Deliverable 7.1

Summary / comparative review of findings

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27 March 2011

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About the Ecologic Institute

The Ecologic Institute is a private not-for-profit think tank for applied environmental research, policy analysis and consultancy with offices in Berlin, Brussels, Vienna, and Washington DC. An independent, non-partisan body, the Ecologic Institute is dedicated to bringing fresh ideas to environmental policies and sustainable development. The Ecologic Institute's work programme focuses on obtaining practical results. It covers the entire spectrum of environmental issues, including the integration of environmental concerns into other policy fields. Founded in 1995, the Ecologic Institute is a partner in the network of Institutes for European Environmental Policy. The Ecologic Institute acts in the public interest; donations are tax-deductible.

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1 Aim and Structure

1.1 Project objectives of IN-STREAM

The IN-STREAM project is conducting qualitative and quantitative assessments to link key mainstream economic indicators with key well-being and sustainability indicators. The key objectives of the project are thereby:

- **Identification of key strength and weaknesses** of mainstream economic indicators (especially GDP) and indicators for sustainable development (especially environmental ones).
- **Analysis of quantitative links** between mainstream economic indicators and indicators for sustainable development to identify potential political trade offs and synergies.
- **Modelling of costs and benefits** of reaching sustainability targets. The project estimates values for benefits without a market value and assesses second round cost effects of sustainability measures, such as effects on competitiveness.
- Evaluation of **institutional needs and opportunities** to understand the key drivers and obstacles to institutional adoption of the reviewed indicators.
- Based on the qualitative, quantitative and engagement work, the project aims to produce a **recommendation** of composite indicator approaches and strategies on how to use indicators and indicator systems.

1.2 Indicators and the policy cycle

One important reason for the increasing relevance of indicators is the drive for more quantification in impact assessments and other policy analysis processes. This increased use of quantifications creates a strong demand for more robust and precise indicators, but it also requires policy makers to become more accomplished in the use of these quantifications and indicators.

This paper provides several examples of how the indicators developed and assessed in IN-STREAM can be useful for policy makers in different stages of the policy making process. We distinguish four main roles that indicators can play:

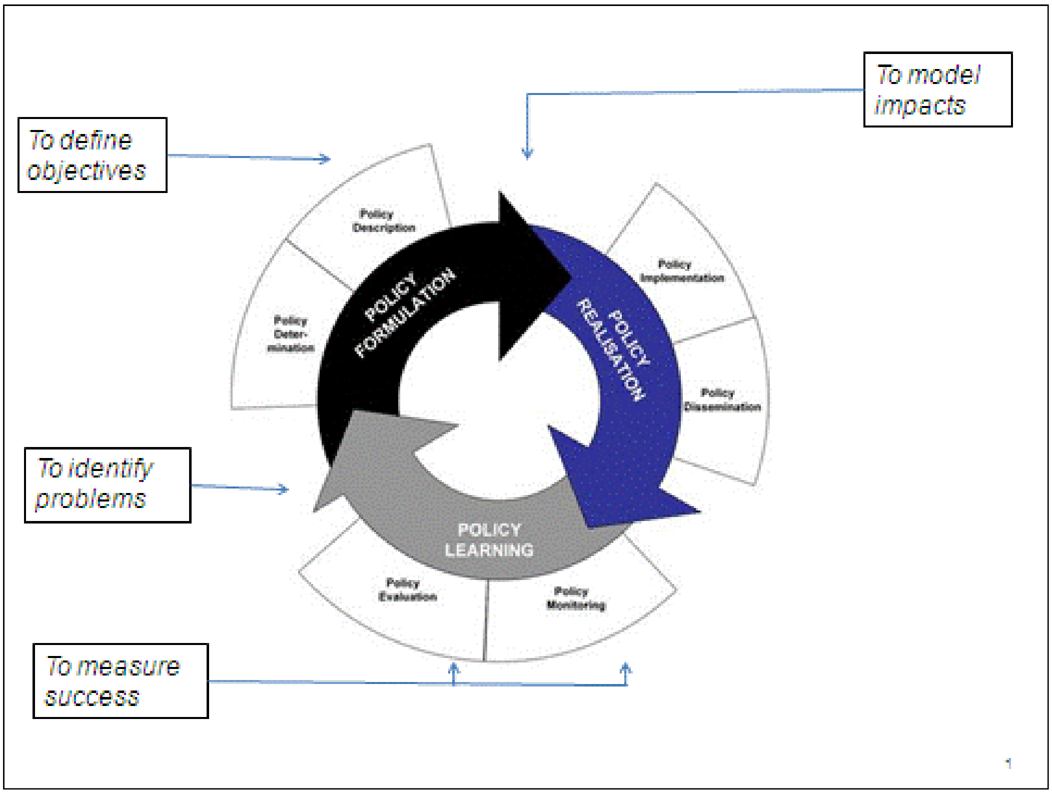
- Identification of problems: Indicators can support policy makers that would like to gain a quick overview of the nature and the scale of problems that have been raised by stakeholders.
- Definition of objectives: One reflection of the existing drive for more accountability in policy making is a constant pressure on policy makers to define quantitative objectives for any intended policy change. A well chosen quantitative indicator can be a powerful benchmark for the success of a policy.
- Impact assessment: Indicators which describe relationships, causations and valuations for costs and benefits that have no market valuation can be useful in policy

analysis procedures like an impact assessment and can help policy makers to include all costs and benefits in their policy assessment.

- Measuring success: Directly related to the definition of objectives is the monitoring and evaluation of the policy following the implementation. If the right indicator is chosen the success of a policy can be accurately measured highlighting whether a policy is working as intended and when it stops working.

The use of indicators in policy making is summarised in the following Figure.

Figure 1: Indicators and the policy process



The examples of IN-STREAM indicators provided fall into these different categories, and show how IN-STREAM results can contribute to different stages in the policy cycle.

1.3 Objectives and structure of this report

The aim of this paper is to summarize the results of the research done in IN-STREAM. The diversity and breadth of the research done within IN-STREAM makes it difficult to summarize the research results in one common narrative. Rather than summarizing the work conducted in each of the six substantive work packages, we have decided to focus on three potential applications of the research, and to show how the results of the project could help to improve policy making in these areas.

The report therefore does not claim to cover all the research work that has been conducted within IN-STREAM. Rather, it focuses on the IN-STREAM results that can be related to the three selected policy fields:

- One important objective of the Europe 2020 process is sustainable or **green growth.** Chapter 2 discusses how the work done under IN-STREAM can support this agenda.

- Another important objective within the Europe 2020 process is the improvement of **resource efficiency** in the European Union. Chapter 3 will discuss how IN-STREAM results can contribute to this discussion.
- Chapter 4 focuses on **biodiversity** and summarizes how biodiversity indicators analyzed in IN-STREAM can support policy effectiveness in areas that have an impact on biodiversity.
- Chapter 5 summarises the conclusions from the different policy areas.

2 Green Growth and Green Innovation

2.1 The political context

The notions of "green innovation" and "green growth" have captured policy makers' attention, and are endorsed in different strategies at the EU and OECD level. These concepts promise to reconcile several seemingly contradictoy policy objectives: to achieve sustainable economic growth, create high-quality jobs, and secure the competitive edge of EU businesses over competitors from other regions, while at the same time achieving a drastic cut of CO_2 emissions. Additionally, green growth holds the promise of emerging stronger and greener from the economic crisis. Green innovation is seen as an essential ingredient to achieving such green growth: through innovations in environmental industries, such as renewable power and energy efficiency, it is expected that European businesses can secure technological leadership and a competitive edge in markets for green technologies and products, which are considered as future growth markets.

Green innovation is therefore a crucial element to realizing the EU's declared policy ambition of transforming Europe's economies into low-carbon economies. The link between green innovations and the transition to a low-carbon economy is explicit in the Europe 2020 strategy. This strategy for smart, sustainable and inclusive growth, which the European Council adopted on 17th June 2010, has three main goals: to boost job creation, foster economic growth, and increase competitiveness. This should be done under the umbrella of sustainable development and with the explicit goal to move toward a "low-carbon economy". The main vehicles to implement the Europe 2020 strategy are seven "flagship initiatives". Of these, the the initiative "innovation union" makes the link between green innovation and the decarbonisation agenda. Two other initiatives – "resource efficient Europe" and "an industrial policy for the globalisation era" – are also directly related to the low-carbon transition.

The notion of green innovation and its contribution to green growth is very much enshrined in the forthcoming OECD Green Growth Strategy. The interim report of the Green Growth Strategy focused very strongly on environmental policy and its potential impact on relative prices by reducing environmentally harmful subsidies and environmental taxes and trading permits.

As with other comparably broad concepts – such as "green investments" or "clean technologies", it is nearly impossible to provide a clear and unequivocal definition of green growth or green innovation. Green innovation is generally understood to include technological innovations in areas such as renewable energies, energy efficiency, electric cars or fuel cells, as well as non-technological innovations. In an effort to measure whether countries are moving toward green growth, the OECD has suggested to consider five broader groups of indicators: (i) indicators reflecting the environmental efficiency of production as well as the absolute pressures associated with production, (ii) indicators reflecting the environmental efficiency of consumption as well as the absolute environmental pressures associated with consumption (iii) indicators describing the natural asset base of the economy, (iv) indicators monitoring environmental quality of life, and (v) indicators describing policy responses and instruments.[1]

The green growth agenda therefore established an important connection between different approaches to measuring economic, social and environmental progress, as well as between different types of alternative well-being indicators. Green growth strategies aim to not only protect the environment, but also contribute to social and economic objectives by creating employment and strengthening the competitiveness of the European economy. In this sense, the notion of green growth is therefore quite closely linked to some interpretations of sustainable development.

This mix of objectives or targets which is at the core of the Green Growth agenda does also mean that many different policies will essentially influence the outcome of green growth even though their main objective is not or only partially related to green growth.

2.2 Examples of relevant policies and their trade-offs

While the notions of green growth and green innovation are designed to overcome the trade-offs between economic growth, employment and environmental objectives, the interelations between these three are more diverse and complex in practice. Environmental policies affect the relative prices of goods and services, either directly by determining production patterns, or indirectly by influencing the demand for certain goods. By changing the relative prices, environmental policies can improve or deter competitiveness, as well as trade and production patterns. Additionally, changes in relative prices can affect consumption and employment patterns, which in turn may affect social objectives like employment and income distribution.

The Commission communication “An Integrated Industrial Policy for the Globalisation Era: Putting Competitiveness and Sustainability Centre Stage” highlights the balance that any policy fostering green growth must strike. It describes this “new appoach of industrial policy” in the following way:

“This communication proposes a fresh approach to industrial policy that will put the economy on a dynamic growth path strengthening EU competitiveness, providing growth and jobs, and enabling the transition to a low carbon and resource efficient economy.”

Some of the new policies anounced in the communication highlight these trade-offs:

- Resource, Energy and Carbon Efficiency: The communication formulates the objective to induce a more carbon, energy and resource efficient-economy and it states clearly that these objectives must be reached without adversely affecting the competitiveness of the EU economy or imposing a disproportionate burden on businesses . The Commission announces that it wants to monitor sustainable competitivness in order to ensure that the objectives of resource efficency and competitiveness are both realised.
- Addressing concerns of energy intensive industries: The communication explains that in order to manage the risk of carbon leakage, energy intensive industries must be

[1] OECD 2010: Interim Report of the Green Growth Strategy: Implementing our commitment for a sustainable future, p. 60

able to produce in Europe and yet remain competitive on world markets. The Commision strategy therefore foresees a range of activities especially targeted at energy intensive industries to ensure strong incentives for emission reduction while maintaining conditions for competitive production in Europe. Again, efficient indicators and indices can help to balance these policies in the right way.

The policy examples above were chosen as we believe that the work of IN-STREAM can be useful for policy makers in these policy fields. The following chapter summarizes the results of IN-STREAM and discusses their relevance for policy making.

2.3 Insights from the IN-STREAM project

2.3.1 Qualitative assessment of indicators

IN-STREAM analyses a range of over 20 indicators using qualitative assessment tools[2] to identify their key strengths and weaknesses in respect to both data quality and their suitability to implementation in the EU policy. The assessments aim to allow policy makers to choose the right indicators for their specific policies and objectives.

Three of these indicators are particularly relevant to assess green growth policies. The evaluations provide insights into the potential and the limitations of indicators and accounting systems that assess economic performance, economy-environment interactions, or sustainability, such as: Gross Domestic Product (GDP), the Adjusted Net Savings (ANS) indicator, and the System of Integrated Environmental and Economic Accounting (SEEA-2003).

The results of this evaluation are summarized below.

- GDP is often used as a proxy measure for welfare more generally. However, it is widely known that GDP has significant shortcomings as a welfare measure, and this has been acknowledged by its devleopers. When it comes to measuring green growth, its main limitation is the fact that it does not account for the depletion of natural capital or losses in ecosystem quality. In contrast, GDP increases if natural resources are depleted. GDP can therefore measure economic growth to an extent, but it cannot tell us whether this growth is achieved by increasing environmental or social burdens. However, by linking it to other indicators, these limitations can partly be overcome. For instance, combined with gross energy consumption and carbon emissions, GDP can be used to measure an economy's resource and carbon intensity.
- The SEEA-2003, on the other hand, is a coherent and comprehensive international accounting framework that measures how environmental functions contribute to the economy and how the economy exerts pressures on the environment. Prima facie, it would therefore seem to be a good measure of green growth. However, the evaluation within IN-STREAM has shown that several limitations still exist; one being that it remains vague on the operational definition of sustainability and the fact that it

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[2] RACER and SWOT analysis are conducted on each indicator.

does not promote actual sustainability indicators. The SEEA-2003 does not provide indicators for whether a country's economic activity is sustainable or not, instead tracking environmental and economic capital, rents, and expenditures. A relevant policy indicator would need a robust methodology for summarizing these data sources into one indicator.

- Similarly, the ANS aims to be a measure of the sustainability of investment policies by measuring changes in wealth during a specified accounting period. In particular, it allows to test whether rents from natural resources and changes in human capital are balanced by net saving in man-made capital. However, the evaluation of the indicator has shown that the underlying concept of sustainability is weak sustainability (i.e. allowing for virtually unlimited substitutability between natural capital and man-made capital). For instance, there is no exhaustive accounting of natural resource depletion and degradation (missing are, for example, water resources, fisheries, soils, and biodiversity).

All the evaluated accounting approaches have their limitations when it comes to measuring green growth. But when applied together, they complement each other in several ways: GDP measures economic performance, which is supplemented by environmentally and socially adjusted savings and further supported by information on the stock and flows of environmental assets, the pollution generated by economic activity, and the resulting damages to future environmental resource streams.

However, although the collection of GDP, ANS, and SEEA allows for a more nuanced depiction of economic performance and its relationships to the environment, none of the three accounting approaches provide a complete measure of sustainability, individually or as a group. In defining the objectives and measuring the success of green growth policies the indicators can therefore play an important role but as the indicators overlap in some areas, a robust way of combining the indicators would make them even more useful for policy makers.

The methodology is suitable for the identification of the right indicators for setting objectives and subsequent monitoring. It can be operational in a relatively short timeframe and therefore suits short policy cycles. For more information please see Deliverable 2.1 on the IN-STREAM website www.in-stream.eu.

2.3.2 Correlation analysis of indicators

One part of IN-STREAM has been to look at the correlations of different indicators used in the project. To this end, the International Institute for Applied Systems Analysis and the Ecologic Institute employed a set of statistical tools to analyse the correlations between a set of commonly used social, environmental and economic indicators.

Such correlation analysis can help to set the scene for green growth strategies, and thereby supply guidance to decision makers. What are the conditions under which green growth strategies operate and what constraints and trade-offs do they face? What synergies can be observed between different development objectives, and where do conflicting targets need to be resolved? And last but not least, which indicators are best suited to measure whether the economy as a whole is moving towards a greener growth pattern?

In this way, the analysis sheds more light onto the uncertain(?) relationship between economic growth and environmental indicators. For example, per-capita greenhouse gas emissions and per-capita GDP are positively correlated, which means that higher per-capita GDP tends to coincide with higher greenhouse gas emissions. At the same time greenhouse gas emissions grow slower than GDP per capita. This shows that an absolute decoupling – i.e. falling absolute greenhouse gas emission levels and a growing economy – has rarely been achieved, whereas a relative decoupling – greenhouse gas emissions that grow slower than the economy – can be observed more often. The analysis can also provide examples of countries that achieved relative decoupling and point to best practice.

The relationship between environmental composite indicators and GDP offers another example of how the analysis can offer new insights for policy choices. In general, better performance in the Environmental Performance Index (i.e. a higher absolute value) tends to coincide with higher GDP. However, the same is true for the Ecological footprint, which also features higher absolute values (implying a worse performance) in countries with higher GDP. Hence the two indicators show that while on average GDP growth allows countries to improve their environmental policy efforts, the actual environmental impact of richer countries (in terms of the Ecological Footprint) will be higher than that of poor countries. Again, there are exceptions to this rule, and an analysis of such outliers can point to potential policy solutions.

The relationship between GDP growth and unemployment offers a third example, which touches upon the core of the ongoing debate about how we should define and measure our national welfare. One reason for the continued dominance of GDP as a measure of economic welfare is its relation to (un-)employment: Arguably, decision makers are not so interested in GDP as such, but consider it to be a useful proxy for employment (and possibly also for other aspects of economic welfare). In this regard, the correlation analysis on the one hand shows that the correlation between GDP and unemployment is not very clear or strong. The variance within the sample is very high, meaning that a number of countries have either experienced "jobless growth", or have managed to reduce unemployment despite sluggish growth. This suggests that other important influences (e.g. labour market policies) have to be taken into account to fully understand the relationship between economic growth and employment, and to develop adequate policy responses.

The three examples above highlight the usefulness of correlation analysis in situations where decision makers need to navigate between a diverse – and potentially conflicting – set of objectives. Although correlation analysis does not provide insights into causal relationships, it can be used to identify and quantify synergies and trade-offs between objectives. For more information please see Deliverable 3.2 which will be available on the IN-STREAM website www.in-stream.eu.

2.3.3 Valuing health effects of emission reductions

As mentioned above, policies aimed at fostering green growth have to balance social, environmental and economic considerations. One example of the interconnected relationship between social and environmental considerations would be the health effects of environmental measures. The first air emission regulations were mainly introduced to reduce the negative health impacts of pollution on humans. Recently other reasons (like climate change) have become a more important justification for policy initiatives that reduce air pollution, but nonetheless decreasing air pollution will also have positive impacts on human health. A fair consideration of economic, environmental and social impacts should therefore take those impacts into account.

The evaluation of policy measures aimed at reducing greenhouse gases in order to meet global or regional climate change targets needs to be based on an integrated assessment in order to cover all the different aspects of these measures. This integrated modelling approach extends the analysis to include the side effects of the changes resulting from the policy. Examples include impacts on human health and the ecosystem or other utility losses of the affected individuals, e.g. in production technologies or behavioural patterns.

Furthermore, the integrated assessment approach requires a comprehensive analysis across all economic sectors and needs to include the most relevant pollutants. However, it is not sufficient to only estimate changes in the emissions of non-greenhouse gases. These pollutants have different impacts on human health and the ecosystem and thus need to be weighted according to the extent of the impacts caused. For human health impacts this weighting is based on epidemiological studies regarding the effect on human health resulting from an increase in the ambient concentration of a pollutant. The resulting consequences for human health, e.g. additional cases of chronic bronchitis or losses in lifetime expectancy, are then weighted according to their duration and severity.

In the course of the EU-projects HEIMTSA and INTARESE, human health impacts have been aggregated according to the disability adjusted life years (DALY) they cause. In a further step human health impacts are valued in monetary terms – including the cost of illness (hospitalization and medication) as well as the utility losses of an imperfect heath status. This monetisation allows comparisons across impact categories, e.g. comparing human health effects to ecosystem damages, for instance as part of a cost-benefit analysis. The monetary valuation also allows to factor in the external effects caused by changes in the emission of non-greenhouse gas pollutants: for instance, where policy measures to reduce greenhouse gases coincide with higher emissions of primary particulate matter, the impacts on human health caused by the primary particulate matter can be compared and weighed against the policies' other benefits and costs.

In the ongoing EU-project HEIMTSA (Health and Environment Integrated Methodology and Toolbox for Scenario Assessment) a substantial number of different policy measures targeting the reduction of greenhouse gases have been assessed with respect to their impacts on human health. The policy measures include already existing and agreed climate policy actions as well as additional policy scenarios for further greenhouse gas emission reduction. The overall goal for greenhouse gas emissions was to achieve a reduction of 70% in 2050 compared to 1990 levels, which would reflect a global temperature increase of 2° Celsius. An analysis of the results of this project will serve as important input for the development of sustainability indicators for human health impacts and biodiversity losses presented in the IN-STREAM project.

The methodology and the results of this work are useful in integrated impact assessments on policies aiming towards green growth. The existing trend for more quantification in policy analysis bears the risk that costs and benefits which are difficult to quantify are not adequately considered. In the case of green growth the costs for companies are straightforward to quantify while some benefits like the health benefits require more complex methodologies for a robust quantification. The methodologies outlined above can provide these quantifications and can help policy makers to balance costs and benefits of green growth policies by providing better information. For more information please see Deliverable 5.1 which will be available on the IN-STREAM website www.in-stream.eu.

2.3.4 Costs of sustainability

There are many studies which focus on the assessment of climate policies on a national and international level. However, in countries with a federal system, climate policies at the sub-national level also come into the picture. Depending on their specifications, these may support, or in the worst case, counteract the national climate policies. An example of this is a programme by the state government of the German federal state Baden-Württemberg to increase the share of renewable energy carriers in electricity generation to 20 % by 2020. In the case of heat supply the share of renewables shall be increased to 16 % by 2020. As part of the IN-STREAM project, researchers of the ZEW in Mannheim examined the regional impact of this program using an input-output model. These impacts are of particular interest as in Baden-Württemberg the export-oriented manufacturing industries are of great importance.

The analysis quantifies the effects of the policy actions on the turnover as well as the employment of several sectors. To this end, the ZEW researchers constructed a regional input output table of Baden-Württemberg and introduced seven renewable energy types in order to examine different paths to achieve the state government's targets. As there was no sufficient data to regionally disaggregate a computable general equilibrium (CGE) model, the researchers chose an input output approach for their analysis. In an input output context it is easier to construct a regional data source. Furthermore, it is an appropriate way to carry out the tasks, as the analysis of turnover and employment effects can be represented within an input output approach with a similar accuracy compared to a CGE framework. Also the sectoral disaggregation of the input output table is not inferior to that of most applied CGE models.

We consider two scenarios with different funding sources for the investments in the construction and operation of renewable energy installations. In the first scenario, all the necessary investments are funded completely by internal sources. Hence, the scenario is driven by the assumption that these investments either crowd out investments in other industries of the regional economy or the investments are paid by the government, i.e. by commercial and income taxes. Therefore, the final demand of all other sectors decreases. In this scenario, we have a slight positive total turnover effect although in many sectors the turnover effect is negative. In addition, the total employment effect is negative since the more labour-intensive industries are affected more heavily by the policy than the less labour-intensive industries. The second scenario considers the case of a partly external funding by taking into account that the installations may be demanded from "abroad", i.e. from outside of Baden-Württemberg. Therefore, investments in other industries are not completely crowded out in this scenario. Here we also find positive turnover and employment effects for most industries outside the energy sector.

Our findings suggest that policy actions promoting renewable energy do not necessarily create new jobs for the whole economy. They rather induce a structural change in the economy since other investments might be crowded out by investments in installations of renewable energy and the demand in other sectors might decrease. However, if the producers of the installations are able to export parts of their products to the rest of Germany and the rest of the world, these effects can be attenuated and turnover and employment effects might be positive in total.

Again, the methodology and the results can be used by policy makers in an impact assessment or other analyses of policies aimed at green growth. The results show where oft assumed trade-offs between “green” and “growth” are real and have to be dealt with and how big these trade-offs may turn out to be. Furthermore they enable the policy maker to counter irrational fears about the impact of green policies on growth and to focus on actions that mitigate any negative impacts that might occur. For more information please see Deliverable 6.3 on the IN-STREAM website www.in-stream.eu.

3 Resource Efficiency

3.1 The political context

Resource efficiency describes the management of raw materials, energy and water in order to minimise waste and thereby reduce cost. In January 2011 the commission published a communication[3] on "A resource efficient Europe – Flagship initiative under the Europe 2020 Strategy".

The communication lays out the benefits of an EU policy for more resource efficiency, which again highlights the diverse set of objectives that such a policy must consider. The communication states that a push for more resource efficiency will help Europe to

- *boost economic performance while reducing resource use;*
- *identify and create new opportunities for economic growth and greater innovation and boost the EU's competitiveness;*
- *ensure security of supply of essential resources;*
- *fight against climate change and limit the environmental impacts of resource use.*

To emphasize this point the communication identifies synergies and trade offs between the range of objectives. For example it refers to the savings that more resource efficient approaches can bring to businesses working in resource intensive sectors, as well as the social and economic benefits that can be achieved by reinvesting potentially higher tax revenues from resource usage. Another example mentioned of a trade off is designating land use for energy crops (to reduce the use of fossil fuels) and the resulting implications for food production and prices.

Additionally the communication details the activities of the commission in a diverse set of policy fields that aim to achieve these objectives. Policies set out include energy policy, water policy, transport policy, biodiversity policy and others. The commission will provide a framework to integrate all these policies in early 2011 with a low-carbon 2050 roadmap.

Indicators will be of utmost importance in monitoring the achievements towards these objectives. Currently, Eurostat lists resource productivity among its eleven sustainable development headline indicators (SDI). In August 2010, the European Commission's Joint Research Centre (JRC)[4] published a new type of life cycle based indicators for quantifying and monitoring progress towards sustainable development. The JRC developed three sets of indicators on resources (including resource efficiency, eco-efficiency, resource productivity, and resource-specific impacts), products (focussing on products' environmental impacts) and waste (covering the entire waste management chain).

Indicators will also be relevant for defining resource efficiency targets. At this stage, however, it remains unclear whether the EU will adopt a resource efficiency target as part of the

[3] http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf

[4] Decoupling indicators, Basket-of-products indicators, Waste management indicators: Framework, methodology, data basis and updating procedures. Draft for public consultation.

Flagship Initiative, how binding this target would be, and whether it will be broken down into national targets for each Member State.

3.2 Examples of relevant policies and their trade-offs

Some policies in the EU target resource efficiency specifically; other policies that mainly aim towards different objectives nonetheless have a substantial impact on resource efficiency. Policy makers need to balance different types of objectives and manage the inherent trade-offs.

The EU Action Plan for Sustainable Consumption and Production focused on demand side policies like eco-design, labelling and green procurement. All these policies aim at improving resource efficiency, though as a side effect they could potentially have an impact on social objectives. In case that these policies are directly affect a wide range of goods, the likely increase in prices of some goods or services will affect the purchasing power of all people and may have a disproportionate effect on the poor. Given this, an effective policy has to assess this potential range of impacts and balance the trade offs involved.

3.3 Insights from IN-STREAM

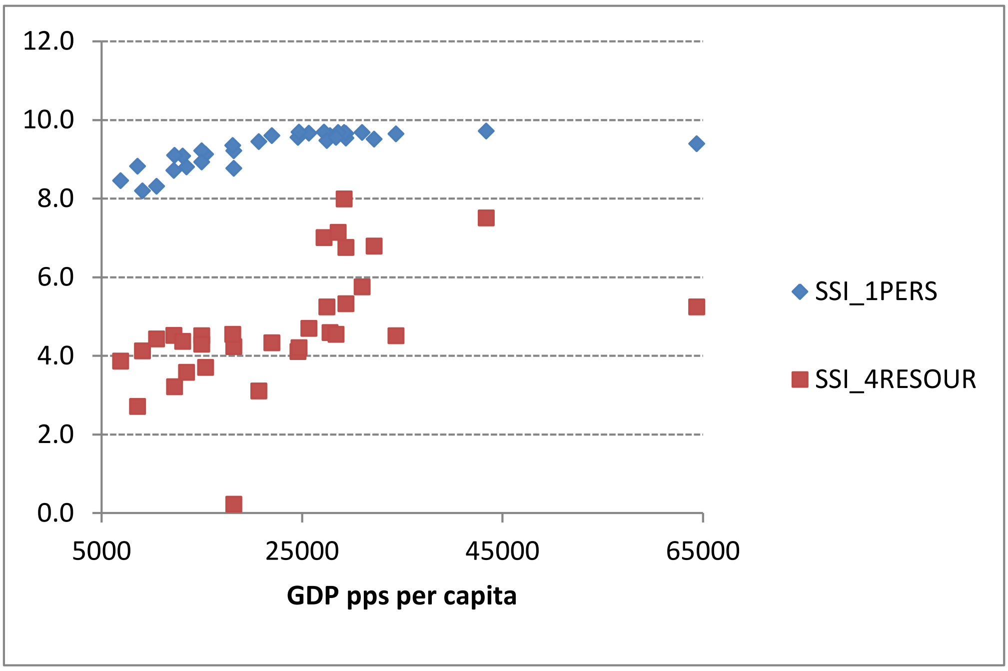
3.3.1 Correlation analysis of indicators

The correlation analysis undertaken in the IN-STREAM project (see chapter 2.3.2. for a more detailed description) can also influence the choice of indicators for resource efficiency, and thereby measure the success of policies targeting resource efficiency. The correlation analysis can convey some simple but effective messages about the scope and the limits of any policy to achieve resource efficiency.

One example of this would be the relationship between resource use indicators and GDP. The graph below shows the relationship between GDP per head (measured in purchasing power parities) and the resource use component (SSI_4RESOUR) of the sustainable society indicator (SSI).

On average resource use increases with rising per capita GDP. However, it is the variance that offers interesting examples for policy makers: Countries with a resource use indicator of 4.0 have per capita GDPs between just over 5,000 and up to nearly 40,000, while for countries with a per capita GDP of around 25,000 the resource use indicator ranges between 4.0 to more than 8.0.

Figure 2: Correlation of GDP per capita with Personal Development and Resource component of SSI



On the one hand, this shows that while incomes and resource consumption are generally linked, there is also a huge variation in terms of resource efficiency: Some countries achieve the same income level as others with half the ecological footprint, and thereby provide evidence that a resource-light economy does not have to be at odds with high income levels.

On the other hand, the analysis also sheds light on the limits in achieving resource efficiency in the current economic framework. For example, until now no country with a per capita GDP above 20,000 US$ has managed to achieve an ecological footprint below 2.0. If we aim to reduce our ecological footprint beyond this, the analysis would suggest that, unless countries were prepared to accept lower income levels, technological advances would be necessary at a much larger scale than currently available, and that the economy would need to be restructured in a more fundamental way than has been observed anywhere until now.

Again, this example should only highlight the use of correlation analysis to support resource efficiency policy, and cannot replace a more substantiated discussion of national resource-efficiency targets and objectives. For more information please see Deliverable 3.2 on the IN-STREAM website www.in-stream.eu.

3.3.2 Analysis of social impacts of resource efficiency policy

Work of the Charles University Environment Center in Prague analysed the social impacts of resource efficiency policies.

Most of the studies which estimate the relationship between economic and environmental variables cannot analyse the reason why, for example, per capita income and emission level have (or do not have) a relationship. To overcome this knowledge gap, we statistically analyse the local air pollutants in one of the CEE countries, Czech Republic during its transition and post-transition period 1995-2007.

We find that in the period 1995-1999, when the command and control type of regulation was implemented, in fact, the firms increased their production resource efficiency and thus managed to considerably reduce the emissions of some of the air pollutants, such as particulate matter, SO_x and NO_x. Particularly the result of our statistical decomposition analysis suggests that during this period, the firms achieved resource efficiency by improving end-of-pipe type technology. However, after the firms fulfil the requirement, i.e., after 1999, our analysis suggests that the firms lost incentive to further decrease their emissions, and thus, their emission levels as well as environmental efficiency stayed more or less the same.

The structure of the economy in the Czech Republic contributed to an increase in the emission levels. In other words, during the period of 2001-2007, the composition of the Czech economy seemed to become less resource efficient instead of more.

The interlinkages between the environmental and social pillars of sustainable development are investigated using three different analyses that all are performed for the Czech Republic.

First, we investigated which specific household segments (such as income deciles) consumed more environmentally 'dirty goods' like energy, fuel or personal vehicles. For instance, while a household in the lowest decile (i.e. the poorest tenth of all household) spent almost 20% of their net income on energy, a household from the highest decile (i.e. the richest tenth) spent about 7%. These differences might have further consequences for energy consumption and savings. While the former usually lack the financial resources to install energy efficient durables, the latter lacks strong motivation to increase energy efficiency due to their lower budget share on energy.

Second, in order to describe a trend during the transition and post-transition period, we measure inequality in these expenditures by a concentration-based index, such as the Suits index.

Last, the Czech study examined the likely effect of a price-based policy measure such as an increase in the energy tax of goods consumed by households on the environment and distribution. We investigated the price responsiveness of various household segments, which is one key factor for energy consumption. In fact, we found that the price elasticities vary across the household segments, which suggests a different response on price signals delivered by resource-saving policy. Specifically, using a micro-simulation model built for the Czech Republic, embedded with parameters of household behavioural response, we assess the distributive aspects of policy with respect to energy consumed, impact on progressivity of taxes and regressivity of income.

The results and the methodology of the study are useful to investigate the financial burden policies bring to specific household segment under various policy settings. Many policies which aim to improve resource efficiency will have an impact on relative prices and thus will indirectly impact the income distribution in Europe. In an impact assessment process, such analyses can help policy makers counter fears about social imbalances of the suggested measures and start mitigation measures when aiming to increase resource efficiency.

Table 1: The effect of energy taxation on the Czech households, as percentage of total expenditures

household group	total net expenses	expenditures on energies				Welfare			
		ET	ETR-SSC	ETR-PIT	ETR-PITSOC	ET	ETR-SSC	ETR-PIT	ETR-PITSOC
1	211 685	0.12%	0.20%	0.24%	0.26%	-2.08%	-0.81%	-0.25%	-0.13%
2	201 817	0.13%	0.21%	0.23%	0.26%	-2.19%	-0.85%	-0.47%	-0.23%
3	193 458	0.12%	0.19%	0.19%	0.20%	-2.29%	-1.14%	-1.01%	-0.88%
4	189 292	0.01%	0.06%	0.07%	0.10%	-2.27%	-1.26%	-1.22%	-0.77%
5	193 613	-0.06%	0.00%	0.01%	0.03%	-2.22%	-1.10%	-1.06%	-0.82%
6	203 732	0.12%	0.18%	0.19%	0.22%	-2.08%	-0.89%	-0.85%	-0.66%
7	236 399	0.04%	0.12%	0.13%	0.14%	-1.72%	-0.23%	-0.23%	-0.31%
8	258 626	0.03%	0.11%	0.11%	0.11%	-1.75%	-0.09%	-0.14%	-0.39%
9	273 708	-0.05%	0.04%	0.04%	0.03%	-1.60%	0.26%	0.09%	-0.20%
10	359 590	0.02%	0.10%	0.08%	0.07%	-1.31%	0.46%	-0.06%	-0.32%
Pensioners [1]	141 117	0.96%	0.97%	0.96%	1.11%	-2.60%	-2.54%	-2.60%	-0.57%
Pensioners [2]	142 959	0.30%	0.30%	0.30%	0.40%	-2.43%	-2.38%	-2.43%	-1.12%
Pensioners [3]	135 476	-0.04%	-0.04%	-0.04%	0.02%	-2.93%	-2.88%	-2.93%	-2.00%

Note: [1] refers to a household of pensioners living in small municipalities (with less than 2000 inhabitants), while the adding [2] and [3] refers to a household of pensioners living in medium-sized town (between 2000 to 20000), or larger town (with more than 20000) respectively.

[ET] describes the policy on energy taxation without recycling the additional revenues, while [ETR-SSC] and [ETR-PIT] describe two revenue-neutral tax reforms, which recycle the revenues through lowering social security contribution payments, or personal income tax respectively, and, finally, [ETR-PITSOC] provides a social transfer of CZK 10,000 per year to those households with energy expenses after taxation larger than 25% of their total expenditure, the rest is used to personal income tax cuts.

For more information please see Deliverable 6.4 which will be available on the IN-STREAM website www.in-stream.eu.

3.3.3 Costs of sustainability

As described above all policies aiming to reduce carbon emissions have a strong impact on resource efficiency. The work undertaken in the IN-STREAM project demonstrates the extent to which trade-based competitiveness concepts (indicators) at the sectoral and national levels can introduce an ‘operational element’ into the current discussions on EU leadership in GHG emission reduction. Employing a set of appropriate competitiveness indicators in the multi-sector, multi-region model for the world economy, we investigate the implications of alternative emissions pricing strategies under stringent unilateral carbon emissions regulation on economy-wide adjustment costs and competitiveness in the EU.

From the methodological perspective, we find that the use of comparative advantage indicators within this framework can add to our understanding of changes in trade patterns in different industries, an issue that is of immense importance to the European policy makers. For a balanced view on competitiveness, it is, however, important to account for changes across the various sectors of the domestic economy rather than to focus on a very narrow segment of the economy which might be most affected by policy-induced structural change. In addition, sectoral implications must be traded off with economy-wide impacts.

Obviously, improvements in competitiveness for some industries may not only work at the expense of competitiveness of other industries but may also induce an overall loss in national competitiveness measured in terms of real income. The overall result is very much dependent on the specific measure and the sectoral structure of the economy. Our analysis warrants the careful and complementary use of macroeconomic and competitiveness indicators: Results based on any (sectoral) competitiveness indicator as a cardinal measure are highly sensitive to the particular indicator chosen but we find a considerable consistency among alternative indicators as a binary measure.

Within the policy process, the results and the methodology can be used to improve the evidence base of policy analysis procedures like impact assessments for resource efficiency policies. By estimating the size of any competitiveness effects politicians are able to focus potential mitigation action on the sectors which really need them, and gain an understanding of the scale of the mitigation action required for sectors or companies. For more information please see Deliverable 6.1 on the IN-STREAM website www.in-stream.eu.

4 Biodiversity & Value of Ecosystem Services

4.1 The political context

Biodiversity – the variety of ecosystems, species and genes – is the world's natural capital, and its conservation and restoration is a key environmental priority for the EU.

While it is a very complex task to measure all aspects of biodiversity, an increasing number of indicators have emerged throughout the past few years to communicate trends in biodiversity and ecosystem health to policy-makers. Drawing upon a number of biodiversity related indicators, the latest assessments[5] revealed that, despite some progress here and there, the state of Europe's biodiversity is still a serious cause for concern. A number of ecosystem services have been damaged in recent years, and continue to deteriorate. It also made evident that a major failure of existing biodiversity policy instruments was related to the lack of appropriate indicators, milestones and baselines to measure progress. In order to create useful progress assessments it was therefore necessary to retrofit indicators[6].

Having failed to meet its target to halt biodiversity loss by 2010, the EU adopted this year, as part of its **post-2010 biodiversity strategy**, a new target to halt biodiversity loss and ecosystem services by 2020. The increasing importance given to the value of biodiversity and the conservation ecosystem services further fuelled the demand for reliable biodiversity and ecosystem service related indicators. As part of this process, the EU has established a solid biodiversity baseline for the year 2010. This will act as a reference point for measuring future changes in biodiversity, for instance as a result of EU policy.

Part of this EU biodiversity strategy will be a sub-**strategy on Green Infrastructure**, planned for 2011. In this regard, the Commission seeks to develop ways to assess its future implementation efficiency. It will therefore be important to identify the best indicators for demonstrating and assessing the contribution of different elements of Green Infrastructure to ecosystem resilience and to determine what specific requirements for indicators are lacking.

The recently released **TEEB study**[7] highlights the link between ecosystem health and the (often overlooked) value of the important services that these provide. The TEEB for National Policy-Making[8], among other things calls for suitable indicators and/or accounting

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[5] Monitoring the impact of EU biodiversity policy (2010):
http://ec.europa.eu/environment/nature/info/pubs/docs/biodiversityindicators_factsheet.pdf

[6] Herkenrath P., Fournier N., Gantioler S., Good S. and Mees C. (2010) Assessment of the EU Biodiversity Action Plan as a tool for implementing biodiversity policy. June 2010. European Commission Biodiversity Knowledge Base. Service contract nr 09/543261/B2

[7] TEEB Synthesis Report:
http://www.teebweb.org/LinkClick.aspx?fileticket=bYhDohL_TuM%3d&tabid=1278&mid=2357

[8] Chapter 3: Strengthening indicators and accounting systems for natural capital:

http://www.teebweb.org/LinkClick.aspx?fileticket=J3_lcRRutGw%3d&tabid=1019&language=en-US

frameworks to measure our natural capital and highlights urgently needed measures that would allow for the formation of a solid evidence base for informed policy decisions. It calls for: improved measurement and monitoring of biodiversity and ecosystem services, better macro-economic and societal indicators and more comprehensive national income accounting.

The importance of biodiversity and health ecosystems for human well-being and long term prosperity is increasingly recognised. The recent developments in EU biodiversity policy, the latest CBD COP meeting in Nagoya and the strong attention received by TEEB make ecosystem valuation a very crucial and timely topic. IN-STREAM reflects the emerging consensus in this area and highlights the different indicator approaches that have been suggested.

4.2 Examples of relevant policies and their trade-offs

Biodiversity policy is a cross-sectoral policy. This means that many European Union policies have an impact on biodiversity even though the main objectives of these policies are not related to biodiversity. Biodiversity indicators are crucial. to ensure that policy makers in other fields take possible impacts on biodiversity into account,

In preparation for the tenth conference of the convention of biological diversity (Nagoya December 2010), a motion for a resolution[9] was introduced into the European Parliament in September 2010. The motion called for the development of further valuations for ecosystem services in order to inform policy makers and the wider public and improve awareness raising campaigns.

The **Common Agriculture Policy** (CAP) contributes to the provision of a range of public goods, both environmental (agricultural landscapes, farmland biodiversity, water quality, water availability, soil functionality, climate stability, air quality, resilience to flooding and fire) and social (food security, rural vitality and farm animal welfare and health). While the impact of the CAP on these public goods is generally accepted, the balancing of trade-offs within and among these public goods is contentious. In the current process of "CAP reform beyond 2013," many commentators urge the EU to forge a stronger connection between CAP payments and public goods that are produced and maintained by the agricultural sector.

One precondition for making CAP payments conditional on the delivery of ecosystem services is a robust indicator system that shows the development of ecosystem services and the impact of agricultural production on them. An even stronger case for such conditions could be made if widely accepted valuations of such ecosystem services could be used to estimate the size of subsidies justified by the services.

[9] http://www.europarl.europa.eu/sides/getDoc.do?type=MOTION&reference=B7-2010-0536&format=XML&language=EN

4.3 Insights from the IN-STREAM project

The results of several work packages in IN-STREAM can be useful for policy makers balancing diverse those sets of objectives. We want to especially emphasize the following results.

4.3.1 Qualitative analysis of indicators

At a later stage in the IN-STREAM project, a group of resource indicators will be evaluated, including the Ecological Footprint (EF), Environmentally-weighted Material Consumption (EMC), Human Appropriation of Net Primary Production (HANPP) and Landscape Ecological Potential (LEP). Using the same Racer and SWOT methodologies as described under chapter 2.3.1., the evaluation will also cover the group's potentials and limitations with regard to measuring resource efficiency. For more information please see Deliverable 2.2, which will be available on the IN-STREAM website www.in-stream.eu.

4.3.2 The use of indicators for ecosystem effects

Research conducted by the University of Stuttgart assessed and evaluated the impact of air emissions and related policies on biodiversity.

Impacts on biodiversity due to eutrophying and acidifying substances from airborne pollution were successfully developed and tested in the NEEDS[10] integrated project. In the following, we will show why this indicator is particularly suited for the assessment of changes in biodiversity due to atmospheric deposits of acidifying and eutrophying substances.

First, the methodology will be shortly described. The assessment of impacts on biodiversity due to atmospheric deposits is mainly based on the work of Goedkoop and Spriensma (2001) in Eco-Indicator99. Since eutrophication and acidification do not necessarily lead to a reduction of species numbers but rather to an increase (as many nitrogen compounds are primary nutrients), the concept of "target species" is applied. Target species are species specific to an ecosystem type if there are no man-made changes in the nutrient and acidity level. The indicator used is called Probability of Occurrence (POO). The relationship to PDF (Potentially Disappeared Fraction) is as follows: PDF = 1- POO, meaning that the fraction of the species that do not occur can also be described as the fraction of the species that have disappeared.

In the methodology, the increases or decreases in the number of target species due to additional deposits (with respect to original levels) are modelled with a damage model (Natuurplanner). The model also contains information for more than 40 types of ecosystems. A species is considered to be experiencing unfavourable conditions if this probability is lower

10 The integrated project NEEDS (New Energy Externatities Development for Susatinability) was funded by the European Commission, 6th Framwork Programme. More information on the project and the deliverables is available at http://www.needs-project.org/

than some threshold value (set to 2.5%) and is suffering from stress caused by combined effects of eutrophication and acidification.

The model results are then converted into PDFs per kg of deposited substance/m²/year. Since first calculations refer to the total area of the Netherlands and since biodiversity loss occurs only in natural habitats, not areas already heavily settled by humans, the actual maount of natural land in the Netherlands has to be included in the calculation.

Additionally, within the NEEDS methodology it is suggested to consider country-specific background conditions of acidification and eutrophication, Since additional atmospheric deposits will be more harmful the more elevated the background conditions already are and hence the lower the capacity is to absorb the additional atmospheric deposits. For this reason, the acidification and the eutrophication pressure index was introduced. The acidification and eutrophication index is calculated by determining the critical load[11] for each grid cell and the corresponding nitrogen and phosphorous deposits.

If the sulphur and nitrogen deposits are below the critical loads, no threat to biodiversity is assumed (meaning pressure index = 0), and if the depositions are higher than 5 times the critical loads, threat to biodiversity is assumed to be at its maximum level (pressure index = 100) (ten Brink et al. (2000)). Between these values, a linear relationship between exceeding critical loads and pressure index is assumed.

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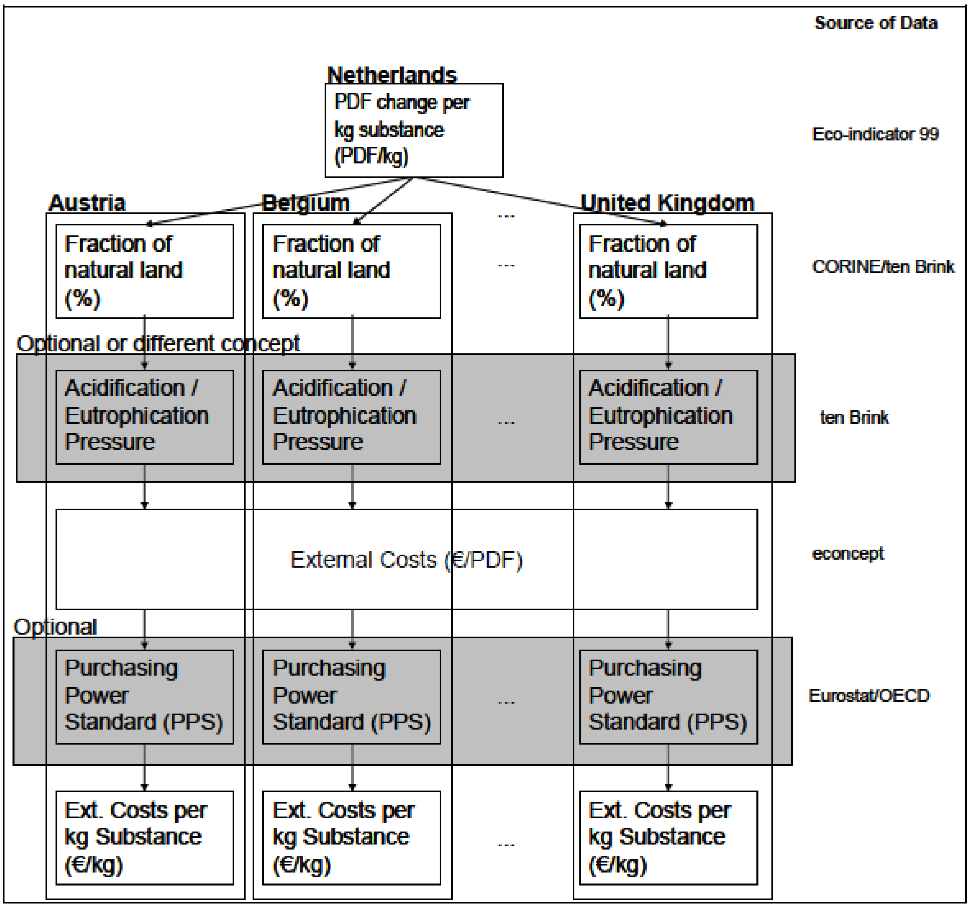
[11] A critical load is defined as "a *quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge".* The concept of critical loads was developed within the framework of the Convention on Long Range Transboundary Air Pollution (LRTAP) by UNECE (United Nations Economic Commission for Europe) in 1979. More information can be found under www.icpmapping.org; UNECE Convention on Long-range Transboundary Air Pollution: Mapping Manual 2004. Manual on methodologies and criteria for modelling and mapping critical loads & levels and air pollution effects, risks and trends.

Figure 3: Procedure to calculate external costs per kg of pollutant deposition for different countries



Source: Ott etl al. (2006), p. 34

In Figure 3, the procedure of calculating the external costs per kg of pollutant deposits is presented. The results are not yet published, but the indicator will be able to support policy makers when assessing air emissions policies. Since an easily understandable value for each avoided ton of emissions for each respective pollutant is provided, policy makers can easily take the biodiversity benefits into account when deciding on reduction measures. As a reference scenario (for 2004) already exists, the modelling of different future scenarios is also feasible. The results could therefore be used in impact assessments or other policy analysis processes. In addition, some of the results could be relevant not only for air emissions policy: the valuations developed for the destruction or the preservation of biodiversity could be applied to all other policies that have an impact on biodiversity. The above mentioned common agricultural policy is one example. If biodiversity and ecosystem services are to be included in the subsidy system of the caps, credible valuations for those services are needed as a basis for those subsidies.

5 General Conclusions – Indicators in the Policy Cycle

The choice and the use of indicators are becoming increasingly important for the policy process. IN-STREAM's core objectives were to highlight ways that indicators can be chosen and used to inform and improve policy making processes.

The examples provided are necessarily selective, but were chosen in order to provide a good overview of how results and methods used and developed in IN-STREAM can help policy makers to reconcile a diverse set of (possibly conflicting) objectives. The examples could thereby provide support in different phases of the policy cycle:

- **Qualitative Analysis** of indicators using, for example, RACER or SWOT methodologies can help policy makers to identify the right indicators for setting objectives and, later, for successful monitoring. Different indicators and indicator systems have both distinct advantages, and shortcomings and, because of this, each of them can be more useful for some policies and less so for others. Additionally, the analysis can provide a summary of data quality, which is important for use in all policy contexts. Identifying the right indicator set to quantify the objectives of the policy can improve the quality of policy making both by facilitating decisions and by making communication of policies more effective.
- **Correlation Analysis** of indicators can allow policy makers to build a coherent indicator system for policies with a diverse set of objectives. Policy makers can use correlation analysis to understand the relationship between different sets of indicators. Differences in correlations over time and between countries can give important insight into how realistic or how transformative certain targets could be. Additionally correlation analysis enables the identification of policy trade-offs and synergies if policies have a diverse set of objectives and constraints.
- **Monetary Valuation** can allow policy makers to adequately consider those types of impacts that have no market valuation, such as health effects or impacts on biodiversity and ecosystem services. With the general trend towards evidence-based policy making and quantification of objectives and impacts (as witnessed e.g. in the impact assessments), quantified costs and benefits tend to receive more attention, whereas non-quantified costs and benefits end up underrepresented. Robust valuations of indicators like health effects of emissions or ecosystem services can ensure that the impacts receive the attention they deserve during impact assessments or similar policy analysis.
- **Modelling of economic impacts** with Input-Output or CGE models can support policy makers in assessing the need for compensation or transitional support caused by policy changes and, in so doing, support policy implementation. One other potential flaw of impact assessments or other quantified policy assessments can be to overrate direct impacts of policy changes and to not take indirect effects sufficiently into account, as they are less certain and more complex to quantify or measure. Modelling those indirect impacts can help policy makers to take account of secondary or indirect impacts such as those on competitiveness or income distribution.

For all three policy fields discussed above, IN-STREAM indicators can make a contribution to more efficient policy making. As the number and diversity of indicators is always increasing, informing policy makers about the usefulness and the limitations of indicators is just as important as the creation of robust and meaningful indicators itself. The IN-STREAM project has undertaken to contribute to both areas as shown in the three policy areas chosen.