Executive Summary:

Key Messages of IN-STREAM

- Indicators should be used to support the integration of sustainability considerations across a wide range of policy areas. For instance, biodiversity and climate change related indicators can be useful for informing a wide range of policies, from budget allocations (e.g. EU Cohesion Funds) to environmental policies.
- As the concept of sustainability is complex and multifaceted; developing a "one size fits all" sustainability indicator for the assessment of any given policy is not possible. Sustainability measures and indicators have to reflect the preferences and value judgements of policy makers and the public, which depend on the policy issue in question and may change over time.
- Choosing the right indicator is therefore crucial in any step of the policy cycle. Policy makers need to understand the capacities of indicators to ensure that they are interpreted and used adequately. Qualitative assessments like the RACER or SWOT analysis used in IN-STREAM can provide that understanding.
- Building an efficient set of targets for multi objective policies requires a thorough understanding of the relationships among different indicators. Statistical techniques like correlation analysis or Principal Component Analysis can give a quick overview on those associations and help policy makers focus further analysis and policy making efforts.
- Composite indicators can be very effective tools in communicating overarching sustainability messages to non-experts, although subjectivity is intrinsic to the construction of such indicators. However, this subjectivity can provide an additional layer of information when composite indicators are used to make the underlying preference structure and value judgments more explicit and transparent.
- General equilibrium models allow estimating the often-claimed negative effects of climate change actions on competitiveness. They can also support policy makers determine compensations for the energy-intensive sector, as they highlight the potential tradeoffs between sector-based competitiveness measures and overall economic efficiency.
- Analyses of the regional employment impacts of climate change actions can show whether and how investments in renewable energy are displacing other investments. Additionally, they can estimate whether potential job losses can be compensated for by fostering an export industry that creates additional jobs.
- Policy makers setting ambitious biofuel targets to reduce GHG emissions can use models to determine whether the induced additional land conversion may offset much of the GHG emission reductions. The models also allow policy makers to take into account the potential impacts of those targets on food availability, risk of hunger and deforestation.
- Environmental indicators are very often only available as pressure indicators. Complementing those indicators with impact indicators, like health effects or biodiversity gains of emission reductions, supports policy makers in making the relevant tradeoffs within sustainability categories.

Project Context and Objectives:

Context

The EU is committed to enhancing the economic prospects and human well-being of Europe's people. Through the Lisbon Strategy and more recently the Europe 2020 strategy, EU policymakers aim to increase the international competitiveness of the European economy and expand employment opportunities. To assist in this, key economic indicators of each Member State are closely watched as a means of assessing the performance, structure and growth of the market economy. Though mainstream economic measures such as GDP are useful measures with great influence on public and private decisions, they are flawed as measures of human welfare. In addition, they give little information as to whether the market is helping Europe make progress on its environmental goals and its commitment to sustainable development.

There is therefore a critical need in Europe for indicators and measurement systems that-working in conjunction with mainstream economic indicators-provide a useful measure of progress toward economic success, human well-being, environmental protection and long-term sustainability.

This need has already been partially addressed. For example, a comprehensive set of indicators has been developed by the Sustainable Development Indicator (SDI) Task Force to assist the EU in achieving the objectives of its renewed Sustainable Development Strategy (SDS). This set of 12 headline indicators, 45 core policy indicators and 98 analytical indicators covers ten themes related to the policy priorities of the SDS. And world-wide, since the early 1990s, there has been significant work on indicators and green accounting as a means of providing information not offered by traditional economic indicators. The Compendium of Sustainable Development Indicator Initiatives lists over 680 different indicator efforts going on around the world. In recent years, significant progress has been made on sustainability indicators and green accounting measures, as evidenced in the 2005 report, Indicators for Sustainable Development: Proposals for a Way Forward, prepared for the United Nations Division for Sustainable Development. However, despite the significant work undertaken on indicators, indicator sets and composite indicators, these initiatives have failed to end the hegemony of mainstream economic measures as the dominating indicators of human progress.

More recently the Europe 2020 strategy has developed as an attempt to bridge the gap between economic development strategies (Lisbon strategy) and sustainability strategies. The Europe 2020 Strategy has named 8 targets from all three dimensions of sustainability as one indicator set which is able to measure the European progress towards an environmentally, socially and economically sustainable future.

Over the years, ambitions regarding indicators seem to have been scaled back, away from an integrated system of greened" national accounts to the more modest goal of complementary headline indicators that, taken together, can capture economic performance, human well-being and sustainability. There is now a renewed interest and momentum on the part of policy makers and researchers in developing headline indicators that go beyond economics to more comprehensively assess societal progress. Major conferences on the topic are taking place this year. The OECD hosted the Istanbul World Forum Measuring and Fostering the Progress of Societies" in June 2007 (over 1,200 attendees), and the European Commission, European Parliament, Club of Rome, OECD and WWF hosted the international conference Beyond GDP" in November 2007 (650 attendees). Two IN-STREAM partners, Ecologic and IEEP, were the lead organisers for the Beyond GDP conference and a third (FEEM) was represented there.

During the three years of the project the process of going "Beyond GDP" has won further impetus from the fallout of the economic crisis. Many organisations (OECD, UNEP and others) have created indicator systems to measure Green Growth. The European Commission published the communication "GDP and beyond Measuring progress in a changing world" based on the recommendations of the Beyond GDP conference and the French government commissioned a high level committee led by Sen/Stiglitz/Fitousi to develop better Measurements for Economic Performance and Social Progress.

Objectives

The IN-STREAM project will undertake the qualitative and quantitative assessments necessary for linking mainstream economic indicators with key well-being and sustainability indicators, thus providing needed insight into the synergies and trade-offs implicit in Europe's simultaneous pursuit of economic growth and environmental sustainability. The project has the following key objectives:

Qualitative analysis objectives

1. Evaluate key indicators and indicator efforts. Research will result in a summary evaluation of mainstream economic indicators (especially GDP) as well as selected measures designed to incorporate sustainability concerns (especially environmental ones). Policy makers and researchers need a guide to what is feasible, what is useful, and how indicator efforts can be adapted to supplement the national level data collection that Eurostat and national governments currently undertake. Of particular interest for the assessment will be the ability of mainstream economic indicators to assess progress towards the objectives of the SDS, as well as the ability of sustainable development (SD) indicators to yield insights into the economic implications of pursuing sustainable development.

2. Evaluate institutional needs and opportunities. Central to the qualitative analysis will be an effort to understand the key drivers and obstacles to institutional adoption of the reviewed indicators. Through stakeholder participation and outreach activities, the project will seek to increase the level of knowledge and acceptance among key policy makers and statistical offices of an integrated approach to assessing economic growth, human well-being and sustainable development. It will also help clarify the way forward, developing a road map for development at EU level with insights from national practice.

Quantitative analysis objectives

1. Improve quantitative models linking indicators. The project will build on previous modelling and statistical work that has attempted to bridge the gap between macroeconomic indicators and sustainability measures, particularly the GARP, GREENSTAMP, GREENSENSE (FP5), and MOSUS (FP5) projects, as well as the more recent research efforts INDI-LINK (FP6) and EXIOPOL (FP6).

2. Assess the costs of reaching sustainability targets. Using the models developed in the project, future value estimates for selected Member States will be generated, using both partial and

general equilibrium techniques. The analyses will estimate the expected costs in traditional economic terms of pursuing targets for selected sustainability indicators.

Summary evaluation objectives

1. Recommend composite indicator approaches and implementation strategies. Based on the qualitative and quantitative analyses, recommendations for new indicator approaches will be proposed. Recommended indicators (and sets of indicators) will be those that perform best in terms of their robustness, feasibility and suitability to EU policy objectives. Strategies for implementing these approaches will be identified and developed in consultation with stakeholders. The recommended indicator approaches should not only aim at complementing GDP in policy debate but also at establishing links with the Lisbon and Maastricht criteria.

Project Results:

1 Introduction - Measuring Sustainability in Policy Making

1.1 Sustainability Indicators and their use in the policy process

There is an increasing recognition of the need for policy to be driven not only by economic and financial motives, but also by wider sustainability concerns. In the pursuit of economic development, natural resources and environmental quality are degraded, undermining the foundations of socioeconomic development over the long term.

Several initiatives aiming to stir policy making away from narrow economic motives have been carried out in the past decade. The European Union, inter alia, stated its commitment to integrating economic indicators with sustainability principles at the 'Beyond GDP' conference. Its related Communication (COM(2009) 433) formalised a system of 'environmental accounts', and the EU recently unveiled its Strategy 'Europe 2020: A strategy for smart, sustainable and inclusive growth' (EC, 2010), which aims to turn the EU into a smart, sustainable and inclusive economy. At Eurostat's 2011 conference, Environment Commissioner Potoc?nik stressed the need to develop indicators to monitor progress on green growth, green public procurement and eco-innovation, as well as to improve the measurement of natural capital and its eco-system services. Sustainability indicators are therefore emerging as crucial tools to inform policy making.

IN-STREAM seeks to link sustainability measures with mainstream economic indicators and aims to integrate those sustainability measures with policy making where sustainability concerns currently do not get the attention required.

Part of the IN-STREAM analysis was dedicated to exploring the policy needs and opportunities of an increased use of sustainability indicators for selected policy areas, and providing guidance on how these could be adopted at different phases of the policy development process.

An analysis across three broad topics (biodiversity, resource efficiency and green growth) and a number of related policy areas (biodiversity, agriculture, fishery, resource efficiency, climate change and cohesion policy) identified in which stages of the policy cycle indicators can be particularly useful, and what type of support they can provide to each step of policy development.

The policy cycle proved to be a useful approach for understanding and improving how sustainability indicators can support the policy making process. By breaking down policy development into clear, distinguishable stages, the decision making process becomes more understandable, allowing for useful comparisons and analyses of distinct stages and helping to identify weaknesses and opportunities in each step of the policy making process. This, complemented by the DPSIR model (Driver-Pressure-State- Impacts- Response), can also help clarify what type of indicators have been used so far and for what purpose, and how they should develop in the future.

The policy cycle approach also is helpful for understanding the key criteria which sustainability measures have to fulfil to be useful to policy makers. These key criteria differ substantially according to the phase of the policy cycle.

Problem identification: Indicators can support policy makers who would like to gain a clear overview of the nature and the scale of problems raised by stakeholders. To be useful in this policy phase, indicators have to be well-known and their importance recognised by the general public. Policy makers often need to make a case for action to the public, therefore it is crucial that the general public (including the media) recognises the relevance of the indicator used to justify action. Media analysis conducted during IN-STREAM has shown that most sustainability indicators are not well known to the public. This could be one reason why sustainability concerns do not always get the political attention they deserve.

Objective setting: There is increased pressure on policy makers to define quantitative objectives for any intended policy change. For example, policies aiming to halt biodiversity loss, halt ecosystem service losses and improve restoration of natural areas, as well as the new interest in green infrastructure, all require additional inputs in biodiversity indicators in order to appropriately define their objectives. In particular, the importance of ecosystem service indicators is increasingly recognised. These should be taken into account in several policy areas, besides biodiversity and nature related policies. To achieve this, policy makers need indicators that are available over time and for different countries, as comparisons across time and areas might support and justify the setting of ambitious, yet reasonable, targets.

The issue of ecological thresholds and tipping points is also of concern. Sustainability indicators have a key role to play, as they can inform about the proximity of such thresholds and the speed at which we are reaching them, and therefore help develop adequate policies to prevent trespassing them. The recognition of the over-exploitation of EU fisheries, for instance, underlines the importance of having good indicators to measure stock, determine sustainable yields, set targets and monitor progress, as well as to measure the performance of the Common Fisheries Policy. In this regard, internationally comparable data are particularly useful, as dangerous developments in a single country can be identified and acted upon.

Impact assessment: To increase public scrutiny of policy proposals some Member States and the European Commission have introduced obligatory quantitative policy assessments and/or impact assessments for policy proposals. On the one hand this quantitative focus can improve the transparency of assessments. On the other hand, it can reduce the attention paid to the costs and benefits of policies that are not easy to quantify, because within the framework of a quantitative assessment, qualitative assessments are often neglected. Such a lack of recognition can hurt sustainability; very often environmental damages and social impacts are more difficult to quantify because they are indirect and complex.

In order to carry out such assessments, the use of meaningful indicators that capture the environmental, social and economic dimensions of a given policy proposal is crucial to making informed decisions.

The impact assessments of several EU and national policies already take into account some sustainability indicators. Arguably, there is still a relatively strong emphasis on economic performance and administrative burdens, which may overshadow the measurement of environmental and social impacts. Additionally, there is currently a lack of harmonised guidance on the type of indicators to be used at different levels of the impact assessment. It will be therefore helpful to define a common set of useful indicators, which should ideally take into account the indicators already used at EU and Member State level and the data available.

The EU statistical office's development of 'environmental accounts', which build on the system of integrated environmental and economic accounting (SEEA), appears to be a step in the right direction towards measuring the potential impact of economic and social activity on the environment.

Appropriate assessments which make use of sustainability indicators can also have a significant impact on the allocation of future funding. For instance, the EU Cohesion Policy would particularly benefit from appropriate ex-ante and ex-post assessments of funding decisions. The Cohesion Policy's focus on economic development, particularly growth and jobs, has arguably granted more importance to the use of economic and employment indicators (e.g. GDP, competitiveness and jobs) at the expense of other sustainability indicators. Recently, it has been stressed that its effectiveness should be improved through, inter alia, more result-focused programming and increased emphasis on evaluation and indicators (EU Presidency, 2011).

Policy monitoring: When a policy is enacted, indicators are used to measure the success of the policy or strategy. For example, in order to monitor the achievement of the ambitious EU climate change targets, sustainability indicators have a crucial role to play, especially those measuring GHG emissions, energy intensity and the share of renewable energy consumption in total final energy consumption.

Overall, the IN-STREAM analysis reveals that there is currently a fair amount of indicators that focus on state and pressures, while fewer metrics are used for measuring impacts and responses. As a result, indicators seem to be used especially in the early phases of the policy cycle, e.g. for problem recognition and decisions on policy options. Our assessment suggests that there is scope to use them further, especially in the later stages of policy development. Monitoring and ex-post analyses should arguably be improved, both at EU and Member State level, in order to assess the effectiveness of policies. Sustainability indicators will be essential to make sure social and environmental considerations are duly taken into account.

1.2 Key weaknesses of mainstream indicators in measuring sustainability

While on one hand it is crucial to make sustainability measures more attractive to use, on the other hand it is very important to understand exactly where widely-used mainstream economic indicators are failing to capture all dimensions of sustainability. The proponents of GDP very often claim that although the later does not measure social and environmental issues, increases in GDP are very often closely related to progress in environmental and social areas. A discussion of sustainability indicators begs for an account of the failures of GDP to be used as such a tool. To identify those failures, value judgements are very important as the definitions of well-being and sustainability obviously determine the right way to measure both concepts.

The discussion on the failures of GDP is nearly as old as GDP itself but in recent years the debate about the correct measurement of economic and personal welfare has received a substantial new impetus partly from the fall-out of the financial crisis. An important starting point was the Beyond GDP conference in the autumn of 2007 where over 650 participants came together to discuss how measures of progress, true wealth, and well-being can be improved and integrated into decision-making. The conference featured high-level speakers, like Hans-Gert Pöttering, President of the European Parliament, and José Manuel Barroso, President of the European Commission. Based on this success the Commission published the communication "GDP and Beyond Measuring Progress in a changing world" in August 2009 , identifying a number of actions to be taken in the short and medium term.

In addition to these activities from the European Commission, in 2008 the French government assembled a high profile commission led by Joseph E. Stiglitz, Amartya Sen and Jean-Paul Fitoussi which published important conclusions on the key failings to address in measuring economic, social and environmental welfare. Especially influential was the succinct summary of the key failings of GDP as a welfare measure, which has become for many scientists a reference point to structure the broad Beyond GDP discussion.

The recommendations developed by the European Commission and the commission of the French government have now been taken up by many national and international organisations (EUROSTAT, the OECD, national statistical offices, several FP7 funded research projects to name but a few) and, currently, significant work is seeking to improve existing indicators and to create new indicators that better reflect all dimensions of sustainability. IN-STREAM sees itself as part of this broad undertaking, contributing to very specific problems in the measurement of economic, social and environmental welfare.

The discussion on improving the measurement of economic, environmental and social welfare is very wide but we would summarize the key challenges in the following points.

- Flow versus stock: As an indicator measuring financial flows the GDP neglects any changes to stocks. This means that changes to financial wealth are ignored as much as any changes to environmental or social capital.
- Environmental damages: Environmental damages or impacts are not reflected in GDP as far as they have no market prices. Accordingly, policies focused on GDP growth are likely to discount environmental costs of economic growth.
- Production versus consumption: As consumption is more closely related to well-being than production, a well-being indicator based on consumption levels would be superior to GDP.
- Income distribution: It is also criticized that GDP does not take income distribution into account assuming thereby that income produces the same amount of welfare however distributed.
- Social sustainability: Many commentators also demand the development of better indicators for social sustainability. Currently it is not possible to capture important dimensions of "social capital" like community cohesion, political voice or safety, which are known to influence well-being.

Even though there is a relatively broad consensus among commentators about these deficits, there is still no emerging consensus on whether all these extra dimensions of sustainability should be merged into one common sustainability indicator or whether a suite of indicators would be preferable. Frequently, policies that aim mainly at economic sustainability (e.g. cohesion policy aiming at regional economic growth) have significant environmental and social impacts that have to be reflected in policy decisions. Whether those policies would be better measured using composite indicators including all three dimensions of sustainability, or using a suite of indicators, is still controversially discussed.

Currently, there is a lack of understanding of how society can create well-being from economic and environmental resources and how these processes and institutions can become unsustainable over time. This reinforces the oversimplified view that sustainability is an environmental and economic issue. However, for society to be able to maintain well-being into the future, social functions must be monitored and encouraged. It is therefore important to pay attention to the indicators that demonstrate how society's capacity to produce and distribute well-being is changing, such as crime rates, inequalities, youth unemployment, and social mobility.

The Beyond GDP Agenda is very wide and any project can only hope to take forward some parts of the agenda while necessarily neglecting others. IN-STREAM focused on addressing the following areas:

- Dissemination: The IN-STREAM team has worked on facilitating the use of sustainability measures by policy makers by analyzing the needs of policy makers, assessing the strengths and weaknesses of existing indicators and analysing statistical relationships between different indicators.
- Aggregating and balancing of tradeoffs: Additionally, the IN-STREAM team has developed a composite indicator of sustainability based on computerized general equilibrium models, with the key objective of showing the additional informational capacity which such an indicator can bring. Furthermore the team has modelled the impacts of environmental policies on competitiveness to show the tradeoffs and synergies between environmental, social and economic sustainability targets.
- Environmental Damages: Lastly, the research consortium has modelled and valued the costs and the benefits of environmental policies to human health and ecosystem preservation.
- In order to ensure that the results are useful to policy makers, three policy fields or story lines were chosen as examples for potential applications of IN-STREAM results. For each policy field, one stakeholder workshop was conducted to understand the concerns and expectations of policy makers in the field and to discuss the IN-STREAM results with them.
- Biodiversity: The COP convention in Nagoya in 2010 set an ambitious agenda for Biodiversity policy, and to achieve this, biodiversity indicators have to be more widely available and more widely used not only in biodiversity policies but also in other policies affecting biodiversity.
- Green Growth and Green Innovation: The fallout from the financial crisis has sharpened the need to balance different objectives in policies aiming at green growth. Various international organisations have analysed how to measure success in multi-objective policies like green growth.
- Resource Efficiency: One part of the green growth agenda which currently receives more attention is the resource efficiency agenda. One important precondition of success in reducing resource use in the EU will be to make progress in measuring resource use and the environmental impact of resource use. For this report, resource use was summarized under the green growth heading.

2 Composite Indicators to measure sustainability

2.1 Policy monitoring with composite indicators

The possibility to develop synthetic measures of sustainability through aggregate or composite indicators is one of the most debated topics in sustainability literature. On the one hand indices simplify the complexity, and summarize the relationship among the variables. They also facilitate communication to decision makers. On the other hand any step in their construction - the choice of indicators to include, the "weights" to assign to each, the aggregation procedure - are prone to subjectivity, no matter the effort made. Therefore, many criticisms can be perfectly legitimate and correct.

Against this background, part of IN-STREAM's methodological quantitative research aimed to: (a) explore the potential/value added of composite indicators to monitor sustainability in business as usual and policy scenarios (b) investigate if and how economic modelling tools could support this analysis.

These issues have been addressed by applying a recursive-dynamic general equilibrium model for the world economic system (the Intertemporal Computable Equilibrium System (ICES) model) to a reference (no-policy) and an emission reduction scenario where the EU unilaterally cuts its GHG emissions by 20% by 2020 with respect to levels of 1990. This can be considered the "climate-change component" of the Europe 2020 strategy. 23 sustainable development indicators belonging to the three pillars of sustainability (economic, environmental and social) have been extracted from the model output and compounded into an innovative sustainability index: the "FEEM" sustainability Index (FSI).

This exercise highlighted that the use of a composite indicator can be an invaluable communication/investigation device by making the preference structure and value judgments more transparent, including the relations between the different components of sustainability. It can also offer the opportunity to investigate in depth how and if this assessment can change when those preferences and values change. This information can be very interesting to policy and decision makers and particularly needed when complex policy implications are involved, like in the case of climate change policies. Rather than providing un-controversial and subjectivity-free unifying measures of sustainability, which is not possible no matter how comprehensive, complex and innovative composite indicators are, their correct use should be that of unfolding the complexity and explicating values. In this respect, transparency of construction of an index is its most important feature.

These properties are strengthened if composite indicators are used in combination with modelling approaches. On the one hand, the internal consistency of a mathematical structure allows "by construction" a coherent integration of different dimensions of sustainability inside an index. On the other hand, the possibility of conducting forward-looking simulations allows one to assess the implications for sustainability in different (BAU or policy) futures. That is, sustainability can be estimated ex ante and not only ex post. This can be appealing to a decision maker.

In this particular context, the use of CGE models presents two specific advantages: their large database makes it possible to calculate the indicators for several regions and sectors; their explicit modelling of market interactions and international trade is ideal for capturing how potential tradeoffs in sustainability originate and propagate through the economic system.

This said, the use of composite indicators and modelling approaches has to be considered just as a possible enrichment to the standard analysis of sustainability, particularly helpful for capturing quantitatively and explicitly the relations between a limited number of its very different parts. Indeed, the multifaceted nature of sustainability can be only partially encompassed by a model or an index, and the synthesis they provide suffers from all the limitations of the model and of the index themselves. For instance, when CGE are involved, limits are the full equilibrium view of the economic system, the assumed instantaneous often costless adjustments to that equilibrium, the crucial dependence of results on the calibration process, the simplified dynamics, the difficulty in dealing with non market values, and the "weak" representation of the environmental and social component. As such, models and indices should be considered support instruments within an ampler toolbox for a multi-criteria assessment.

More information on the "FEEM sustainability Index" is available at http://www.in-stream.eu/download/INSTREAM_FSI_final.pdf.

2.2 Setting the right targets for multi-objective strategies - Europe 2020

Policy makers who set targets for multi-objective strategies like Europe 2020 have to solve an important dilemma. On the one hand they should not choose too many different targets as this will reduce communicability and accountability. On the other hand setting no targets for important parts of a large set of objectives could skew the attention and the effort of policy makers towards objectives with quantitative targets attached to them.

Policy makers can solve this dilemma if they have good information on the statistical relationships between different indicators. This will enable them to choose the lowest number of indicators which provide sufficient coverage of the objectives of the policy or strategy.

Correlation analysis or other statistical methodologies, which only require a limited analytical capacity, can support policy makers in this task. Analytical tools for statistical analysis include correlation analysis and advanced statistical techniques such as Principal Component Analysis (PCA) resulting in a variety of data patterns using scatter plots and bivariate correlation analysis, time series patterns, as well as PCA and Cluster Analysis (CA).

The methodology is very flexible and can be used to test all types of indicators and targets for multi objective strategies or policies. For example Europe 2020 has set 8 targets for 2020 aiming at environmental, social and economic sustainability:

- Increase the employment rate to 75% of the 20-64 year old
- Increase R&D spending to 3% of European GDP
- Reduce Greenhouse emissions by 20-30%
- Increase the share of renewable energy production to 20%
- Improve energy efficiency by 20%
- Reduce school drop-out rates to below 10%
- Increase the rate of 30-34 year old completing third level education to 40%

- Reduce the number of people at risk of poverty by 20 million

Lessons can be learned from the analysis conducted by IN-STREAM on the choice of a set of indicators and on the interpretation of the indicator results.

GDP and Energy Efficiency: Correlation analysis between GDP and energy intensity (which is the inverse of energy efficiency) show that generally, energy intensity is negatively correlated with GDP growth meaning that energy intensity decreases (and energy efficiency increases) with rising GDP (as GDP is the denominator of energy efficiency). However, the differences among countries are significant. While in some countries the negative correlation is strong in others it is very weak. This can be used to identify countries with good practice (that have achieved some success in decoupling GDP growth from energy use) and focus countries (where no decoupling has been achieved and so policy actions would bring more significant rewards). It is worth noting that decoupling can occur for reasons unrelated to policy like the changing industrial structure of an economy. Statistical analysis should not replace more detailed analysis, but it can give a first indication where to look for good or bad examples. The results additionally can be used for the process of setting national targets. A time series analysis can also reveal whether the overall target is ambitious enough (or too ambitious) as the correlation can be used to calculate energy efficiency under different GDP growth scenarios.

Employment - unemployment rate: The Europe 2020 set of indicators does not include a very important social indicator: the unemployment rate. Obviously the employment rate is very much correlated with the unemployment rate but from a social point of view one might well argue that this does not suffice as labour markets could be very successful in creating jobs in general, nonetheless leaving some behind due to regional or skill imbalances. The analysis found that there was indeed a very strong negative correlation of employment rate and unemployment rate, and even more interestingly, that this negative correlation was even stronger between employment rate and the long term unemployment rate. In view of this strong correlation, the omission of the unemployment rate from the indicator set is not perceived as such a problem even from a social point of view.

At risk of poverty rates versus long term unemployment rates: To really understand the relationships of the economic variables and the social variables, it would be advisable to test the correlation between the long term unemployment rate and the risk of poverty rate. The time series analysis shows that many European countries have achieved serious drops in the rate of long term unemployment in the last decade (at least before the financial crisis set in). For many of those countries this has contributed to a drop in the risk of poverty rate, but for some countries the correlation was much weaker or even negative. This analysis delivers important messages to policy makers; in some countries the relationship might be weak because poverty is mainly concentrated in households outside the working age, or because low wages do not offer enough protection from poverty. This signalling can be used both for national target setting and for the formulation of specific policies aiming to achieve the Europe 2020 targets.

GDP and resource use: Another example of the signalling function of statistical analysis would be the relationship between GDP growth and resource use. Currently the Europe 2020 targets do not include a target on resource use, but such a target is expected to be adopted in the next year. Correlation analysis can be used to provide overview information for the negotiations of such a target. Generally, there is a strong positive correlation between resource use and GDP growth, but there are significant differences between nations. For example the scatter plot of ecological footprint and per capita GDP shows that some countries with an ecological footprint of 4 reach per capita GDPs of more than $50,000 while other countries using as many resources, display a GDP of only $10,000 per capita.

The plot also points out that for countries with an average per capita GDP nearing $20,000, some have an ecological footprint of 2 while others reach a footprint of nearly 6. These differences can both help set an ambitious agenda (as they show the values that other countries have achieved) and to nationalise these targets.

This statistical analysis cannot replace an analysis of the causalities between the different variables as they only provide first indications where tradeoffs and synergies between objectives can be found and where to look for good and bad examples. This being said, it becomes apparent that they are more appropriate in the first phases of policy making. The later stages such as impact assessments or evaluations will require a more refined set of tools. For example, they are useful tools that can help build a comprehensive and small set of quantitative targets for any policy. Relatively non-time consuming, they can be used even in policy processes with significant time pressure and can help to set more consistent and ambitious targets in multi objective policies.

More information on the statistical analysis of indicators is available at http://www.in-stream.eu/download/WP3_Deliverable3.2_FINAL.pdf

3 Measuring Green Growth and Green Innovation

Even though not explicitly named a green growth strategy, the European Commission's Europe 2020 strategy has green growth at its heart. This strategy for smart, sustainable and inclusive growth aims to improve the European competitiveness, increase job creation and improve the innovation potential of the EU, while explicitly aiming to reduce the environmental impact of this growth by, for example, moving to a "low-carbon economy". In this respect, green growth is a very important subset of overall sustainability. While green growth aims to reconcile environmental and economic well-being, an overall view on sustainability would add the social dimension of sustainability to this assessment. Many commentators would even argue that social sustainability is also a necessary component of a green growth framework. Very often the three pillars of sustainability are closely connected. For example: job creation is crucial both for economic and social well-being, and a reduction in air emissions can be important both for environmental as for health reasons.

The question of how to measure progress towards green growth and how to balance the different objectives in the green growth agenda is also at the center othe OECD Green Growth Strategy as published in May 2011 . The strategy focuses on setting a policy and measurement framework for green growth but also discusses strategies to promote green growth. The strategy points out that it is necessary to adress social issues caused by green growth strategies like distributional impacts and labour market implications. Notwithstanding some commentators' reluctance to include these social issues into a green growth agenda, an acknolwedgement and mitigation of these social impacts is seen as crucial for the political success of green growth strategies. This focus on all three pilars of sustainability can also be observed in the choice of indicators, where social indicators feature heavily beside the economic and environmental indicators.

The IN-STREAM work summarized in this chapter is working according to the same agenda. The research conducted in IN-STREAM shows how the different objectives of green growth strategies can be monitored and reconciled by:

- evaluating indicators to choose the right indicator set;

- modelling impacts of environmental policies on competitiveness and job creation;
- valuing environmental benefits of policies in order to make them comparable with potential economic costs;
- estimating the impact of biofuel targets on land use;
- and assessing the distributional impacts of emission reduction policies.

3.1 Choosing the right indicators with qualitative assessments

Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies (OECD 2011). Therefore, a green growth strategy is centred on mutually reinforcing aspects of economic and environmental policy. It takes into account the value of natural capital and environmental pressures. Several EU and international agreements (the latest being Cancun (2011)) recognise the need to reduce emissions and provides the foundations for long-term global action.

Within this context, GHG emission (per capita/in levels) and energy intensity are commonly considered key structural indicators and are also part of the Europe 2020 indicator set. Accordingly, they have been considered particularly appropriate candidates (together with others, see IN-STREAM D2.2 and D4.1) to undergo a thorough qualitative analysis to provide both a practical application of qualitative procedures in indicator selection and to test the properties of the indicators themselves.

GHG emission reduction: GHG emissions are considered the most important structural indicator of climate change pressure, given their direct contribution to global warming, depending on specific heat absorptive capacity and lifetime in the atmosphere. According to Global Warming Potentials (GWP), different GHG emissions can be converted into CO2 equivalents and aggregated into a single figure. This composite indicator is thus able to summarize all the anthropogenic GHG covered, for instance, by the Kyoto Protocol from 1990 (base year) onwards. Several countries have used environmental indicators to monitor their progress towards international and national policy targets as required by UNFCCC since 1992 for countries listed in Annex I. Following the RACER analysis (see box at the end of the section), the GHG emission indicator is relevant and commonly accepted (has a strong link to the environmental component of sustainable development and is largely used in international and EU policies). Moreover, (EU Member) states can evaluate their progress towards meeting required reductions, track the timeliness, consistency and comparability of relevant policies and are encouraged to report the presence of implementation problems. Thus it is also credible (highly connected to its methodological and explanatory transparency) and easy (data are available, it is technically feasible and show complementarities with other indicators). Robustness is proven by statistical validation and its transparency.

Energy intensity and efficiency: Reducing energy consumption and eliminating energy wastage is an important objective pursued by the European Union and is the focus of the June 2011 "EU Energy Efficiency Directive MEMO/11/440, 22" (EU, 2011). Energy intensity is the indicator most often used as a proxy for developments in energy efficiency, but the two concepts are not exactly the same. The energy intensity indicator describes how much energy is needed to produce one monetary unit of value (GDP or value added or sectoral production etc.). Measuring energy/GDP allows one to capture in a synthetic way where there is a "decoupling" between final energy consumption and the economic performance of a country, sector or process. A shift towards "decoupling" is generally seen as indicating a relative decrease in pressures on the environment from energy production and consumption. Energy efficiency is a narrower and more technological related concept (OECD/IEA 2009). For a sector or a firm, increasing energy efficiency means a decrease in energy consumed per unit of goods or service produced ("technical energy efficiency"). For a country, energy efficiency measures the amount of energy consumed per unit of output produced (IDDRI 2011). The Climate Change and Energy Package (COM(2008)16, 17 and 19) includes a 20% target in increasing energy efficiency. It is therefore an "absolute energy savings" target. Following the RACER analysis, the energy intensity indicator is relevant (has a strong link to sustainable development) and commonly accepted (it is partially used in EU policies). It is credible, easy and robust but it needs the support of other indicators for a better explanation of energy use.

The qualitative analysis is completed by a strength and weakness assessment (SWOT see box at the end of the section) of the two indicators. Notwithstanding their pros, (relevance, acceptance, credibility, relative easiness and robustness) they present some drawbacks.

Firstly, being pressure indicators, they do not reflect damages. GHG emissions for instance cannot per se capture effects of emission on human health. Or an increase in the "technical energy efficiency" does not always imply sustainable energy use as it can well be coupled with increased energy demand (rebound effect). For instance, the fact that the "rebound effect" might undermine the effectiveness of the energy package in achieving its objective has not been sufficiently acknowledged to date, resulting in a slight mismatch between the overall target set and the means to achieve it (IDDRI 2011).

Secondly, being often used "in aggregate" to summarize different information at the country level, they share part of the deficiencies of composite indicators. When GHG emissions are concerned for instance - given that each source has its specific carbon content, each sector a specific fuel mix and each country is more intensive in some sectors than others - a breakdown of the indicator into sector and fuel specific component can better help to tailor more effective policies.

Similarly, an energy intensity indicator at the country level is not informative on changes in energy mix and on developments of clean technologies.

The major conclusion of this analysis is that the choice of indicators surely needs to be based on criteria of relevance, acceptance, credibility, easiness and robustness. However, these are necessary but insufficient conditions to get the desired information on sustainability. On the one hand, the analysis and the indicator used should be carefully tailored to the policy investigation performed. On the other hand, even though the area of interest may seem very narrow and the indicators chosen very appropriate, it is often useful to complement the analysis with additional indicators to avoid misinterpretations.

More information on the qualitative assessment of sustainability indicators is available at http://www.in-stream.eu/download/D2.2_final.pdf.

Assessment Methodologies:

In the qualitative assessment of the selected indicators, the INSTREAM project applied two methodologies, RACER and SWOT, described below.

RACER evaluation framework has been developed by the European Commission , for assessing the value of scientific tools used in policy making processes. RACER is an acronym for:

- Relevant = closely linked to the objectives to be reached
- Accepted = by staff, stakeholders, and other users
- Credible = accessible to non experts, unambiguous and easy to interpret
- Easy = feasible to monitor and collect data at reasonable cost
- Robust = not easily manipulated

The INSTREAM project enriched the RACER approach with additional sub-criteria to tailor it to indicator analysis.

SWOT analysis is a tool usually applied to assessing an organization's, business' or program's ability to achieve a stated objective. It evaluates the internal and external factors that influence the probability of success of the objective . Applied to indicator analysis, SWOT is an acronym for:

- Strengths: Positive aspects of the indicator. The "core" strengths are the strongest aspects and main advantages of the indicator and the "important" strengths are those strengths that are highly significant but that may be shared with a host of other indicators.
- Weaknesses: Negative aspects of the indicator. The "critical" weakness may preclude implementing the indicator at an EU level. The "important" weaknesses limit the usefulness of the indicator
- Opportunities: Those aspects of the institutional, political, intellectual and technological environments that could help improve the indicator, lead to its successful adoption, or both.
- Threats: Those aspects of the institutional, political, intellectual and technological environments that could hinder the successful adoption of the indicator.

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3.2 Emission reduction policy and competitiveness

At the sixteenth United Nations Climate Change Conference in Cancún, the world community committed itself to the objective of limiting the rise in global average temperature to no more than 2° Celsius above pre-industrial levels in order to hedge against dangerous anthropogenic interference with the climate system. According to scientific knowledge compiled by the Intergovernmental Panel on Climate Change in its Fourth Assessment Report, this implies that over the next decades global greenhouse gas emissions must be halved from their 1990 emission levels. To date, however, prospects for a Post-Kyoto agreement covering all major emitting countries are bleak. Even in the case of a broader follow-up agreement to the Kyoto Protocol, it is much more likely that emission reduction targets will be quite unevenly spread across the signatory regions with OECD countries taking a lead role reflecting their historical responsibility and higher ability to pay.

One-sided commitments to ambitious emission reduction targets raise competitiveness and emission leakage concerns in all the major economies implementing or proposing unilateral responses to the threat of climate change. At the fore of climate policy discussions, competitiveness and leakage concerns refer in particular to the performance of energy-intensive and trade-exposed (EITE) industries. Obviously, unilateral emission pricing of domestic industries where emission-intensive inputs represent a significant share of direct and indirect costs will put these sectors at a disadvantage compared to competing firms in countries abroad which lack comparable regulation. The loss in competitiveness is to some extent associated with the potential for emission leakage, i.e., the change of emissions in non-abating regions as a reaction to the reduction of emissions in abating regions.

Leakage can arise when energy-intensive and trade-exposed industries in emission-constrained regions lose competitiveness, thereby increasing emission-intensive production in unconstrained regions (the trade channel). A second important leakage channel works through international energy markets (the energy channel): Emission constraints in larger open economies reduce the demand for fossil fuels, thereby depressing world energy prices which in turn lead to an increase in the level of energy demand in other regions. Competitiveness and leakage concerns have motivated claims for special treatment of energy intensive and trade-exposed sectors ranging from reduced emission prices or output-based emission allocation to border carbon adjustments.

A prime example of the competitiveness and leakage issues at stake in unilateral climate policy is provided by the European Union (EU) which considers itself as a leading force in the battle against anthropogenic climate change. During the Spring Summit in March 2007, the European Council agreed upon an ambitious climate policy with unilateral greenhouse gas emissions reductions in 2020 by at least 20% compared to 1990 levels. But as described above this is only one of the targets of the Europe 2020 agenda, which also stipulates employment growth, social objectives and other environmental targets. The simultaneous pursuit of environmental and competitiveness objectives has led to the preferential treatment of EITE industries in EU climate policy. The aggregate EU emission reduction is divided between energy-intensive sectors - of which EITE industries are a subset - covered through an EU-wide emission trading system (the so-called EU ETS) and the remaining parts of the EU economy (without direct trade linkages). Mirroring competitiveness and leakage concerns, the emission reduction requirements for ETS sectors have been relatively lax compared to the reduction targets for non-ETS segments of the EU economy which effectively boils down to preferential emission pricing of EITE industries .

While the issue of competitiveness ranks high and has tangible implications for the design of unilateral emission regulations, the climate policy debate lacks a rigorous clarification of competitiveness notions and a comprehensive quantitative analysis of policy proposals that respond to competitiveness concerns of specific industries. In the assessment of unilateral EU climate policy, the bulk of competitiveness research is skewed towards a partial equilibrium perspective focusing on EITE industries that are directly affected by the EU ETS.

The sector-specific partial equilibrium framework allows for neither a comparison of competitiveness implications across different industries nor a simultaneous assessment of economy-wide performance in terms of an overarching welfare metric. General equilibrium analyses of EU climate policies based on multi-sector, multi-region computable general equilibrium (CGE) models emphasize the excess cost of emission abatement induced by emission market segmentation and overlapping regulatory measures rather than the competitiveness and leakage aspects.

In the IN-STREAM project, we analyzed alternative indicators that can be used to quantify specific aspects of competitiveness at the level of sectors and countries. We then used a computable general equilibrium model complemented with selected competitiveness indicators to facilitate the quantitative impact assessment of EU leadership in climate policy. Price discrimination in favour of EITE sectors may be warranted to preserve industrial competitiveness of these politically influential industries. From a broader economic perspective, however, the narrow focus on competitiveness concerns of EITE industries can be misleading. The sector-specific gains of preferential regulation in favour of these branches must be traded off against the additional burden imposed on other industries to meet an economy-wide emission reduction target. Beyond burden shifting between industries, differential emission pricing runs the risk of substantial excess costs in emission reduction as policy concedes (too) low carbon prices to EITE industries and thereby foregoes relatively cheap abatement options in these sectors. From the perspective of global cost-effectiveness, we find that differential emission pricing of EITE industries hardly reduces emission leakage since the latter is driven through robust international energy market responses to emission constraints. As a consequence, the scope for efficiency compared to uniform pricing is very limited. Only towards stringent emission reduction targets will a moderate price differentiation achieve sufficient gains from leakage reduction to offset the losses of diverging marginal abatement cost.

More information on emission reduction policy and competitiveness is available at http://www.in-stream.eu/download/D6.1%20ZEW_Competitiveness%20final.pdf.

3.3 Renewable energy targets and employment

Many studies focus on the assessment of climate policies on a national and international level. However, in countries with a federal system there may be different climate policies in place that, in the worst case, might counteract national policy actions. An example for this is a program by the state government of the German state of Baden-Wuerttemberg to increase the share of renewable energy carriers in electricity generation up to 20 % by 2020. In the case of heat supply, the share of renewables shall be increased to 16 % by 2020.

The findings of a simulation within the IN-STREAM project (with the case of the region of Baden-Wuerttemberg in Germany as an illustrative example) suggest that regional policy actions (e.g. within a member state promoting renewable energy types) do not necessarily create new jobs and additional production for the whole economy. Instead, they induce a structural change of 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 to the rest of the world, these crowding out effects can be reduced and production and employment effects might be positive overall.

This project examined the regional impact of this program by using an input output approach. These impacts are of particular interest because in Baden-Wuerttemberg the manufacturing industries are more important than in the rest of Germany. Thus we analyzed the effects of the policy actions on production as well as employment in several sectors. We therefore constructed a regional input output table of Baden-Wuerttemberg and introduced seven renewable energy types in order to examine different paths for achieving the state government's targets.

We considered two scenarios with different methods for funding 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 taxes which are borne by all other industries and by the households. Therefore, the final demand of all other sectors decreases. In this scenario, we have a slight positive total production effect although in many sectors the production effect is negative. In addition, the total employment effect is negative since the more labour-intensive industries, in particular the manufacturing industries, are affected more heavily from 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. the rest of Germany and the rest of the world. Therefore, investments in other industries are not completely crowded out in this scenario. In this scenario we also find positive production and employment effects for most industries besides the energy sector. Net production and employment effects for aggregate model sectors for this scenario are presented below.

Technically we chose an input output approach for our analysis since the data availability did not suffice to regionally disaggregate the underlying database of a computable general equilibrium (CGE) model. In an input output context the construction of a regional data source is less problematic. Furthermore, it completely serves the purposes of the tasks, i.e. the analysis of regional production, and employment effects can be represented within an input output approach with a similar accuracy as within a CGE framework. Also the sectoral disaggregation of the input output table is not inferior to that of most applied CGE models.

More information on regional labour market impacts of renewable energy targets is available at http://www.in-stream.eu/download/SVI_In-Stream%20D%206.3%20Regional%20indicators%20ZEW%20v2.pdf.

3.4 Distributive impacts of emission reduction measures (CUEC)

Adverse social and distributive impacts have often been considered the main obstacle to environmental regulation. It has been argued that energy taxation, as an example of emission reduction measures, would affect low income households more and may result in fuel-poverty. Although macro structural models, such as CGE type models, assess sectoral impact in detail, the distributive impacts on households are examined only broadly, most frequently through the impact on one household that represents the whole country or region.

One method of assessing distributive effects is to look at the budget shares of various household segments on regulated goods, or goods whose price will be affected by second-order effects. In our study we specifically examine expenditures of Czech households on energy and motor fuel, and find large differences in consumption patterns across household segments.Nobody demands energy or propellants per se, but energy demand is a derived demand that arises from the household's demand for the services supplied by electric appliances, the heating or the cooling systems, or by vehicles. As such, energy is not demanded directly; rather, it is used in a combination with other goods, typically capital goods, to produce the services we ultimately desire. Emissions can therefore be effectively reduced by policy measures targeting relevant durables. Distributive impacts will thus depend not only on pre-policy budget share, but also on whether a certain household possesses the durable or not. We identify several important socio-demographic and housing structural factors that determine the choice of having a private car in Czech households and based on the review of the OECD project on "Household Consumption and Environmental policy" we identify several household segments, which are more likely to possess electric durables and install energy efficient devices.

One can hardly expect household consumption to remain unchanged under a prospective policy's new conditions. Consequently, proper evaluation of distributional effects of policy should not ignore the behavioural responses of individuals on price and wealth changes connected to a policy. To consider the behavioural responses of the consumers, key parameters of household demand have to be plugged into any simulation or prediction model. Using a micro-simulation model for the Czech Republic, embedded with price and income elasticities, we predict the impact of several pricing policies on consumption, expenditures and welfare separately on several household segments.

We highlight that distributive impact assessment based on both household expenditures and the cost of living index can provide useful but different information for decision-makers. Changes in household expenditure patterns may inform a policy maker about the expected fiscal impact and environmental effect, and because the change in expenditures may determine investment in energy saving, the predictions of household energy expenses can serve as a useful indicator for the possible targeting of social mitigation measures and/or for considering a support measure in order to enhance energy saving installations within households. In comparison, the cost-of-living-based measures provide information about welfare loss or benefit induced by intended policy. Overall changes in welfare inform a policy maker about the economic efficiency and desirability of a proposed policy.

Providing predictions on both the expenditure patterns and welfare for several household segments separately is one way to address the distributive impacts. A second approach might rely on measuring indicators on equality. The Gini Index is the most well-known indicator to measure income inequalities before and after the implementation of policy. The Theil Index might be used to measure inequalities within and in between groups. Useful information also exists that can provide a measurement of distribution of tax payments, basically indicating whether taxes are paid evenly, or if there is regressivity or progressivity (eg: the Suits and the Jinonice Index).

Although, the indicators are very policy relevant, in most cases they represent a basic estimate of the true, but unknown, index and, as such, it is a function of the underlying distribution, which is unknown. In reality, we only observe a reasonably appropriate sample from that distribution, in light of which it makes sense to derive the underlying statistical distributions for testing and inference purposes. We document this problem on statistical inference of Gini and Suits indexes computed for the Czech Republic and find that only some changes in the indexes, but not all, are statistically significant.

3.5 Economic effects of sustainability scenarios in land-use and agriculture

The IN-STREAM project has also assessed agricultural sustainability by exploring the linkages among economic and sustainable development aspirations in land-use, specifically in the area of biofuel production. The requirement of climate change mitigation has increased interest in land-based renewable energy sources. This requires an in-depth analysis of all components of sustainable development in a consistent framework: environmental, social and economic. The policy relevance of the quantified sustainability indicators is demonstrated by their suitability for formulating recommendations for environmentally sound agricultural and renewable energy policies.

For the analysis of the global agricultural system, a state-of-the-art ecological-economic modelling framework is applied. It has two major components: the FAO/IIASA Agro-ecological Zone (AEZ) model and the IIASA world food system (WFS) model. An initial baseline assessment provides the point of reference against which alternative biofuel scenarios are compared for assessing their impacts. This reference scenario assumes historical biofuel development until 2008 and thereafter keeps biofuel feedstock demand constant at the 2008 level. Biofuel scenarios explore the impact of different levels of biofuel demand and composition. The simulations were carried out on a yearly basis from 1990 to 2030.

Biofuel scenarios include an overall energy scenario with detailed elaboration of the regional and global use of transport fuels; pathways depicting the role of biofuels in the total use of transport fuels; as well as assumptions about the role and dynamics of second-generation biofuel production technologies and about the fraction of total biofuel production supplied by first-generation feedstocks (based on conventional agricultural crops such as maize, sugar cane, cassava, oilseeds, palm oil, etc.).

The primary intended outcome of the biofuel scenarios is to reduce GHG, mainly CO2, emissions from the global transport sector. Therefore a net reduction of GHGs of the whole lifecycle of biofuel production and consumption, including land use change effects, is imperative for accelerated biofuel deployment. This is reflected in the sustainability criteria being established for biofuel use. Land conversion and changed land management practices to produce biofuel feedstocks (direct land use change) and displacing agricultural activities to other areas and causing land use change somewhere else (indirect land use changes) due to regional development induced by biofuel initiatives can lead to both carbon losses or gains in the biospheric carbon stock. Of particular concern for greenhouse gas impacts is conversion of carbon-rich habitats such as forests, natural grassland, or wetlands to cultivated land.

The net GHG balance of a biofuel scenario (shown in blue, bar "Net GHG balance") is determined by the GHG savings achieved from biofuel replacement of gasoline and diesel (Bar "Biofuel use") minus the GHG emissions caused by direct and indirect land use changes (Bar "Land use change").

Carbon losses from vegetation and soils due to land use changes (deforestation and grassland conversion) occur mainly at the time of land conversion. In contrast GHG savings resulting from the replacement of fossil fuels with biofuels accumulate only gradually over time. For the biofuel scenarios net GHG balances only become positive after 2020. By 2030 the amount of second-generation biofuels increases GHG savings via biofuel use while at the same time only a little additional land use conversion is required. The additional net greenhouse gas savings from the assumed biofuel use for the period 2020-2030 amounts to roughly 3 Pg CO2 emissions, while there are hardly any emissions due to additional land cover conversion, resulting in a net accumulated production by 2030 of 2-3 Pg CO2 emissions.

The biofuel scenarios have important implications for the social dimension of sustainability. Equity and access to food and energy are important concerns in sustainable development. According to the Reference scenario without additional biofuel targets, the number of people at the risk of hunger declines gradually over the coming decades, reaching 807 million people in 2030 and 720 million in 2030. This positive trend is undercut by the introduction of ambitious biofuel targets. Demand for cereals is projected to increase in all biofuel scenarios and, despite expanding arable land to satisfy this demand, cereal prices will increase as well. Higher prices will worsen the access to and affordability of food for the poor.

The number of people at risk of hunger will increase relative to the REF scenario under all biofuel scenarios in all regions of the world. This increase is larger in 2020 than in 2030 because adjustments on the production side (land conversion, capacity expansion, etc.) take time; therefore achieving the 2020 biofuel targets implies diversion of food crops and increasing prices. With more time for production adjustments and for improvements in second-generation biofuel technologies, the pressure on crop prices in general, and on cereal prices in particular, is smaller in 2030, leading to lower but still significant increases in the number of people at the risk of hunger.

The conclusion from the selected results of the biofuel scenarios above is that economic and sustainability characteristics of the global agricultural system are resulting from a complex set of cause-effect relationships. Their assessment requires an in-depth representation of the natural resource base (land, climate, agronomic features) and the socio-economic processes involved in their utilization. This globally connected system involves remote causations in which policies pursued in one region or country affect the conditions (commodity trade and prices) in other regions. The two main implications are that sustainability targets in one region can negatively affect prospects for sustainable development in other regions, and that sustainability improvements in one domain (e.g., GHG emissions reduction) can degrade sustainability characteristics in other domains (e.g., equity and hunger, deforestation). Analysts need to assess these linkages thoroughly so that policy makers can make informed judgments about the benefits and costs of the policy options available to them.

More information on biofuel and land use changes is available at http://www.in-stream.eu/download/Deliverable_6.4.pdf.

3.6 Climate change - Assessment of greenhouse gas emissions

Climate change and its impacts should be accounted for in future political decisions. A possible general measure to reduce climate change impacts is the internationally agreed upon 2 °C target. Reaching this target will entail considerable costs to the economy, which policy makers will need to justify to the general public. The following assessments can be used to estimate the benefits of reaching these emission targets, and to compare these benefits against the costs.

GHG emissions: By observing greenhouse gas emissions, it is possible to compare the actual emissions expressed in CO2-equivalents with a modelled sustainable emission path that resulting in the 2°C target. The model not only includes the dominant CO2 emissions and other GHGs, but also includes as a novel feature the non-GHGs Black Carbon (BC), organic carbon (OC) and SO2. A possible deviance between the sustainable future path (e.g. Europe's contribution to the 2 °C target) and the actual path (in the future) can be depicted. Here, energy-related emissions modelled with the TIMES model are presented; the REF scenario represents a business-as-usual emission path.

Costs distance to target: The distance to target can also be expressed as costs. The difference between the Annual System Costs of the two scenarios thus expresses the avoidance costs for meeting the climate change target. The avoidance costs are relatively minor for the first 15 years of the policy but increase sharply in the later stages.

Total damage costs: The benefits of the avoidance of emissions are the avoided total damage costs of emissions related to climate change. These can be expressed by multiplying the emitted tons of carbon with the damage cost per ton of carbon. Marginal damage costs of climate change are assessed with integrated assessment models.

An extra feature is that avoided damages can be compared with avoidance costs (annual system costs shown above).

Conclusion

The indicator "GHG emissions" is easy to calculate and only minor errors occur. A new aspect is the incorporation of non-GHGs like black carbon (BC), organic carbon (OC), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO2) and carbon monoxide (CO). Two weaknesses of the approach are that, firstly, only a relative comparison to the previous year is possible and that, secondly, there is uncertainty regarding the sustainability of the target path.

With the "distance to target", a sustainable path is visible, but the path has to be calculated by a model, and the 2 °C target is placed and not deviated from research results. The indicator "costs of distance to target" is comparable to other indicators and an aggregation is possible.

The comparison of the avoidance cost of emissions and the avoided damage costs of these emission reductions can give insights into the economic impacts of emission reduction policies. This will help policy makers justify the costs of emission avoidance. Forecasts on innovation have been included in the estimates of costs and benefits, but significant uncertainties remain, as innovation is difficult to predict.

The overall avoidance costs exceed the avoided damage costs if the results are not equity weighted. This result corresponds nicely with the well known fact that many costs of climate change caused by European emissions will not fall on European countries, but on other (mostly poorer) countries outside Europe. A disadvantage of the methodology is that not all damages are included, as they are either not assessable or not yet known.

More information is available at http://www.in-stream.eu/download/IN-STREAM_deliverable-5%201_110727_FINAL.pdf

3.7 Policy Conclusions from Sensitivity Analysis

Simulation exercises in economics, like in other model based sciences (as done in IN-STREAM), depend on the choice of the basic parameters of the model. While these themselves should be well founded on underlying assumptions, only a thorough sensitivity analysis can establish the robustness of the deductions (or alternatively show weaknesses of the approach). In such an exercise, the modeller analyses the measure of variation of key output variables of the model with respect to a sensible variation of input variables. In the case of IN-STREAM, we did a sensitivity analysis for the simulations on economy-wide and sectoral competitiveness indicators (see section 3.3), and on the composite sustainability indicator (see section 2.1).

The results on competitiveness confirm the validity of the results of the IN-STREAM project, with the exception of one indicator, the Relative Trade Balance (RTB) index, which is very sensitive to the underlying assumptions. Across the robust indicators, there are also important differences: while the economy wide Terms of Trade are largely unaffected by the sensitivity analysis, the magnitude of the sectoral indicators apparently depends on that choice.

Regarding the composite sustainability indicators, the construction and use of these indicators raise criticisms and debate. The reason for this is that any step of the process - the choice of indicators to include, the choice of "weights" to assign to each, the aggregation procedure - are subjectivity prone, no matter the effort made. When this is the case, many criticisms can be perfectly legitimate and correct.

As shown by the present exercise, it must be accepted that, notwithstanding the technical feasibility, it is neither possible to un-controversially summarize sustainability in just one figure, nor to rule out the subjectivity of composite indicators. In fact, we have shown that the country ranking proposed by the complex FEEM-Sustainability-Index demonstrates a rather good degree of robustness, especially concerning the positions at the top and at the bottom. Nonetheless, this robustness is far from offering full objectivity and invariance.

Regardless, there are very good reasons in favour of the use of composite indicators. As shown by IN-STREAM research, they can be invaluable communication devices to make the preference structure and value judgments more transparent, originating a given synthetic sustainability assessment. They can also offer the opportunity for an in depth investigation of if and how such an assessment can change when those preferences and values change. In this respect, sensitivity analyses, coupled with the transparency of construction, are key features to apply to composite indicators. All the information gathered can then be of significant interest to policy makers, and can be potentially more important than the synthesis provided.

As a policy conclusion, the IN-STREAM project demonstrated that the robustness and sensitivity of indicators are important criteria for decision makers to examine.

More information on sensitivity analysis of IN-STREAM models is available at http://www.in-stream.eu/download/D6.6a_sensitivity_%20FSI.pdf and http://www.in-stream.eu/download/D6.6b_Sensitivity_ZEW.pdf.

4 Measuring the success of Biodiversity Policies

Biodiversity - the variety of ecosystems, species and genes - is an essential part of the world's 'natural capital', and its conservation and restoration is thus a key environmental priority for the EU. The Economics of Ecosystems and Biodiversity initiative (TEEB, 2010) highlights the link between biodiversity, the health of ecosystems and the often overlooked important goods and services, and the related value that these provide. The TEEB for National Policy-Making (TEEB, 2011), emphasising the need for correct metrics, calls for suitable indicators and accounting frameworks to measure our natural capital, and highlights urgent steps to allow the formation of a solid evidence base for informed policy decisions.

While it is a very complex task to measure all different aspects of biodiversity, over recent years an increasing number of indicators have been developed due to the need to provide manageable information on biodiversity and ecosystem health, pressures leading to its loss and potential impacts on human well-being to policy makers. A recent indicator-based assessment by the European Commission revealed that, whilst some progress had been made, the state and trends of Europe's biodiversity are still a serious cause for concern, with a wide number of ecosystems and ecosystem service flows having degraded in recent years. For instance, some biodiversity-rich areas like grasslands and wetlands are declining, and up to 25 per cent of European animal species, including mammals, amphibians, reptiles, birds and butterflies face the risk of extinction.

The development of indicators has been mainly driven by several key biodiversity policies. This includes the implementation of the Birds and Habitats Directives and the related Natura 2000 network, which are legal cornerstones of EU biodiversity policy. In addition, indicators were adopted to monitor and communicate progress against the global and European commitment to either significantly reducing or halting biodiversity loss by 2010, as well as related actions set out in the Strategic Plan adopted by Parties to the Convention on Biological Diversity (CBD) in 2002 and the EU Biodiversity Action Plan (BAP) in 2006. The targets were not met and it has been highlighted that, inter alia, a major failure of the EU BAP was related to the lack of appropriate indicators and baselines to measure progress .

After the 2010 target was not achieved, new global and European missions, visions and targets were agreed upon in order to achieve the halt of biodiversity and ecosystem services loss, and restore them as far as possible by 2020. At the European level it resulted in the adoption of the new EU biodiversity strategy, which proposes a range of new initiatives that will arguably require a set of indicators to assess their future efficiency. New objectives on losses of ecosystem service and improving restoration, as well as the new interest in green infrastructure, clearly require the development of additional indicators, particularly on ecosystem services. Similarly, the new CBD Strategic Plan (Aichi targets 2011-2020) has initiated discussions on the further development of the basket of indicators applied to measure progress towards the previous plan.

Additional efforts are particularly needed to streamline biodiversity considerations into broader EU and national policies. Evaluations at both the global and European level recognized the insufficient integration of biodiversity into wider policies, strategies and programmes as one of the main reasons for failing to meet the initial targets. Numerous EU policies - for example, the Common Agricultural Policy, Common Fisheries Policy, Cohesion Policy, trade and development policies - have an impact on biodiversity or can benefit from (and sometimes even rely on) ecosystem goods and services. Indicators are essential to ensure that policy makers in other fields take possible impacts on biodiversity into account, recognise its value and quantify the efficiency/effectiveness of integration into different policy areas.

Overall, it is apparent that the importance of biodiversity and healthy ecosystems for human well-being and long term prosperity is increasingly being recognised. The latest developments in EU biodiversity policy, the recent CBD Conference of the Parties (COP) meeting in Nagoya and the strong attention received by TEEB in the EU and globally make the development of adequate means of measurement a very crucial and timely topic.

4.1 Choosing the right indicator for monitoring the EU Biodiversity Strategy

The level of complexity in measuring the different components of biological diversity - species, genetic and ecosystem diversity - poses considerable challenges regarding the construction of policy-relevant biodiversity indicators. It is difficult to derive an indicator that reliably covers all facets of biodiversity simultaneously, and allows for addressing all different challenges in measurement (e.g., reports on a limited number of well studied species from a much larger whole that remains largely unknown). For example, the Red List Index mainly addresses species at risk of extinction, whereas losses of more common species are not captured. In addition, very species-rich taxonomic groups, such as insects, are only poorly covered compared with other groups, such as mammals and birds. Recent efforts have therefore been concentrated on developing and agreeing upon a basket of indicators that complement each other and jointly capture biodiversity's multiple dimensions and potential interactions.

A first set of CBD indicators was adopted in 2004, during the 7th Conference of the Parties to the CBD. The EU followed suit, setting in motion a process for streamlining European biodiversity indicators (SEBI) in 2005, to be linked to the global framework and consisting of an initial set of 26 indicators. The conceptual basis of both baskets thus, to a large extent, followed the content of the CBD and aimed at capturing status and trends of biodiversity, key threats and the sustainable use of its different components.

Amongst the indicators that underwent a qualitative analysis in the IN-STREAM project, the Common Bird Index, Red List index, Favourable Conservation Status (FCS) and Marine Trophic index are all included in the SEBI set of indicators used to monitor biodiversity trends and progress towards EU biodiversity conservation targets. Although it is the principal measure of performance of the Habitats Directive, the FCS indicator has not fully integrated core sets of indicators for policy areas impacting and/or relying on biodiversity, including agriculture, fisheries or cohesion policy. Its long time lag in capturing the impact of policy implementation on biodiversity is raised as one of the main reasons for the failed integration. On the other hand, the Common Bird index is applied as a key indicator for agricultural policy, being perceived as more amendable to change. The Red List index and Marine Trophic index are also used in the context of annual assessments of EU fisheries policy.

However, the examples above also illustrate that so far only a few biodiversity indicators have entered other policy areas. As mentioned above, the insufficient integration of biodiversity concerns continues to be one of the main reasons for failing to meet the target of halting biodiversity loss. This might be linked to a number of limitations that have been identified in relation to the existing indicator framework and need to be addressed. These include, inter alia, the poor representativeness of state indicators, and the limited information captured in the indicators of sustainable use (which do not fully reflect the extent to which fisheries, forests and agricultural ecosystems are sustainably managed). The development of streamlined sets of biodiversity indicators to be integrated into other policy areas could help to support further mainstream biodiversity policy.

Furthermore, the SEBI indicators provide only a limited picture of policy responses to address biodiversity loss and the impact of such responses. The targets and actions of the EU Biodiversity Action Plan largely addressed the implementation of relevant responses, rather than the achievement of a specific status or reduction of impacts. In this regard it markedly differs from the SEBI indicators, which put a stronger emphasis on status and key threats. To inform the selection and design of new policies, indicators should reflect not only where we stand with regard to the targets set, but also why we have met or missed certain targets. Response indicators are essential in this regard. While it is not always feasible to capture multiple dimensions of policy responses into a quantifiable indicator, the development of standardised reporting and analysis could support the application of qualitative indicators of response.

The post-2010 biodiversity policy also marks a shift in emphasis towards ecosystem services and the importance of biodiversity for human well-being. The increased focus on ecosystem services demands suitable indicators to estimate trends in their provision and to provide a more complete picture of ecosystem resilience. It is assumed that the linkage between ecosystem services, biodiversity and resilience is strongest where all the diversity of ecosystem services is captured. However, such indicators are a relatively new tool, currently available for only a fraction of the wide array of services derived from ecosystems . There is a need, on the one hand, to address current gaps through further development of ecosystem services indicators and, on the other, to better integrate the indicators developed by the scientific community into biodiversity policy-making, in order to increase our understanding of the true value of nature.

More information on qualitative assessments of indicators is available at http://www.in-stream.eu/download/D2.2_final.pdf.

4.2 Sustainability indicators for health and ecosystem impacts

Estimation of health and ecosystem impacts allows policy makers to assess the sustainability performance of environmental policies. One major result of the IN-STREAM project is the support for a range of different economic, ecologic and social indicators to analyse different developments with respect to achieving sustainability. Therefore, an assessment of policy measures and technologies requires integration among these three pillars of sustainability. With respect to environmental (and partly social) indicators for measuring sustainable development, the estimation of impacts on human health and ecosystems are the most prominent. Furthermore, the monetary valuation of these damages allows for cost-benefit and cost-effectiveness analysis of policies and technologies and help decision makers to identify (environmental) policy options.

Pressure indicators (e.g. emissions of pollutants) or state indicators (e.g. concentration of pollutants) are often used as environmental indicators. However, these indicators have several disadvantages, e.g. they do not give an indication about the degree of sustainability reached. Only a comparison with values of past years or other countries is possible. Furthermore, there are numerous pollutants and there is no criterion on which to make choices. In addition, no aggregation (to reduce the number of indicators) and no comparison with indicators of other categories are possible. Thus, the focus on pressure and state indicators does not provide a reliable guidance for policy makers with respect to the identification and development of policy measures for emission reduction. Instead, pressure indicators should be transformed into impact indicators.

The transformation of pressure and state indicators into impact indicators can be done using the impact pathway approach (IPA). The estimated impacts include damage and risk to human health, ecosystems, crops and materials. The IPA takes into account the non-linear relationships between pressures and effects and the dependency on time and site of the activities.

The IPA was developed in the ExternE project series of the European Commission. The impacts of different pollutants are highly dependent on the site of emission and the affected population. Thus the assessment starts with an analysis of the site specific characteristics of the emitting source (height of emission releases, urban or rural source of emissions). Complex models for chemical transportation and transformation as well as studies of impacts of changes in concentrations of pollutants, e.g. epidemiological studies, relate the changes in emissions to impacts on human health and ecosystems. In a final step, these impacts are expressed in monetary terms in order to compare the different impact categories. These impact categories consist of damages to human health, buildings and materials, crop yields and biodiversity. The latest update of the IPA and all its components has been achieved in the recently finished EU-funded NEEDS and HEIMTSA projects.

Health impacts can be aggregated to DALYs (disability adjusted life years). DALYs include the reduction in life expectancy, measured in years of life lost (YOLL) and the reduction in the quality of life due to health impacts measured in years lived with disabilities (YLD). For ecosystem damages, the aggregated impacts can be expressed in PDFs (potentially disappeared fraction of species). PDFs indicate the changes in the number of species in a certain area.

In the original report of the IN-STREAM project (Deliverable 5.1.) 14 different airborne pollutants, including so-called classical air pollutants (NOX, SO2, NH3, NMVOC and particulate matter), heavy metals (As, Cd, Hg, Se) and other pollutants (CO, Benzo(a)pyrene, PAH), have been identified as being relevant for the development of an indicator for human health impacts for the EU-27. For these pollutants, damage factors in terms of mortality and morbidity impacts per tonne of emission have been applied.

For the assessment of ecosystem damages, only three air pollutants have been identified as being relevant for the analysis: NH3, SO2 and NOX. For these pollutants, the impacts on ecosystems in form of biodiversity losses due to acidification and eutrophication were estimated.

The estimated damage factors for human health and ecosystems have been applied to two emission scenarios which have been developed in the EU-funded HEIMTSA project. The objective of the project was to assess the impacts on human health caused by climate policy measures. Within this project a business as usual (BAU) scenario without further climate change policies after 2012, and a scenario including these policy measures (e.g. the EU energy and climate package for 2020) have been estimated. The scenarios were built for the years 2020, 2030 and 2050. The increase in health impacts in the climate policy scenario for 2020 and 2030 relates to the chosen policy measures to decrease GHG emissions. One prominent measure in this context is the promotion of the use of biomass in domestic heating. This leads to a reduction in CO2 emissions but increases emissions of particulate matter (especially PM2.5), causing negative health impacts. In 2050, technological change and additional policy measures are expected to reduce GHG emissions and health impacts simultaneously compared to the BAU case.

The effects for biodiversity caused by the policy measures mentioned above are comparable to those for human health for the years 2020 and 2030. However, in contrast to the resulting benefits to human health in 2050, the impacts on biodiversity still remain higher for biodiversity. For all three years of the assessment, the higher biodiversity losses in the climate scenario are related to higher emissions of NH3 in this scenario. As NH3 mostly results from agricultural processes, the increase in emissions is related to the applied policy measures for this sector, e.g. changes in diets, changes in fertilisation processes, etc.

Conclusions

The assessment of air pollution requires transforming the existing pressure indicators into impact indicators for different air pollutants, as only then can comparisons among these pollutants be made and an aggregation of the pollutants with respect to different impact categories, e.g. human health or ecosystems, becomes feasible. The study provides an introduction into the methodology applied for these impact assessments, i.e. the impact pathway approach, and presents an exemplary application of damage factors for health and ecosystem damages for future emission scenarios.

The estimation of impact indicators provides a useful tool to decision makers when it comes to quantifying the ecological effects of different policies and technologies. In addition, the monetary valuation of the impacts allows for cost-benefit analysis of the policies and technologies. Thus, the quantification of impacts to human health and ecosystems for past and future years serves as an indicator for measuring development with respect to the ecological issues of sustainability.

More information on the valuation of ecosystem services and health impact is available at http://www.in-stream.eu/download/IN-STREAM_deliverable-5%201_110727_FINAL.pdf.

Potential Impact:

Potential Impact of IN-STREAM

The IN STREAM Dissemination focused on two distinct objectives:

- Firstly to provide better information to policy makers how to identify the best available indicators and to use indicators correctly,
- Secondly to provide better indicators and measurements which enable policy makers to make informed decisions in balancing the trade offs of sustainability.

In reaching these objectives IN STREAM results can contribute to policy making which better takes sustainability into account. Policy makers, which use robust indicators and make informed decisions using those indicators, will find it easier to identify the synergies between different dimensions of sustainability and to balance the trade offs.

Identifying needs and opportunities for better communicating the importance of indicators

Any successful move towards a new or reformed set of indicators for policy making depends on, inter alia, whether such metrics are perceived as useful and pertinent by the general public. Indicators that the press and the public can easily identify with and understand (e.g. GDP, unemployment rates, inflation etc.) are arguably more readily picked up by policy makers.

In the context of WP7, an analysis was conducted on selected media and indicators to provide a better understanding of which and how sustainability indicators have been most reported on, and what it is needed to improve their communicability.

The methodology adopted for this analysis covered a limited number of sources (14 newspapers) and indicators (19), and therefore aimed to provide illustrative examples rather than an exhaustive statistical analysis. Nevertheless, even from this limited analysis it was possible to identify some interesting lessons.

Overall, there appear to be still a wide disproportion between the coverage of sustainability indicators and of traditional mainstream indicators, like GDP. Often, the alternative indicators mostly taken up by the media are not necessarily the most important at policy level. The media tend to prefer indicators that are easy to understand and that the people can more easily relate to, or indicators that are already strongly publicised by their creators.

Among the sustainability indicators analysed, the most popular appear those measuring a combination of economic and social factors (e.g. HDI, GNH). In the selected media analysed, such indicators received far more attention over time than pressure or status indicators linked to specific environmental matters, like biodiversity. In some cases this appears to be related to the reputation of the source (e.g. the United Nations for the HDI), as well as the 'popularity' of the issue measured (e.g. 'happiness' is a topic that people can easily relate too). Other indicators, like the water and ecological Footprints, are generally very popular thanks to their immediate way to convey a complex metric (e.g. ecological impacts measured in terms of 'planets' used) and the intensive marketing and/or awareness campaigns conducted by NGOs.

In general, there seem to be a more prominent focus on indicators measuring social and economic factors at the expense of those measuring the pressures on and status of biodiversity. This lack of attention from the media can be in stark contrast, in some cases, with decision-making actors. For example, the Common Bird Index is a headline indicator in the Sustainable Development Strategy and is widely known and discussed in the wider policy community but, across more than 20 years, has never been mentioned in the selected media sources.

Sustainability indicators as a whole are, seemingly, rarely referred to as alternatives to GDP when measuring or discussing progress by the media. A cursory research shows a vast difference in popularity between the two sets of indicators. Nonetheless, the limitations of GDP in measuring true progress have been extensively covered by the print media.

Discussions on such a topic, and on sustainability indicators in general, have tended to cluster around specific events, such as domestic or international political developments, the regular publication of statistical or qualitative reports on sustainable development, and the creation of a new indicator.

There is clearly a gap between the sustainability indicators that are most used or needed by policy makers and the information passed on to the general public. There is therefore a need to improve the communicability of some key indicators, for instance by translating their result into more understandable messages and increasing public interest though more frequent awareness rising campaigns.

On the other hand, some indicators may be simply too complex to be easily communicated. For instance, an indicator like the Human Appropriation of Net Primary Production (HANPP) can be extremely informative for policy making (e.g. for agriculture policy and resource efficiency), but too technical to be communicated to the general public. Others indicators, like the Ecological Footprint, can be considered less robust by the scientific community, but widely taken up by the media for their clear message. Similarly, an accurate indicator like the Marine Trophic Index (MTI) can be difficult to be appreciated by the public, while a more simple measure of 'fish catch' would be easy to communicate. This does not mean that some indicators are better than others, but rather that indicators can have different functions. While some may be more suitable for policy and research, others would be more appropriate to communicate a message to the outside world.

It is therefore important that the right indicators are used for the right purpose. There is sometime a trade-off between meaningfulness and clarity that should be taken into account in policy making. While in general the communicability of sustainability indicators and the awareness around their importance should be improved, it may also be necessary to choose different indicators for analysis and for communication. This can ensure that the most robust indicators are used to inform policy choice, and at the same time that the importance of sustainability criteria is fully appreciated by the public.

Stakeholder workshops and final conference

In the context of the IN-STREAM project, three workshops were organised in the course of 2011 to disseminate and discuss preliminary results with relevant stakeholders in different European cities. Each of the events was structured around one of the three storylines developed in the context of the project: biodiversity, resource efficiency and green growth.

The key aims of these events were to:

- Introduce the IN-STREAM project and its objectives;
- Present useful findings and approaches of interest for policy makers, indicators users and researchers;
- Share views and experiences on how sustainability indicators have been used and should be used in the future for policy making; and
- Contribute to the sharing of information and increased use of sustainability indicators.

The first workshop focused on the use of sustainability indicators for biodiversity policy, and took place in Brussels on the 8th and 9th of February 2011; it was carried out jointly with a workshop of the Footprint indicators organised in the context of the OPEN:EU (One Planet Economy Europe) FP7 project.

The second workshop centred on the use of sustainability indicators for resource efficiency policy, and took place in Prague on the 7th of April 2011.

The third workshop focused on the use of sustainability indicators for green growth, and took place in Berlin in July 2011.

Overall, the workshops' participants showed significant interest in the issues investigated by the project. There was a general recognition that the IN-STREAM analysis of the use of indicators in various policy areas and at different phases of the policy cycle resulted in valuable insights. The work approach, structured around the three storylines, was also appreciated.

It was noted that the policy areas investigated are closely interlinked with each other. The linkages and commonalities between them makes a whole range of issues very relevant across all the three storylines (e.g. land-use), pointing to the need for sustainability indicators to account for cross-policies impacts.

Across all the storylines, strong support for the development of indicators supporting a life-cycle perspective emerged. It was also stressed that indicators should help provide insights into the pressures of human activities and consumption outside European boundaries. There was a large consensus that the use of policy-specific indicators (e.g. biodiversity indicators, climate change indicators etc.) should be streamlined across different policies to ensure a more holistic and integrated approach towards environmental issues.

The importance of understanding the scale at which indicators can /should be used (national-regional-local) and the different stakeholders groups that would benefit from using them was highlighted.

It was noted that, given the wealth of indicators on offer, efforts should focus on identifying and assessing the indicators which are most promising and that can help improve how we 'measure to manage'. The choice of indicators, it was noted, should also be driven by a clear understanding of the questions they should help answer.

The role of environmental accounting frameworks such as the SEEA should also be given due attention, as they can support indicator development by making data available, and have therefore the potential for being a game changer in the 'Beyond GDP' process.

In this regard, the issues of data availability, timeliness and robustness of information were also mentioned several times in the course of the workshops. The case was made for further harmonisation and improvement of data collection methods in order to strengthen the use of indicators.

In the course of the workshops it was highlighted that the type of analysis the In-Stream engaged in is increasingly on demand, reflecting an increasing interest in sustainability indicators and in their application to policy making. This follows from the recognition that today's environmental challenges are so broad that they require economy-wide solutions. The progressive mainstreaming of environmental policy into other policy areas contributes to the transformation our society and the economy, a fact which increases the demand for orientation and macro-aggregate level analysis.

Further information on the events, including the power point presentations and full minutes, is available on the project website http://www.in-stream.eu/events.html.

Dissemination work of IN-STREAM

Additionally to the stakeholder events described above, IN-STREAM has used several channels for dissemination of its work and its results.

IN-STREAM website

The website has been updated regularly with the newest publications, announcements on stakeholder events, documentations of past events and a newsfeed. The website was also advertised in presentations and newsletters described below. The project website provided a

- Front page with a general description of the project and the project partners and a newsfeed that regularly showed new developments in the politics and research of "Beyond GDP".
- A Documents page providing all deliverables of IN-STREAM and the workshop documentations.
- An events page that advertised the workshops of IN-STREAM including the internal workshops.
- Ad dedicated conference page that provided all details of the final conference including a facility to register online.

Newsletters

Overall three Newsletters have been sent to over 500 recipients interested in the Beyond GDP process. The Newsletters contained links to the most recent results of IN-STREAM and announcements of the stakeholder events. The newsletters were send in January 2011, August 2011 and November 2011 and are available on the IN-STREAM website http://www.in-stream.eu/docs.html .

The workshops and the conference of IN-STREAM were also advertised in the newsletters of IEEP (http://www.ieep.eu/newsletter/autumn-2011/) and the Ecologic Institute.

Scientific Conferences

IN-STREAM project members have been presenting the results on various scientific conferences:

- Arnold, S (2011) The Forgotten Dimension of Sustainability Public Lecture in the Global Futures Series. April 7th, University of Bath
- Arnold, S (2011) Social Sustainability: Concepts and Indicators. Departmental Seminar, Department of Economics, University of Bath. 26th January.
- Arnold, S (2010) Social Sustainability: Issues and Indicators. Presented at the International Workshop on Sustainable Paradigms: From the definition to the operationalisation of sustainability indicators in policy making. FEEM, Venice, May.
- Arnold. S. (2009) Indicators of Economic Success, Human Well-Being and Environmental Protection: The IN-STREAM Project. Invited talk given at the Sustainable Consumption and

Production Network (SCPnet) Networking Event (UK Environment Agency and Regional Development Agencies), October 21st 2009.

- Bosello, F. (2010), Presenting FEEM SI at the, "OECD Annual Meeting of Sustainable Development Experts (AMSDE)", 18 October 2010, Paris, France.

- Bosello, F. (2010), International Workshop on "Sustainable Paradigms from the definition to the operationalization of sustainability indicators in policy making", 24 May - 25 May 2010, Fondazione Eni Enrico Mattei, Venice, Italy

- Bosello, F. (2010),Presenting FEEM SI - "Beyond GDP, Italy in the world sustainability ranking", University of Basilicata, Potenza, Italy, 4 March 2010

- Bosello, F. (2010), Presenting FEEM SI - "Beyond GDP, Italy in the world sustainability ranking", Fondazione Eni Enrico Mattei, 18 December 2009, Venice, Italy

- Bosello, F. (2010), Presenting FEEM SI - "Beyond GDP, Italy in the world sustainability ranking", Fondazione Eni Enrico Mattei, 10 December 2009, Milan, Italy

- Müller, W. (2011) Presentation of the IN-STREAM and EXIOPOL projects at the 6th International Conference on Industrial Ecology organised by the International Society for Industrial Ecology (ISIE) at the University of California in Berkeley, California.

- ?asný, M. (2011), Distributive impacts of emission reduction policies. Presentation at the Final IN-STREAM Conference: Beyond GDP - Sustainability Indicators for Policy Making, Brussels, 27/28th September 2011.

- Toth, F. (2010), FEEM workshop on 'Sustaianble Paradigms', May 24-25, 2010.

- Tsuchimoto, F., ?asný, M. (2011) 'Decomposition Analysis of Air Pollutant in the Czech Republic', Paper presented at the 18th Annual Conference of the European association of Environmental And Resource Economists (EAERE), Roma 29 June - 2 July 2011.

- Tsuchimoto, F. (2011), "The Statistical Decomposition Analysis of Local Air Pollutant in the Czech Republic". Seminar series Super Solidam Petram, 23rd March 2011, Charles University in Prague, Czech Republic.

Scientific Publications

Additionally the IN-STREAM team published and prepared several scientific publications of IN-STREAM results.

Publications:

- Böhringer, Christoph und Victoria Alexeeva-Talebi (2011), Unilateral Climate Policy and Competitiveness: The Implications of Differential Emission Pricing, Oldenburger Diskussionspapiere, V-338-11, Carl von Ossietzky Universität Oldenburg.

- Cardin M., S. Giove, (2008), "Aggregation functions with non-monotonic measures", Fuzzy Economic Review, ISSN: 1136-0593, 13, 2, 3-15.

- Carraro C., F, Ciampalini, C. Cruciani, S. Giove, E. Lanzi, "Aggregation and Projection of Sustainability Indicators: a New Approach", Paper prepared for the OECD 3rd World Forum, 27-30 October 2009, Busan, Korea.

- Carraro, C., Cruciani, C., Lanzi, E., Parrado, R., (2011), "Nuovi orizzonti per lo sviluppo sostenibile", Rivista Delle Politiche Sociali N. 1, 2011.

- Cruciani C., E. Lanzi, Sustainability: the road not (yet) taken beyond GDP?, FEEM Policy Brief 2010.09

- Lanzi, E. e R. Parrado, 'Gli impegni di Cancún, gli impatti sulla sostenibilità', Equilibri 2011.01.

- Lanzi E., R. Parrado, "The hidden trade-off between climate policy and sustainability: an obstacle or a source of incentives to achieve an agreement?", FEEM Policy Brief 2010.08

- ?asný, M., Tsuchimoto, F. (2011), Index-based Decomposition of SO2, NOx, CO and PM Emissions Stemming from Stationary Emission Sources in Czech Republic Over 1997-2007. In: Costantini, V., Mazzanti, M., Montini, A. (eds.), Advances in the Analysis of Hybrid Economic-Environmental National Accounts. Routledge, Series Routledge Studies in Ecological Economics, pp. 240. (Published November 21st, 2011; http://www.routledge.com/books/details/9780415594219/).

- Toth, F. (2011/12), Publication in the "Options magazine", IIASA.

Planned Scientific Publications:

- IEEP will be publishing a non-academic paper under the IEEP series 'Directions in European Environmental Policy (DEEP)' focusing on the current and potential use of sustainability indicators in policy makers, building on deliverable 7.4. The paper is in the process of being finalised and will be soon uploaded in IEEP's website. The team will aim to turn the DEEP paper into a paper/article for publication in an academic journal in the near future.

- The University of Stuttgart is preparing a paper on the spatial characterisation of sectors and the derivation of sector specific monetary damage factors.

Other dissemination events

The IN-STREAM team has also provided input into other dissemination events targeted on a non-academic audience.

- Umweltbundesamt (Federal Office for Environmental Protection): As an evening program to a national German Workshop on Sustainability Indicators, the Ecologic Institute organised a dinner dialogue on the work of IN-STREAM and Klaus Rennings from the ZEW presented the IN-STREAM work on composite Indicators to members of the regional statistical offices and the national Environmental Protection organisations http://ecologic.eu/4268.

- American Voices Abroad: Together with American Voices Abroad the Ecologic Institute organised a seminar on Beyond GDP indicators, presenting work done in IN-STREAM and comparing the European work with the US experiences. http://ecologic.eu/4266 .

List of Websites:

http://www.in-stream.eu

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