al.* (2006) proposed:

- Policy relevance
- Easy to communicate
- Directionally safe information
- Consistent and transparent accounting scheme
- Resource use expressed in absolute numbers
- Distinguish between relative and absolute decoupling
- Harmonised database
- Headline indicator comprehensive in categories included
- Headline indicator to find balance between aggregation and disaggregation
- Comprehensive in terms of geographical coverage
- Geographically explicit
- Compatible with the system of national accounts

A recent study by Bio Intelligence Services (2012) was conducted in parallel with the Commission's Roadmap to Resource Efficient Europe. It provided input to the Commission as it developed the Roadmap, but also had its own objectives and independent findings. It focused on natural resources that are directly used as inputs to the economy, and it used the RACER criteria (Relevant, Acceptable, Credible, Easy, Robust) to evaluate indicators' suitability. It also explains the DPSIR (drivers, pressures, state, impact, responses) framework (see Figure 5), developed by the European Environment Agency, used to classify and structure environmental indicators for policy use. A thorough breakdown of these indicator selection criteria is supplied in this report. A brief summary is provided in Figure 6.

Figure 5: DPSIR Framework. Source: EEA

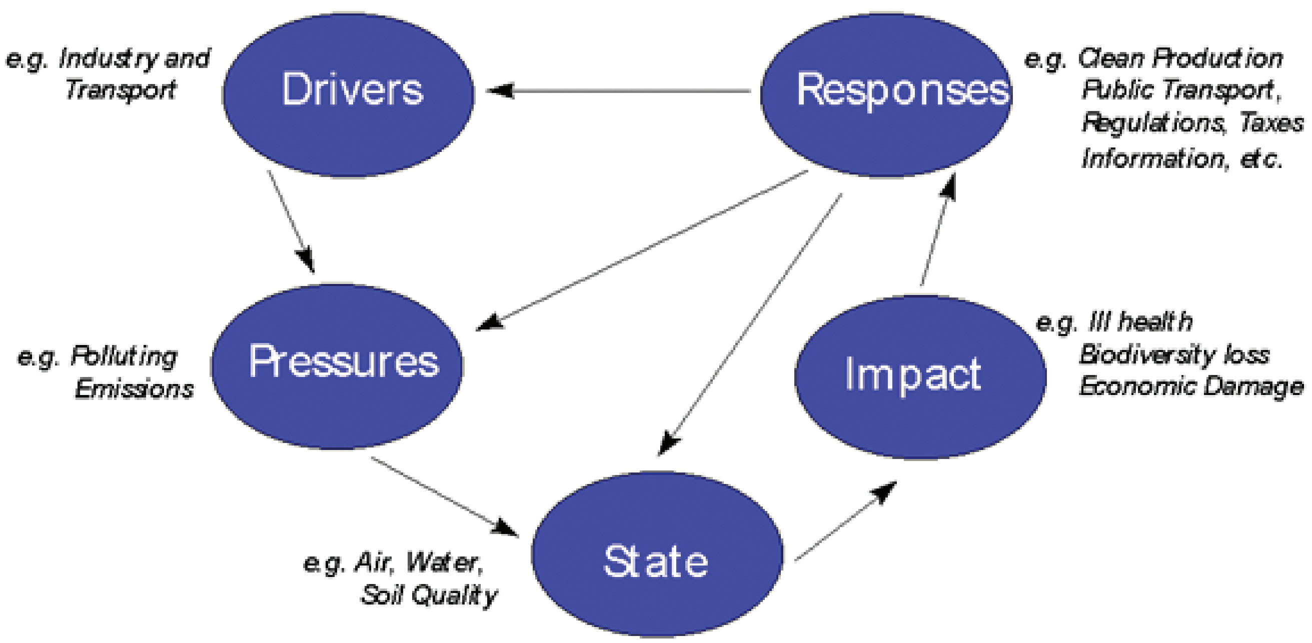
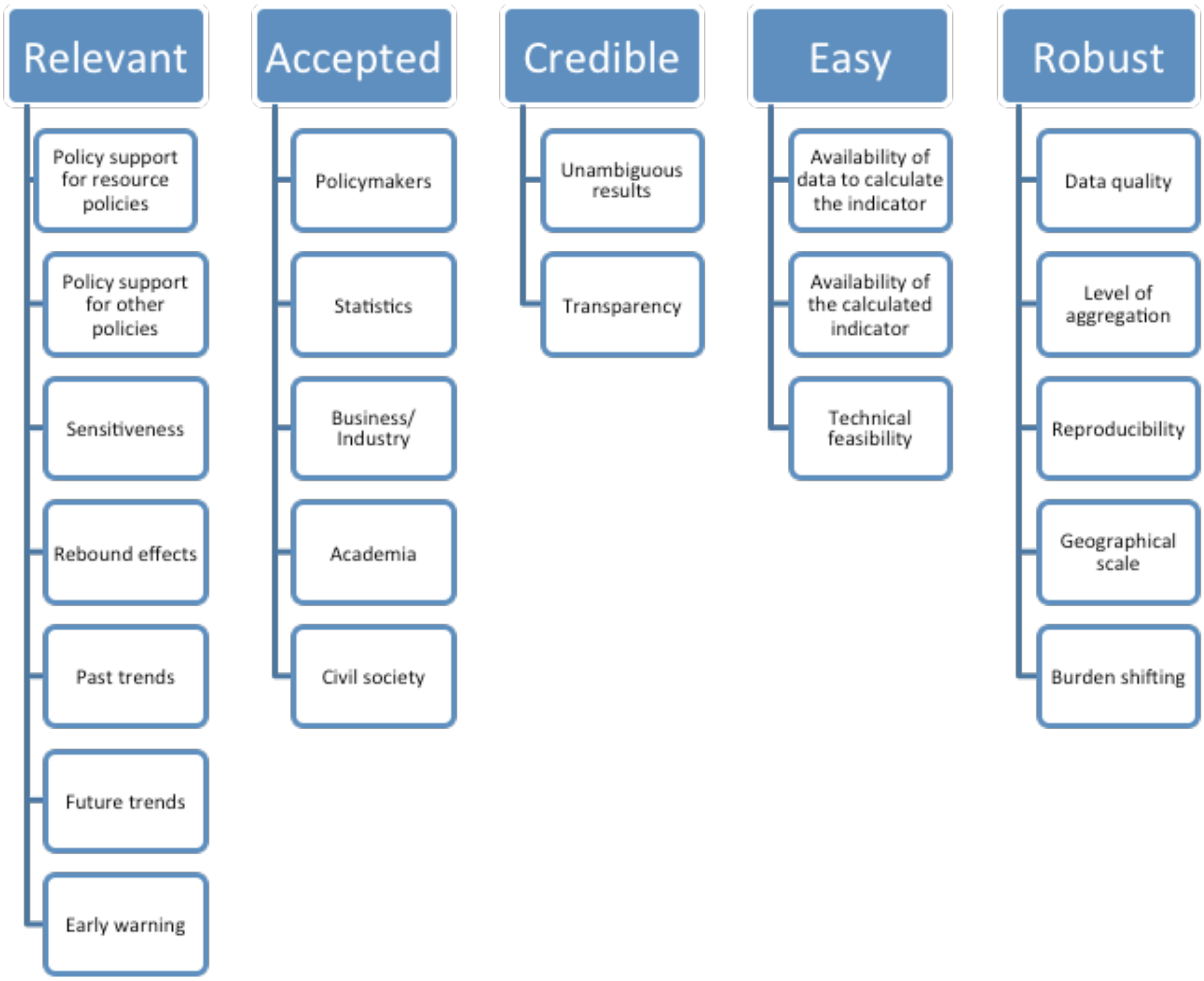


Figure 6: RACER criteria: breakdown of indicator selection criteria



The RACER evaluation is biased towards established indicators that can be used immediately. They have been used previously by DG Environment to evaluate indicators.

This aligns well with the call made by the European Commissioner for Environment, Janez Potočnik, for 'practical and pragmatic indicators that will motivate policy changes.' (Potočnik, 2010).

7.2 Realistic indicators

Indicators that rely on the use of official statistics tend to be more accurate, coherent and comparable. For example, the strength of measures such as enlarged GDP is that they often build on officially available data that are regularly updated. The weakness, on the other hand, is that there are limits to what is officially available and thus what can be included in the measure.

As a contrast, subjective wellbeing measures have the strength that they directly address the wellbeing issue that is in focus. A weakness is that subjective opinions often depend on cultural factors and are thus difficult to compare, for example, across EU Member States.

Another example is that composite indices have the strength of providing a more complete picture, while a weakness is that the weighing of individual indicators is often criticised for not being 'objective'.

Recognising that what goes unmeasured is often ignored, indicators are an important tool both for indicating progress – or the lack of it – towards the specific objectives of a particular programme, and for prompting appropriate response strategies (UNEP, 2012).

7.3 The dashboard approach

To communicate its Resource Efficiency Roadmap objectives, and assess the current situation at any given time, the European Commission aims to use a lead indicator, accompanied by a dashboard of complementary macro indicators.

7.3.1 Regional indicator dashboard – INSURE

A dashboard approach communicates indicators' states and trends visually. By way of illustration, the INSURE project is an project funded under the Sixth Framework Programme (FP6) which aimed to devise a flexible framework for indicators for sustainability in regions using system dynamics modelling . Researchers aggregated information into a dashboard view, where the colour signals the indicator's state and the width of the wedge represents its weight. Moving from the outside to the centre, the values are then aggregated into subthemes and then themes, with an overall impression of sustainable development in the centre.

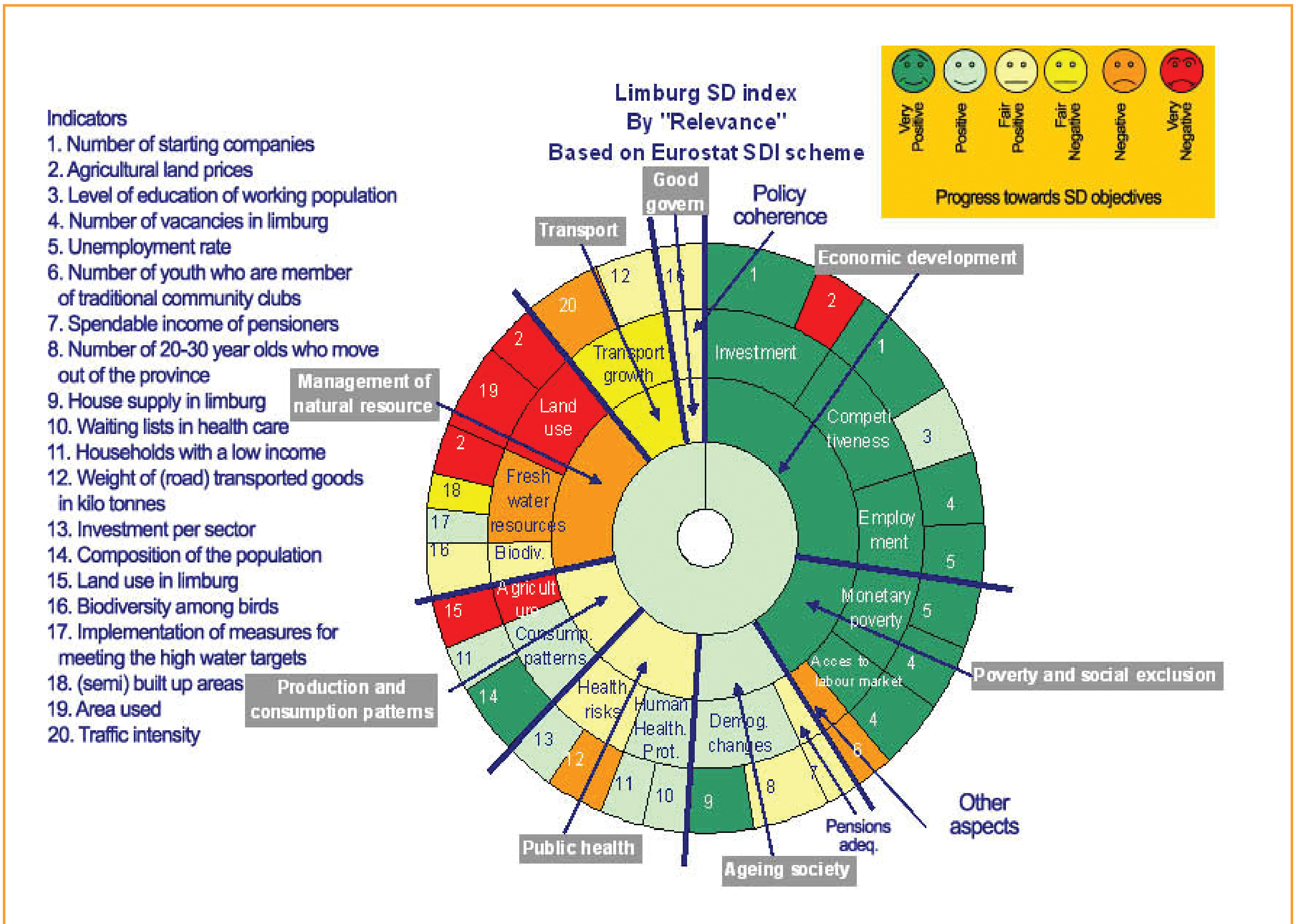
The lower aggregation levels in the outer ring, as well as the qualitative systems analysis, are important for identifying a system's sustainability problems (Zeijl-Rozema & Martens, 2010).

7.3.2 Experience and issues

One issue with indicators is that, by themselves, they tell us little about how well a system is doing in relation to the overarching goal (e.g. sustainability). There are many good indicators available to choose between. Some argue that a more important issue is not so much indicator selection, but finding the best way to put indicators to work. Research conducted under INSURE suggests that indicators are more meaningful when seen within the whole system, and that science and policy have different, but complementary, roles to play (Zeijl-Rozema & Martens, 2011).

Many methods exist for identifying and selecting indicators. This may be via a participatory process, often combined with a literature review. Some bodies consider all indicators to be of equal importance, where others use a participatory process that ranks them to identify the most important indicators for a given context. Experts may use tools, such

Figure 7: The dashboard overview of sustainable development in Limburg for the EU-SDI framework.



8. INSURE (Flexible Framework for Indicators for Sustainability in Regions, Using System Dynamics Modelling.) The research programme was active between 2004 and 2007.

as regression analysis, coefficient generating tools and models, to assess and compare their indicator sets. It is important to bear in mind that indicator selection is not just an objective or scientific exercise, but also a political one. The context leading up to the need for indicators is important, as are the visions and strategies of the actors involved.

Zeijl-Rozema & Martens (2010) discuss the importance of an indicator's originator, and its fit with policy objectives. They outline the pitfalls of policymakers handing over the task of developing suitable indicators to scientists and other experts, in this case having delegated to them the role of defining a vision of sustainable development. However, this is not a role for scientists alone, but for society, elected politicians and stakeholder groups to participate in.

This experience reinforces the importance of a clear definition of resource efficiency at the outset, to ensure that those tasked with developing indicators are contributing to a shared and democratic vision.

7.4 Natural Capital

The current System of National Accounts (SNA) almost completely excludes natural capital and its depreciation. Biodiversity and ecosystem services indicators are needed to highlight and monitor problem areas, as well as to look at future relationships between human wellbeing and nature.

As well as indicators looking at driving forces and pressures on biodiversity, indicators are also needed to consider 'tipping points' as an early warning system to prompt urgent action.

The two main accounting concepts used to derive indicators for natural resource use at the macro-level are material flow accounting (MFA and ecological footprint (EF) accounting.

7.4.1 Material flow accounting (MFA)

Economy-wide material flow accounts provide information about the physical flows of materials through economies. The accounts provide an aggregate overview of the annual extraction of raw materials as well as of the physical amounts of imports and exports. MFA is a quantitative procedure and can be used on a number of levels, from the national to the regional and even down to the individual product.

Two widely used MFA-based indicator systems are from the EU and Japan. The European Strategy for Environmental Accounting (ESEA) identifies Economy-wide Material Flow Accounts as one core module of Environmental Accounts. Eurostat is working to establish a legal base for compilation of environmental accounts, offering a framework for their compilation.

Resource productivity (RP), material reuse and recycling rate, and the rate of waste for final disposal are the three core sustainability indicators in the Japanese material flow indicator system and have been used to address waste and unsustainable consumption issues. Developing indicators for recycling rate, as well as imported hidden flows, has created some challenges (Moriguchi, 2007).

The USA is also developing its MFA capabilities. The World Resources Institute's (WRI) Material Flow Analysis project aims to compile and analyse the Materials Flows Accounts of the USA and encourage the government and other institutions to use these data and indicators in policy formulation.

Box 3: Types of Capital

Manufactured Capital
Human-made capital – traditionally considered as 'capital'

Natural Capital
Natural resources that are hard to put a monetary value on, e.g. species, timber, water, mineral reserves. Natural capital is linked to human welfare.

Human Capital
Individual's health, wellbeing and productive potential. These could include physical or mental health, education and skills.

Social Capital
Similar to human capital, but on a societal rather than an individual level – examples include community associations, political structures, legal structures, social justice, etc.

Source: (TEEB, 2009)

9. See http://www.wri.org/project/materials-flows

The WRI project began building a Materials Flow Accounts database for the USA in cooperation with several US agencies in 2002. This phase of the project represents both a formalisation of WRI's past MFA work, as well as an opportunity to refine the methodology. Its goal is to improve MFA data compilation and analysis in a way that it can be implemented by agencies of the US government.[9]

The project emphasises three main approaches to achieve the desired outcome for this phase: (i) developing the latest and best MFA data and indicators for the USA, (ii) analysing data and critical indicators, and (iii) gaining adoption of national level Materials Flow Accounts and associated indicators by the US government[9].

MFA-based indicators are useful to diagnose links between human activities and environmental issues. However, effective MFA accounts need reliable data to draw meaningful conclusions. MFA is based on material weight, which does not give information of the quality of materials or ecosystems that are interacting. Quantity and quality are both important for decision making and setting policy targets.

As well as directly measurable material flows, hidden flows can also have a significant impact. One example is the soil or other material shifted during mining or construction. Hidden flows have not yet been standardised so that data can be collected.

Limiting MFA accounts to directly traded flows also obscures important information. Industrialised countries in particular tend to import semi-manufactured materials and products and significant material flows in the exporting country that are embodied in the product are not reflected in import/export flow accounts. Quantifying these upstream flows is very complex, but methods are being developed to include them in MFA accounts. Some promising methods include using coefficients from life cycle analysis (LCA) and/or derived from input-output tables (European Commission, DG ENV, 2010).

Pilot studies which quantified upstream flows indicate that, for highly industrialised countries, the raw material equivalent (RME) of imports are three to six times larger than the direct import flows. Even when RME of exports are included in the calculation, the RME of domestic consumption is around 30% higher than DMC.

7.4.2 Ecological Footprint

The Ecological Footprint measures how much biologically productive land and water area is required to provide the resources consumed and absorb the wastes generated by a human population, taking into account prevailing technology. The unit used is global hectares.

The Resource Efficiency Roadmap calls for the establishment of a common methodological approach to enable Member States and the private sector to assess, display and benchmark the environmental performance of products, services and companies based on a comprehensive assessment of environmental impacts over the life cycle. This means an assessment of 'environmental footprint,' which was conducted in 2012. As well as providing better product information, this will also incorporate understanding consumer behavior, and eco-labelling schemes. The projects included a consultation on options for policies implementing organisations' environmental footprinting, looking at the Environmental Footprint of Products and Green Public Procurement.[10]

After the testing phase and a further prioritisation process, JRC will carry out an in-depth analysis of the results of three of the pilot studies and will take the findings into account in the revised version of the technical guide. The results of the other pilot tests will also be used for further refinements of the methodology as a reference for future further improvements. Analysis and training on methodology as well as public consultation were completed, and final methodological guides were recently published.[11]

7.4.3 Human Appropriation of Net Primary Production (HANPP)

HANPP is used to measure how humans use ecosystems. It is an aggregated indicator that reflects both the amount of area used by humans and the intensity of land use. HANPP complements the Ecological Footprint: where the EF measures how much biocapacity a country uses wherever that use occurs, HANPP shows us how intensively an ecosystem is being harvested.

[10] See http://ec.europa.eu/environment/eussd/corporate_footprint.htm for details.
[11] See footnote above, plus http://europa.eu/environment/eussd/product_footprint
Findings on Green Public Procurement in the EU can be found here: http://ec.europa.eu/environment/gpp/pdf/CEPS-CoE-GPP%20MAIN%20REPORT.pdf. The research programme was active between 2004 and 2007.

8.0 Environmental accounting frameworks

The UN System for Integrated Environmental Economic Accounting (SEEA) and National Accounting Matrix including Environmental Accounts (NAMEA) are two widely used accounting frameworks.

8.1 System for Integrated Environmental Economic Accounting (SEEA)

SEEA is an environmental accounting system outlined in the *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003,* an updated version of the original Handbook published in 1993 (UN, EC, IMF, OECD and World Bank, 2003). SEEA is a satellite system to the United Nations System of National Accounts (SNA), which deals with economic statistics. By evaluating data generated through the SEEA system alongside SNA figures, policymakers can compare environmental statistics to economic statistics, to reveal both sustainability trends, and the economic costs of environmental standards being maintained.

SEEA relies on basic environmental statistics (such as those on material flows, pollutants or natural resources including water, energy and forests), and experts can communicate statistics and indicators derived from the SEEA using the DPSIR framework.

SEEA is a relatively new approach in developing integrated national accounts for the environment. One of its strengths is that it does not necessarily need a large amount of data; the SEEA provides the framework so that the available data can be brought together, allowing a better understanding of the interrelationship between different datasets, and to identify data gaps.

Another property of SEEA accounts is that they do not follow the geographical borders of a country, but rather use the boundary of a specific economy. This means that emissions from an aeroplane are tied to the country where that plane's fleet is based, and not to the country where the emissions occur, for example.

A goal of SEEA is to become an internationally agreed framework offering common definitions, classifications and accounting rules. National and international policymakers need to commit to using SEEA to realise the full benefits of this accounting system. SEEA provides indicators that directly respond to the demand of integrated policymaking (United Nations Statistics Division, 2012).

The United Nations Statistical Commission has initiated a multi-year revision process of SEEA. The United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) is overseeing the revision process, assisted by various technical groups. A global consultation on the SEEA Central Framework was completed in 2011 and adopted by the United Nations Statistical Commission in 2012, as the first international standard for environmental-economic accounting. Work on further portions of the SEEA is on-going and expected to be completed by February 2013. (Eurostat).

8.2 National Accounting Matrix including Environmental Accounts (NAMEA)

Statistics Netherlands developed NAMEA in the early 1990s. The NAMEA framework contains detailed information on the environment, and converts this to a number of summary environmental indicators. The accounts express transactions in physical units, rather than in monetary terms. In NAMEA, pollution is registered with the activity where the actual pollution takes place, so, for instance, if electricity is generated for rail transportation, then the associated GHGs are logged for the energy generation, and not for the transportation industry.

The NAMEA system can be used for many purposes, from showing the indirect economic and ecological effects of exports, to estimating the pollution generated to produce one unit of a final product. It can also serve as a framework for modelling future scenarios.

8.3 Comparisons between SEEA and NAMEA

There are a number of differences between these frameworks. One of the major differences is that NAMEA starts by expanding on National accounts with substances accounts. SEEA is mainly focused on expanding upon asset accounts in the SNA, to account for non-produced natural assets (deHaan & Keuning, 1996). European efforts to harmonise environmental accounts results are on-going.

9.0 Beyond GDP

GDP has come to take on the role of a comprehensive indicator for overall societal development and progress. However, GDP does not measure environmental sustainability or social integration.

9.1 Policy progress

In November 2007, the European Parliament (together with the European Commission, the Club of Rome, the WWF and the OECD) held a conference entitled 'Beyond GDP'. There was broad support for development of indicators to complement GDP, providing more comprehensive information to support policymaking.

In August 2009, the European Commission released its roadmap, the Communication 'GDP and beyond: Measuring progress in a changing world'. The Communication outlines an EU roadmap with five key actions to improve our indicators of progress in ways that meet citizens' concerns and make the most of new technical and political developments.

The move to go 'beyond GDP' is not controversial. However, selecting clearly defined and quantifiable indicators that use reliable data is a significant task.

At EU and Member State level, as well as internationally, a great deal of activity on indicator development has been carried out, but identifying the most compelling and usable indicators from those proposed is a major challenge. Policymakers have also emphasised that indicators are just one factor in the policy debate and in taking decisions. A comprehensive concept that incorporates existing measures and that can be implemented in practice would be an ideal outcome.

GDP does little to reveal inequalities, such as how consumption differs between the rich and the poor. A further issue with GDP is that it only offers a snapshot of investments in the year that spending takes place, which limits its usefulness in describing gains and losses in natural, economic and social assets. These are significant from a long-term, sustainable development perspective.

The Beyond GDP initiative seeks to develop indicators that are as clear and appealing as GDP, but more inclusive of environmental and social aspects of progress. Indicators need to address global challenges of the 21st century such as climate change, poverty, resource depletion, health and quality of life.

Beyond GDP's website now hosts detailed reports from experts discussing the pros and cons of numerous alternatives to GDP as an indicator[12].

[12] See http://www.beyond-gdp.eu/indicators.html

9.2 The Alternatives to GDP

Alternatives to GDP that have been proposed include:

9.2.1 Adjusted net savings (ANS) as a percentage of GNI

Adjusted net saving measures the true rate of saving in an economy after taking into account investments in human capital, depletion of natural resources and damages caused by pollution.

Policy advantages include:

- It presents resource and environmental issues within a framework that finance and development planning ministries can understand.
- It reinforces the need to boost domestic savings, and hence the need for sound macroeconomic policies.
- It highlights the fiscal aspects of environment and natural resource management, since collecting resource royalties and charging pollution taxes are basic ways to ensure efficient use of environmental resources.

The regular World Bank publications The Little Green Data Book and World Development Indicators feature the ANS indicator.

However, challenges for the ANS include:

- Lack of data (on, for example, underground water, land degradation, fish stocks, diamonds)
- Lack of methods (i.e. how can we put a value on biodiversity?)
- Measurement errors

9.2.2 Environmentally Sustainable National Income (eSNI)

Environmentally sustainable national income (eSNI) is the maximal attainable production level by which vital environmental functions remain available for future generations, based on the technology available at the time. The eSNI provides information about the distance between the current and a sustainable situation. The theory of and the necessary statistics for an eSNI have been worked on since the mid-1960s.

The eSNI is the only indicator which:

1. is directly comparable with standard NI because it is estimated in accordance with the conventions of the System of National Accounts (SNA);
2. relates the measurable physical environment ('ecology') with subjective preferences ('economy');
3. provides the distance between the actual (NI) and sustainable (eSNI) production level in factor costs;
4. shows the development of this distance in the course of time and thus shows whether or not society is drifting further away from environmental sustainability.

9.2.3 Sustainable National Income (SNI)

SNI is the difference between standard national income and the expenditures that need to be made to respect the sustainability standards. It assesses the distance between the present and the sustainable level of production and consumption, given today's technology.

When the calculation of SNI is repeated in later years it can be assessed whether technological improvement has indeed reduced this distance.

The gap between SNI and NI is an indicator of the extent of unsustainability of an economy.

To compute the SNI, one needs the SNI computer model with a set of environmental restrictions and abatement cost curves, a dataset with economic and environmental (NAMEA) data for a particular country and year, a set of sustainability standards. Drawbacks are that this indicator is complex and may be difficult for the public to grasp.

Case study 1: beyond GDP

The most 'eco-efficient' businesses, industries, or economies may be the ones consuming the greatest quantities of resources and generating the most pollution. York, Rosa & Dietz (2009) illustrates the issues in A tale of contrasting trends: Three measures of the ecological footprint in China, India, Japan and the United States, 1961-2003.

The limitations of focusing on efficiency are highlighted in this research by examining ecological footprint trends in China, India, Japan and the United States. The analysis looks at each nation's total environmental footprint (EF), and their EF per unit of GDP. The latter measure is 'intensity', which is the inverse of efficiency (i.e. high intensity means low efficiency). Strikingly, the trends in total EF and EF intensity illustrate how a focus on efficiency or intensity is misleading. In all nations there is a distinct trend toward declining intensity (i.e., increasing efficiency), which scholars might interpret as a sign of ecological improvements. Yet all countries' EF was increasing, meaning a greater overall impact on the environment.

'It might be more appropriate to say that improvements in efficiency are an example of economic reform not ecological reform and in fact typically indicate rising environmental impacts,' the authors explain. Looking at ecological footprint on a per capita basis can be enlightening – despite the headline figures, an individual in India or China will still have a far smaller environmental impact than each individual in Japan or the US due to their differing consumption. The relationship between GDP and Environmental Footprint is positive and inelastic. The findings also link sustainability policy with other policies, e.g. better education for women, reducing infant mortality and poverty as means to reduce fertility and so the pressure from population. Improvements in economic efficiency alone are not the key to solving environmental problems.

9.2.4 Genuine Progress Indicator

'Green' GDP accounting systems aim to provide a more accurate measure of welfare and to gauge whether or not an economy is on a sustainable time path. Two of the most popular green GDP systems are the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI).

Methodologies differ, but the ISEW, GPI, and other green GDP accounting systems all involve three basic steps. Computation usually begins with estimates of personal consumption expenditures, which are weighted by an index of inequality in the distribution of income to reflect the social costs of inequality and diminishing returns to income received by the wealthy. Additions are made to account for the non-market benefits associated with volunteer time, housework, parenting, and other socially productive time uses, as well as services from both household capital and public infrastructure. Deductions are then made to account for purely defensive expenditures, such as pollution related costs or the costs of automobile accidents, as well as costs that reflect the undesirable side effects of economic progress. Deductions for costs associated with degradation and depletion of natural capital incurred by existing and future generations are also made at this stage.

These adjustments correct for the deficiencies of GDP by incorporating aspects of the non-monetised or non-market economy, separating welfare enhancing benefits from welfare detracting costs, correcting for the unequal distribution of income, and distinguishing between sustainable and unsustainable forms of consumption.

9.2.5 The Regional Index of Sustainable Economic Wellbeing

The Regional Index of Sustainable Economic Well-being (R-ISEW) is a measure of how much a region's economic activity contributes to, and detracts from, wellbeing, and how sustainable this activity is. It is an adjusted economic indicator which attempts to incorporate costs and benefits not normally measured in monetary terms.

The R-ISEW, as a single figure, allows policymakers to assess overall progress towards sustainable economic wellbeing, bringing together a wide range of issues, but weighting them appropriately using a single coherent framework, proponents suggest.

The first ISEW was calculated for the USA in 1989, and brought to the UK in 1994 by Nic Marks of NEF (the New Economics Foundation) and Professor Tim Jackson, currently at the University of Surrey. Together, these two organisations have pioneered the development of regional ISEWs, with the support of the then East Midlands Development Agency, and later a consortium of several regional development agencies. The first complete set of R-ISEWs for all English regions was calculated in 2007, and data now exist for all English regions from 1994 to 2008.

9.3 Data quality and collection

Varying data quality is a major issue when selecting an indicator. Indicators that rely on the use of official statistics tend to be more accurate, coherent and comparable. For example, the strength of measures such as enlarged GDP, is that they often build on officially available data that are regularly updated. The weakness, on the other hand, is that there are limits to what is officially available and thus what can be included in the measure.

As a contrast, subjective wellbeing measures have the strength that they directly address the wellbeing issue that is in focus. A weakness is that subjective opinions often depend on cultural factors and are thus difficult to compare, for example, across EU Member States.

Another example is that composite indices have the strength of showing a complete picture, while a weakness is that the weighing of individual indicators often is criticised for not being 'objective'.

10.0 Current research to develop indicators and targets

POINT (Policy Influence of Indicators – funded under the Seventh Framework Programme (FP7))

The POINT project aims to help find better ways of using indicators in all aspects of policy, by enhancing the understanding of the factors that condition the successful use and influence of indicators in policymaking. The focus will be on the processes through which indicators enter into policymaking, but the project also seeks new ways of improving the conceptual validity and reliability of indicators, so as to improve their relevance for policy. Sustainable development will act as the main thematic focus (Adelle & Pallemaerts, 2010).

www.point-eufp7.info

IN-STREAM (Integrating Mainstream Economic Indicators with Sustainable Development Indicators – FP7)

The INSTREAM project aims to provide insight into the synergies and trade-offs implicit in Europe's pursuit of economic growth and environmental sustainability. It will include quantitative and qualitative assessments to link mainstream economic indicators with key wellbeing and sustainability indicators, whilst also recommending new indicator approaches (and sets of indicators) based on their robustness, feasibility and suitability to EU policy objectives.

www.in-stream.eu

OPEN:EU (One Planet Economy Network, developing Indicators: Ecological Footprint, Carbon Footprint, and Water Footprint. to set targets for a 'One Planet Economy' – FP7)

The OPEN-EU Project aims to develop an academically robust 'footprint family' of sustainable development indicators, place these in a modelling tool for evidence-based policy, and create a new forum for stakeholders to help transform the EU to a 'One Planet Economy' by 2050.

www.oneplaneteconomynetwork.org

A number of research projects funded under the Sixth Framework Programme (FP6) focus on developing indicators for sustainable development at a more local level (the local, regional or city level). These include STATUS[13] and TISSUE[14], projects linked to the Urban Environment Thematic Strategy, as well as INSURE[15] and ECODEV[16] which focused on monitoring sustainable development at the local level. Another project under FP6 in this category is SENSOR[17], which aimed to establish relationships between different environmental and socio-economic processes as characterised by indicators considered to be quantitative measures of sustainability.

Case Study 2: water indicators in Canada

A four year (2008-2012) research project funded by the Canadian Water Network aims to improve governance for source protection and land use. The project, Developing a Canadian Water Security Framework as a Tool for Improved Governance for Watersheds, reviewed all freshwater-related indicators in Canada, coming up with an inventory of 365 in total. Some 40 indicators were developed at the federal level, with 143 at the provincial level and a further 112 at the regional (large scale watershed) level. At least 70 more indicators were developed at the community (small scale watershed) level.

The indicators cover a broad range of water issues, including governance, infrastructure, ecosystem health, human health, quantity, quality, surface and ground water. Economic valuation of water is an emerging trend, with indicators being developed at both federal and provincial/territorial level. One example is the GPI Atlantic indicator developed and applied in Nova Scotia. This incorporates five indicator components: time use, living standards, natural capital, human impact on the environment, and human and social capital. The GPI takes a different approach to most indicator initiatives in Canada, in that it includes mechanisms to measure damage costs due to water quality decline, defensive expenditures (e.g. pollution abatement), restoration costs and health impacts.[18]

Water security is increasingly discussed both in Canada and internationally, but it is still an emerging concept – no common definition of water security exists, and neither is there any widely accepted standard index of water security. The general picture in Canada is one of narrowly-focused indicators and a fragmented approach to water management across this large country. Both Statistics Canada and Environment Canada have called for national frameworks and greater integration to be put in place. Another notable finding is the disconnect between those that develop indicators and those that use them. Local communities are not often using federal government-created indicators, but are instead developing their own. This raises the issue of federal reporting being driven by internal policy requirements, rather than the needs of end users (Dunn & Bakker, 2009).

[13] *http://www.ist-world.org/ProjectDetails.aspx?ProjectId=f53d500b64114dc38086cebb5dfdaec2&SourceDatabaseId=7cff9226e582440894200b751bab883f*
[14] *http://cic.vtt.fi/projects/tissue/index2.html*
[15] *www.isi.fraunhofer.de/isi-en/n/projekte/insure.php*
[16] *http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&CFID=11255828&CFTOKEN=79176214&PJ_RCN=6476388*
[17] *www.sensor-ip.org*
[18] *See www.gpiatlantic.com. Also see Fostering Water Security in Canada: www.watergovernance.ca*

Conclusion

Many indicators have already been developed, and these continue to be refined even as further indicators and accounting frameworks are emerging. Policymakers have an urgent need to move forward using a pragmatic selection of indicators on resource efficiency, ideally forging ahead with a lead indicator that is easy to communicate and understand.

However, even indicator selection is a daunting task. The definition of resource efficiency is still murky, with differing ideas about what it comprises. Despite the wide choice of available indicators, most offer an incomplete picture, at least at present. The science of indicators is elaborate, and the task of defining policy goals to be measured must fall to policymakers in concert with stakeholders, and not just to the scientists developing the indicators. Indicators only indicate – they cannot explain. For policymakers, it may be helpful to communicate approximate signposts pointing to some of the most important issues at the core of resource efficiency (e.g. extent of decoupling, the gap between where we are now and a sustainable future) rather than becoming lost in the detail.

Despite a great deal of measurement, there is still cause for concern about what is *not* being measured. In particular, findings that the business community is working hard towards environmental accountability, whilst not really measuring efficiency at all need urgent attention. The business community itself is keen to move forward in partnership towards clear goals and definitions. Social and natural capital are also areas where accounting methods and indicators are still underpowered, but which are vital components to measure and manage for a resource efficient future.

Resource efficiency can be measured at a global, regional or local level, and in business can stretch from an entire sector down to a single product. It will be important going forward to ensure measurements at all levels, from the macro to the micro, are harmonised for ease of communication and comparison. At the same time, one size does not fit all, and individual regions or companies may continue to adapt or weight indicators to suit their particular needs.

Policy targets often tend to focus on measuring impacts. Efforts to measure resource efficiency should also consider the inputs, too. The quantity and quality of what goes into the system affects the outcome. Dramatic cuts in resource use will be needed, as well as shifts in the structure of the economy and the continued introduction of resource efficient technologies if we are to overcome unsustainable resource use. Finally, we will all need to change our behaviour – a radical socio-economic transformation is the only way to balance increasing population with diminishing resources.

References

Adelle, C., & Pallemaerts, M. (2010). *Sustainable Development Indicators: Overview of relevant FP-funded research and identification of further needs.* Luxembourg: European Union.

BASD 2012. (n.d.). Experiences, Success Factors, Risks And Challenges With Regard To Objective And Themes Of Uncsd Rio+20. Retrieved 2012, from www.uncsd2012.org/files/responses-major-groups/Response%20DESA%20QuestionnaireFINAL%20MAY%2011.pdf

BIO Intelligence Service, Institute for Social Ecology and Sustainable Europe Resarch Institute. (2012). *Assessment of resource efficiency indicators and targets. Final report prepared for the European Commission, DG Environment.* Paris: BIO Intelligence Service.

Bolla, V., Lock, G., & Popova, M. (2011). *Statistics in focus 58/2011.* Eurostat. Luxembourg: European Union.

Clapp, J. (2005). The Privatization of Global Environmental Governance: ISO 14000 and the Developing World. In D. L. Newell (Ed.), *The Business of Global Environmental Governance* (pp. 223-248). Cambridge, MA: MIY Press.

Cohen, M. J. (2011). Editorial. *Sustainability: Science, Practice & Policy*. 7(2):1-3.

deHaan, M., & Keuning, S. J. (1996). Taking the Environment into Account: The NAMEA Approach. *Review of Income and Wealth.* 42(2): 131-148.

Dunn, G., & Bakker, K. (2009). *Canadian Approaches to Assessing Water Security: An Inventory of Indicators Policy Report.* Vancouver: University of British Columbia.

ECORYS (2011). *Sustainable Industry: Going for Growth & Resource Efficiency. Report for Directorate General- Enterprise and Industry.* Rotterdam: ECORYS.

European Commission (2011). *Roadmap to a Resource Efficient Europe.* COM(2011) 571 final. http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf

European Environment Agency (2007). *Technical paper: Accounting fully for ecosystem services and human well-being. EEA contribution to the Beyond GDP conference.* . Retrieved April 17, 2012, from Beyond GDP: www.beyond-gdp.eu/download/bgdp-bp-eea.pdf

European Environment Agency (2010). *The European environment – state and outlook 2010: Synthesis.* EEA (European Environment Agency). Retrieved from: www.eea.europa.eu/soer/synthesis/synthesis

European Environment Agency (2011). *EEA Report No5/2011 Resource efficiency in Europe: Policies and approaches in 31 EEA member and cooperating countries.* Copenhagen: EEA.

European Environment Agency (2012). *Environmental Indicator Report 2012 Ecosystem Resilience And Resource Efficiency In A Green Economy In Europe.* Copenhagen: EEA.

European Commission. (2011). Annex 6: Resource efficiency indicators and targets. *COMMISSION STAFF WORKING PAPER Analysis associated with the Roadmap to a Resource Efficient Europe Part II.* Brussels.

European Commission (2010). *Preparatory Study for the Review of the Thematic Strategy on the Sustainable Use of Natural Resources Annexes.* Retrieved from http://ec.europa.eu/environment/natres/pdf/BIO_TSR_FinalReport_Annexes.pdf

European Environment Agency (2010). *The European Environment: State and outlook 2010 Material resources and waste.* Copenhagen: European Environment Agency.

Eurostat (n.d.). Retrieved May 17, 2012, from Eurostat: Environmental accounts: http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/introduction/historical

Eurostat (2011). *Is the EU on a Sustainable Development Path? Highlights of the 2011 Monitoring Report of the EU Sustainable Development Strategy.* European Union.

Fischer-Kowalski, M. S. (2011). *Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel.* Nairobi: UNEP. Retrieved from http://www.unep.org/resourcepanel/decoupling/files/pdf/decoupling_report_english.pdf

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production.*23: 216-224.

Giljum, S., Hinterberger, F., Wackernagel, M., & Kitzes, J. (2006). *Resource Use Indicators in the European Union*. Aachen: Aachen Foundation.

IGES. (2012). Global Resource Crisis or Sustainable Resource Management? Proposals towards Resource Efficient Global Economy. *IGES Proposal for Rio + 20 Issue Brief* , 4. Institute for Global Environmental Strategies. Retrieved April 2012, from http://enviroscope.iges.or.jp/modules/envirolib/upload/3554/attach/rio_issue_brief_vol4_Resource_mar2012.pdf

Japan Ministry of the Environment (2010). *Establishing a sound material-cycle society: Milestone towards a sound material-cycle society through changes in business and life styles.* Tokyo: Ministry of the Environmnent.

Koneczny, K., Bersani, R., Wolf, M., & Pennington, D. (2007). Recommendations for life cycle based Indicators for Sustainable Consumption and Production in the European Union. *3rd International Life Cycle Thinking Workshop on "Sustainability and Decoupling Indicators: Life cycle based approaches".* Luxembourg: Office for Official Publications of the European Communities. Retrieved from http://lct.jrc.ec.europa.eu/pdf-directory/Recommendations%20for%20life%20cycle%20based%20Indicators.pdf

KPMG. (2012). *Expect the Unexpected: Building business value in a changing world.* KPMG International. Retrieved from: www.kpmg.com/global/en/issuesandinsights/articlespublications/pages/building-business-value.aspx

Moriguchi, Y. (2007). Material flow indicators to measure progress toward a sound material-cycle society. *Journal of Material Cycles and Waste Management.*9(2): 112-120.

Potočnik, J. (2010, March 23). Resource efficiency as a driver for growth and jobs. *2010 Jean Jacques Rousseau Lecture.* Lisbon. Retrieved from http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/10/118

ten Brink, P., Berghöfer, A., Schröter-Schlaack, C., Sukhdev, P., Vakrou, A., White, S., & Wittmer, H. (2009). *TEEB–The Economics of Ecosystems and Biodiversity for National and International Policy Makers.* Retrieved from www.teebweb.org

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank (2003). *Handbook of National Accounting: Integrated Environmental and Economic Accounting* . Retrieved from: http://unstats.un.org/unsd/envaccounting/seea2003.pdf

United Nations Environment Programme. (2010). *Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials.* Paris: UNEP. Retrieved from http://www.unep.fr/shared/publications/pdf/DTIx1262xPA-PriorityProductsAndMaterials_Report.pdf

United Nations Environment Programme (2011). *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth.* UNEP/Earthprint.

United Nations Environment Programme (2011). *Resource Efficiency Economics and Outlook for Asia and the Pacific.* Nairobi: United Nations Environment Programme.

United Nations Environment Programme (2012). *Global Outlook on Sustainable Consumption and Production Policies: Taking action together.* Nairobi: UNEP. Retrieved from http://www.unep.fr/shared/publications/pdf/DTIx1498xPA-GlobalOutlookonSCPPolicies.pdf

United Nations Statistics Division (2012). *The System of Environmental-Economic Accounts (SEEA): Measurement Framework in Support of Sustainable Development and Green Economic Policy.* Retrieved from United Nations Department of Economic and Social Affairs: http://unstats.un.org/unsd/envaccounting/Brochure.pdf

References *(continued)*

Weizsacker, E. V., Hargroves, C., Smith, M. H., Desha, C., & Stasinopoulos, P. (2009). *Factor 5 Transforming the Global Economy through 80% Improvements in Resource Productivity.* Sterling, VA: Earthscan.

Wolf, M.-A., Pant, R., Chomkhamsri, K., Sala, S., & Pennington, D. (2012). *e International Reference Life Cycle Data System (ILCD) Handbook - Towards more sustainable production and consumption for a resource-efficient Europe.* Publications Office of the European Union. doi:10.2788/85670 (print), 10.2788/85727 (PDF)

World Bank. (n.d.). *World Bank.* Retrieved from http://go.worldbank.org/3AWKN2ZOY0

Xue, B., Chen, X., Zhang, W., & Geng, Y. (2010). Study on the adjusting mechanism of regional circular economy. *Soft Science,* 24(8), 74-78 (in Chinese - quoted in Geng et. al. 2012).

Yang, Y., Li, B., & Yao, R. (2010). A method of identifying and weighting indicators of energy efficiency assessment in Chinese residential buildings. 38(12): 7687–7697.

York, R., Rosa, E. A., & Dietz, T. (2009). A Tale of Contrasting Trends: Three Measures of the Ecological Footprintin China, India, Japan, and the United States, 1961-2003. *Journal of World Systems Research.* 15(2): 134-146.

Zeijl-Rozema, A. v., & Martens, P. (2011). Integrated Monitoring of Sustainable Development Cooperation between Maastricht University and the Regional Government. *Sustainability.* 4(4), 199-202. Doi:10.1089/sus.2011.9673

Zeijl-Rozema, P. v., & Martens, A. (2010). An adaptive indicator framework for monitoring regional sustainable development: a case study of the INSURE project in Limburg, The Netherlands. *Sustainability: Science, Practice, & Policy.* 6(1), 6-17.