In-Stream

Energy and Resource Efficiency: Modelling, Analysis, Indicators

Report on the IN-STREAM Workshop of 7 April 2011

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7 APRIL 2011

IN-STREAM minutes - Leonardo Mazza, Samuela Bassi (IEEP, London/Brussels) and Thibaut Henin (Ecologic Institute, Berlin)

IN-STREAM Workshop

Sustainability Indicators for Policy Making

How can our progress towards sustainable development be measured in the area of resource and energy efficiency? Which sustainability indicators are most needed and which indicators are currently being investigated in the IN-STREAM projects to help in decision making relating to resource use? These were the core questions behind this workshop event organised in the context of the FP7 IN-STREAM project (INtegrating MainSTREAM Economic Indicators with Sustainable Development Objectives).

The workshop brought together experts and policy makers to discuss a number of innovative sustainability indicators in the area of resource and energy efficiency and provided a platform for the sharing of experiences and best practices in the use of indicators in this policy area.

The day also provided some preliminary outcomes of the qualitative and quantitative analyses undertaken in the IN-STREAM study, and on possible ways to link economic indicators with measures of sustainability and well-being.

This was the second of a series of workshops dedicated to the use of sustainability indicators in specific policy areas. While the first workshop focused in particular on the use of indicators for biodiversity policy and growth, this second event was focused on energy and resource efficiency. A third workshop on green economy will take place in Berlin on 7 July.

The presentations summarised below as well as reports mentioned therein are available on the project's website.

IN-STREAM is a collaborative research project to better integrate mainstream economic indicators with sustainable development objectives. It is funded through the European Commission Directorate General for Research under Grant Agreement No. 2111759. Further information is available online at http://in-stream.eu.The INSTREAM team involves: Ecologic Institute (Germany; Project Co-ordinator) , Fondazione Eni Enrico Mattei (Italy), University of Bath, Department of Economics and International Development (United Kingdom) , Charles University Environment Center (Czech Republic) , Institute for European Environmental Policy (United Kingdom and Belgium), Universität Stuttgart: Institut für Energiewirtschaft und Rationell Energieanwendung (Germany) , International Institute for Applied Systems Analysis (Austria) , and Zentrum für Europäische Wirtschaftsforschung (Germany).

PART I – MEASURING SUSTAINABILIY WITH INDICATORS

Chair: Bedřich Moldan – Welcome

The workshop was opened by Bedřich Moldan's (Charles University Environment Centre). He pointed out that, when he acted as the Chairman of the UN Commission on Sustainable Development, the institution identified the need for further work on aggregate indicators and on the link between indicators and the different dimensions of sustainable development. Since then, in the past ten years such work has been carried out only in part. This project therefore can positively contribute to advancing in this important field, including in the fast evolving area of resource and energy efficiency.

Samuela Bassi – In-Stream Project Overview & Storylines and Goal of the Prague Workshop

Samuela Bassi (IEEP) presented the outline of the day and provided a short general introduction to the project's purpose and objectives. Samuela briefly explained that the project's findings have been structured around three storylines, in order to facilitate communication: biodiversity, resource efficiency and green growth. She clarified that this workshop's focus was on the resource efficiency storyline. She further illustrated the main aim of this workshop, namely to present and discuss the preliminary results of the project in the area of resource and energy efficiency. She highlighted that this workshop was also meant to show how the project's results can be relevant for Central and Eastern European countries.

Samuela briefly introduced the day's agenda: while the morning was meant to focus on measuring sustainability through the use of indicators (FEEM, IIASA), the afternoon was to be dedicated both to quantitative assessments as well as the project's qualitative work. Samuela finally introduced the project's next steps, in particular the upcoming publications of the quantitative and qualitative analysis on the project's website. Samuela also pointed to the project's two remaining workshops taking place in Berlin on July 7 and Brussels in September 2011.

The full presentation is available here.

Lucas Porsch – In-Stream Overview

After pointing out that far more information is available on the project's website, Lucas Porsch (Ecologic Institute) illustrated the project's overall objectives in more detail, explaining the policy-relevance of the study and the use of the policy-cycle to illustrate the project's main contribution more concretely. He also stressed the project's added value in attempting to bridge the gap between sustainability indicators and mainstream economic indicators, for example by its investigation of the economic impacts of sustainability targets. Lucas clarified that the project would come up with recommendations on how to work with indicators and introduced the project's different focal points (qualitative assessment, quantitative assessment, qualitative/quantitative linking, and integrated assessment) and presented the project team and responsibilities. He explained how data are used in the different stages of the policy-cycle, such as objective definition, problem identification, modelling of impacts or measuring success.

He finally emphasized that the project should result in producing policy-relevant and timely results. Lucas invited the workshop participants to remain involved in the project, either by participating in one of the upcoming workshops or registering to the newsletter and visiting the website.

The full presentation is available here.

Francesco Bosello - *Compounding Sustainability in a Single Measure. The Role of Energy-related Indicators* *(originally agenda item labelled "The role of energy efficiency in determining the overall performance of the composite sustainability indicator")*

Francesco Bosello (Fondazione Eni Enrico Mattei - FEEM) pointed out that building composite indicators/ Index of sustainability is a very controversial issue, probably one of the most difficult within In-Stream. Indeed, while one of the project's aims is to discuss the present use of indicators, the project also aims to devise new ways in which indicators could be used in the future. Francesco pointed out that policy-makers, such as the European Commission, are frequently using economic modelling tools, many of them for ex-post analysis. This prompted the project team to investigate the possibility of producing a model to study sustainability also ex-ante, and capable of producing projections. The team has therefore been working on constructing a composite indicator and testing whether it could tell something different than a simpler indicator such as GDP.

The model used is a general equilibrium model (ICES – Intertemporal Computable Equilibrium System) which replicates market exchanges in a given year. Taking 2001 as a baseline year, it uses a 2020 "reference scenario" and shows what happens to the economic development of 40 countries and 17 economic sectors. The data generated by the model allows for the computation of selected sustainability indicators and the composite index. The composite indicator builds on a core set of 23 indicators selected at the beginning of the project. Different weights are attributed to each of them (weighted average). The weighting is based on expert judgement on how each indicator is able to provide information on the economic, environmental and social dimension of sustainability, and takes into account redundancies and synergies across them (combination of performances).

The final index allows ranking countries. A list of top 10 and bottom 10 counties has been produced. Top countries include Sweden, Switzerland and Austria. The bottom of the list includes countries/Regions such as India and North Africa. In the ranking, "1" corresponds to sustainability. Even the best country, Sweden, is 30 per cent away (FSI of 0.68) from the best possible performance.

A key finding is that the different dimensions of sustainability are not substitutable. The countries with the highest composite indicator score are also those which perform relatively well in all the dimensions of sustainability. Countries with a low score generally underperform in at least one dimension. It is therefore not possible to compensate bad performance in one dimension through good performance in another. Francesco also illustrated in what way the qualitative weighting associated with the different indicators can slightly influence the outcomes. A sensitivity analysis revealed that countries in the

top and bottom positions were mostly the same, while some different ranking for the central positions was possible. Overall, the results were considered sufficiently robust.

The full presentation is available here.

Ferenc Toth– Resource and energy efficiency indicators: Exploring linkages in CEE

Ferenc Toth (International Institute for Applied Systems Analysis - IIASA) presented the results of the statistical analysis which were carried out as part of the project. IIASA's task in particular was to analyse the links between the In-Stream indicators and selected beyond-GDP indicators. Ferenc's presentation focused on the analysis related to resource and energy efficiency indicators. These included energy intensity, freight transport, GHG emissions and government expenditure on R&D (GERD) per capita. Distinguishing EU-15 countries from CEE countries, IIASA looked into the correlations of these four indicators with mainstream economic indicators such as household income, employment rate, etc.

A key finding is that energy intensity appears to be mostly negatively correlated with per capita GDP, as well as with employment rate and labour productivity per capita. Energy intensity is instead strongly positively correlated with GHG emissions in most countries. In some cases, patterns are unclear, such as in the case of business investment and energy intensity. In EEC, a large share of business and government investment seems to lower the energy intensity indicator.

Correlations and interactions between In-Stream indicators and Beyond–GDP indicators were also assessed. Ferenc showed examples of the relation between GDP per capita and some of the beyond-GDP indices. It was evident that GDP fails to fully explain the environmental sustainability index (ESI). The 'stress' component of ESI seems to decline with GDP, supporting the Kuznet curve theory.. The social sustainability index (SSI) seems to be positively related to GDP, but GDP is missing some of the resource components of this index. The positive relation is stronger when all the components of SSI are taken into account.

The analysis also looked into correlations of economic indicators with land use intensity and water abstraction, showing for example a strong correlation between fertiliser use and productivity per hectare, e.g. in the Netherlands and in Belgium. It also emerged that CEE countries have a less intense use of fertilisers compared to western countries. A similar analysis was conducted for water abstraction. The analysis shows that abtraction is declining in most countries.

Overall the statistical analysis confirms a range of well-known relations, such as that economic growth leads to improved energy efficiency, but that resource use increases with wealth. Currently, resource use efficiency in CEE countries is below EU 15 average, both in total and per capita. The challenge is therefore to find a technological development path for those countries that increases resource efficiency and avoids the increasing resource use per capita.

The full presentation is available here.

Discussion

In relation to FEEM's composite indicator and the weighting of the individual indicators aggregated, a participant questioned the fact that economic indicators appear to have been given lower weights than environmental and social indicators, affecting the results. The participant suggested that weights could have been different had experts from developing countries been consulted.

Francesco agreed with the comment and pointed out that the weighting exercise was carried out twice with two different groups of experts. it was pointed out that the weights attached to each pillar of sustainable development (economic, social, environmental) was quite similar, thus reflecting a quite balanced picture. Weights can also be tailored to politicians preferences and policy priorities. Therefore, while a composite indicator is necessarily rather subjective, what ultimately matters is that there is transparency on the weighting procedure and methodology chosen.

Asked why India scored quite highly in the social component while at the same time having a relatively low GDP per capita, Francesco explained that this could be due to the choice of indicators included in the "social" component, reflecting issues such as population growth, food expenditure and education expenditure/GDP. In these areas, India performs quite well. Other indicators, such as democracy, were not suitable for the CGE model, so the choice of the indicators was also driven by practicality/methodological feasibility.

With regard to IIASA's statistical analysis, a participant asked whether a standard or partial correlation had been used, pointing out that a partial correlation analysis can lead to more accurate results. Ferenc clarified that a very simple correlation exercise had been done for the purpose of this presentation, but that more advanced statistical techniques have been applied to other parts of the work.

PART II – ANALYSING EFFICIENCY ON SECTOR AND MACRO LEVEL

Chair: Francesco Bosello (Fondazione Eni Enrico Mattei)

Klaus Rennings –Resource efficiency and competitiveness – an empirical analysis using German innovation data

Klaus Rennings (Centre For European Economic Research, Mannheim) presented the results of a study focused on eco-innovation instruments and on resource efficiency and competitiveness, commissioned by the German Government in 2007. The work investigated a number of environmental technologies with high market potential, including energy production and storage, energy efficiency, resource and material efficiency, sustainable mobility, recycling etc..

Klaus explained that the main motivation behind this stream of research was the assumption that there is a large potential for win-win (environmental and economic gains) from investments in resource efficiency. This is linked to the Porter Hypothesis, which postulates that there are positive competitiveness effects from environmental regulation, as regulation can lead to eco-innovation which in turn leads to increased

competitiveness. The focus of the work was the investigation of the link between eco-innovation and competitiveness, i.e. the so-called "strong" Porter hypothesis.

The analysis focused on energy and material costs, as energy and resource efficiency innovation was expected to lead to the most positive competitiveness effects. Klaus explained the methodology used. Using data from a 2005 German survey, innovating firms where compared to similar firms which did not significantly reduce the use of material and energy. This 'matching' approach showed that companies which are highly energy and resource efficient (i.e. "Energy and Resource Efficiency Innovators (EREIs)") have higher sales than those which did not undertake any innovation. EREIs are more productive (sales per employee are approximately 15 per cent higher), have more innovative partners and are generally very R&D intensive.

Findings for the Czech Republic show that the sectors more advanced on energy and resource efficiency are textiles, IT/computers and machinery.

Finally, it was observed that data from the 2005 Community Innovation Survey (CIS) are now available for the whole Europe, therefore this exercise could be carried out for the EU27.Such an exercise would appear of particular interest in the context of the development of a future European Resource Policy and would help make the case for ambitious policies in this field.

The full presentation is available here.

Sebastian Voigt – Innovations in Energy Efficient Technologies – The Case of Clean Coal Technologies

Sebastian Voigt (Centre for European Economic Research (ZEW) pointed out that 70 per cent of electricity generation is from fossil fuels today. Hence, innovation is crucial in this field if GHG emissions targets are to be met. His presentation focused on the potential for integrated gasification combined cycle (IGCC) and carbon Capture and storage (CCS) technologies and identified triggers for innovation by looking at trends in patent data.

After providing some background information on the technologies, Sebastian presented the economic analysis He highlighted that the major shortcoming of using R&D expenditure as an indicator for innovation is that it does not provide any information on the level of success of that expenditure, therefore patent data were used instead as a measure of innovative activities. Patent data, however, also have potential shortcoming, such as the fact that not each patented invention leads automatically to innovation. The analysis focused on IGCC and CCS patent activity between 1975 and 2005, and looked at the variables which influence patents of those specific technologies - such as energy-related R&D expenditures.

The results showed the significance of R&D expenditures and of Kyoto specifications for CCS and aggregate IGCC + CCS innovation. A peak in CCS patents was recorded in 1998, following the adoption of the Kyoto Protocol, while IGCC was not affected. The results seemed to suggest that the Kyoto Protocol led mostly to innovations related to renewable energy sources and CSS.

Overall, the empirical analysis showed interrelations between patents of all technology types and coal combustion R&D, and identified a clear impact of the Kyoto Protocol on CCS technology.

Future work will look at the effect of policy stringency before and after Kyoto (depending on data availability), take into account technology-specific R&D and examine knowledge transfers. To the extent innovation is seen as an indicator of sustainability, patents can also be seen as a measure of sustainability.

The full presentation is available here.

Discussion

In the discussions which followed the two presentations, a participant asked whether the Kyoto protocol had a negative influence on IGCC. Sebastian clarified that IGCC is a very radical innovation for which a strong incentive is needed, while CCS technologies can be seen as an incremental innovation. It is therefore possible that the Kyoto Protocol has only given marginal incentive to invest in clean coal technologies.

It was also noted that the fact that the Kyoto Protocol seems to have had an impact on CCS technology is a very interesting result, as the effectiveness of Protocol has often been questioned. Establishing the links between the protocol and CCS, however, is probably quite a difficult, since CCS was not explicitly recognised by the Kyoto Mechanism.

Participants also further discussed the relationship between innovation and company results. The question whether researchers were able to control for reverse causality was raised. Klaus answered that the Porter hypothesis actually does not only go in one direction, and that a firm that is quite well managed overall can also be expected to be well managed in the area of resource and energy efficiency. Of course, the role that third factors (e.g. general quality of the management) can play is important, but no meaningful statistical results have been produced so far when attempting to better understand this relationship.

Fusako Tsuchimoto –Linking Economic Performances to the Environmental and Social Sustainability, the decomposition approach and econometric analysis

Fusako Tsuchimoto (Charles University Environment Centre, Prague) presented the results of an investigation of the driving factors of emission changes in the Czech Republic, in view of testing the Environmental Kuznets Curve (EKC), which postulates a negative relationship between per capita income (PCY) and emission level of pollutants. The analysis focused on a set of air pollutants (SO2, NOx, PM, VOC and CO), produced by 60 industrial sectors in the Czech Republic after 1995. The analysis found that the EKC hypothesis is corroborated for some pollutants. The level of emissions of SO2, for example, shows EKC pattern at sectoral level. Air investments appear to have negative effects on the emission of air pollutants, and the effects are particularly strong in the manufacturing sector. However, it was not possible to identify through which channel the investments affected such emissions. A statistical decomposition was therefore conducted to identify these driving forces.

The main finding was that the reduction primarily occurred when the emission limits set by the EU regulation became binding, between1995-2000. The decline of emissions was mostly related to a change in emission intensity. Further analysis revealed that such change in emission intensity was primarily influenced by end of pipe abatement technologies. Such an analysis showed that the driver of reducing the emissions were therefore technological investments on end of pipe technology. Further econometric analysis will be conducted in the future, focusing on different sets of variables.

The full presentation is available here.

Jaroslav Sixta – Updated Supply and Use Tables – Revision 2011

Jaroslav Sixta (Czech Statistical Office, Prague) explained how the Czech national data/accounts and input output tables will change in the near future. The changes will affect time series between 1995 and 2010. The revision will be based on SNA 2008 and ESA 2010. Jaroslav explained that, while symmetric input-output tables have been provided since 1995, the current classification of products and industries was introduced in 2008 and that the new classification for input output tables could be expected to be introduced in September/October 2011. He also announced that in 2014 there will be a further revision in the whole Europe because of the change of national accounting standards, especially with regard to research and development data.

Jaroslav described the key features of the changes to be introduced in September/October 2011. The main differences in the classification will include: a decrease in the categories of goods and an increase in the service categories (e.g. new categories for water, sewage, waste collection, remediation services will be created), a change in the logic of the classification (services will be separated from production), and changes in trade categories (e.g. wholesale, retail). Also new and more detailed categories will be available for energy and resources data (e.g. hard coal, lignite etc). The changes will be discussed with some data users before the final publication.

The full presentation is available here.

Discussion

Regarding the presentation on the factors behind emission changes, a workshop participant explained that, in a similar study, the intensity effect appeared to be dependent on the level of detail of the system analysed. It was found that, when a large number of sectors are considered, the intensity effect nearly disappears and the composition effect becomes dominant. It was therefore decided to join the two effects in to further decompose scale effect. Fusako clarified that in the In-stream analysis disaggregation was conducted at sector level, but no significant differences were found.

Another participant asked for which pollutants an EKC relation was identified and whether consideration was given to including cubic terms in the equation. Fusako explained that, beside SOx, the correlation is less obvious for the other pollutants. With regard to the inclusion of a cubic term, she agreed there might be added value in doing this.

In response to a question relating to the use of the term "negative" to describe some of the correlations, Fusako clarified that this was to be understood in the statistical sense rather than a value judgement. She also clarified while for some pollutants such as CO2, the transport sector is of crucial importance. This sector, however, could not be taken into account in this work because data were not sufficiently disagreed.

PART III – INTERLINKAGES AND POLICY EVALUATION

Chair: Lucas Porsch (Ecologic Institute)

Tomas Hak – Results INDI-LINK Project: Indicator based evaluation of interlkinkages between different SD objectives

Tomas Hak (Charles University Environment Center) presented the findings of the FP-6 INDI-LINK project (Indicator-based evaluation of interlinkages between different sustainable development objectives), a project which looked into a range of issues of relevance to the In-Stream project. Tomas explained that the political context was quite specific at the time: the Lisbon Strategy revision was still due and there was a big discussion between structural indicators and sustainability indicators; beyond GDP process had just been initiated and the Sen-Fitoussi Commission report was being prepared.

Tomas explained that the primary drivers behind the project were the recognition that European Institutions and bodies require constant improvement of the measurements they use and the lack of methodological approaches to assess interlinkages between the indicators. The INDI-LINK project therefore had as primary objectives the further improvement of selected sustainable development indicators and the identification of emerging policy fields; the assessment of interlinkages between different priorities of EU sustainable development (SD) policies (past and future); and the deriving of conclusions for EU SD policies and the implementation of the EU SD Strategy (SDS).

The project's work packages included the development of SD indicators (WP 1), the assessment of interlinkages and policy conclusions. In WP 1 indicators such as the biodiversity index, child wellbeing, Environmentally weighted Material Consumption (EMC), Green Public Procurement (GPP), unmet healthcare spending needs and others were selected. A list of 17 indicators for the emerging policy fields was also identified, including: appropriation of ecosystem services, infectious diseases spread through global travel and trade, fossil energy embodied in national consumption and others. WP 2 focused on the assessment of interlinkages. Its main goal was to present a methodological framework for interlinkage assessment and to conduct analysis of these interlinkages between the different SD dimensions.

The deliverables of the project can be downloaded from the INDI-LINK webpage: http://www.indi-link.net/ .

The full presentation is available here.

Milan Scasny – Residential energy efficiency and consumption: economic, environmental and social aspects

Milan Scasny (Charles University Environment Center) presentation focused on the issue of household behaviour and consumption. Milan provided an illustration of the share of residential energy consumption/expenditures. He pointed out that the main reason why it is not easy to draw conclusions with regard to energy saving potential is that nobody demands energy (and fuels) per se: energy demand is a derived demand and energy is combined with durable goods to produce service. Milan summarised the result from a survey on residential energy efficiency to highlight some of the determinants of energy-savings in households. He underlined the difficulty to obtain and analyse energy-saving behaviour data.

One of the findings was that the price of energy actually was not one of the primary stated motivation for energy conservation measures by households. The price of investment in reduction measures appeared a more important determinant. Other key factors were the availability of energy efficiency products and the clarity of labels.

The work also investigated the use of some energy saving behaviours (i.e. ensuring the washing machine/ dishwasher is fully loaded, turning off appliances not used, turning off lights when leaving a room, switching off stand-by modes, cutting down on heating/AC). The research also confirmed that background characteristics of people (e.g. wealth, education etc.) are not strongly correlated to behaviour, while environmental concerns are.

The analysis further revealed that, on average, fuel expenditures and consumption are rather stable across time. However, emission from transport are increasing, likely due to the increased number of cars per household, the increase in engine size and the purchase of second hand cars. The study further investigate the relation between households characteristics and the probability of owning cars, and the effect of fuel taxes – which appeared to be regressive.

Some of the policy recommendations included that wealthy people should be more targeted for behavioural changes. Tenants should also be targeted because they are less likely to invest into energy efficient durables.

The full presentation is available here.

Samuela Bassi & Leonardo Mazza – Sustainability indicators for resource efficiency policy

Samuela presented an overview of the qualitative approach used in INSTREAM. She explained that the aim was to analyse a set of indicators, identify the policy implications for their use, draw lessons from some case studies, investigate the issue of the uptake of sustainable indicators in the press, discuss results with stakeholders and draw some useful conclusions and recommendations. The work focused on a set of environmental, social and economic indicators selected by the team. An example of analysis undertaken for three resource efficiency relevant indicators (energy intensity, GHG and waste disposal) was provided.

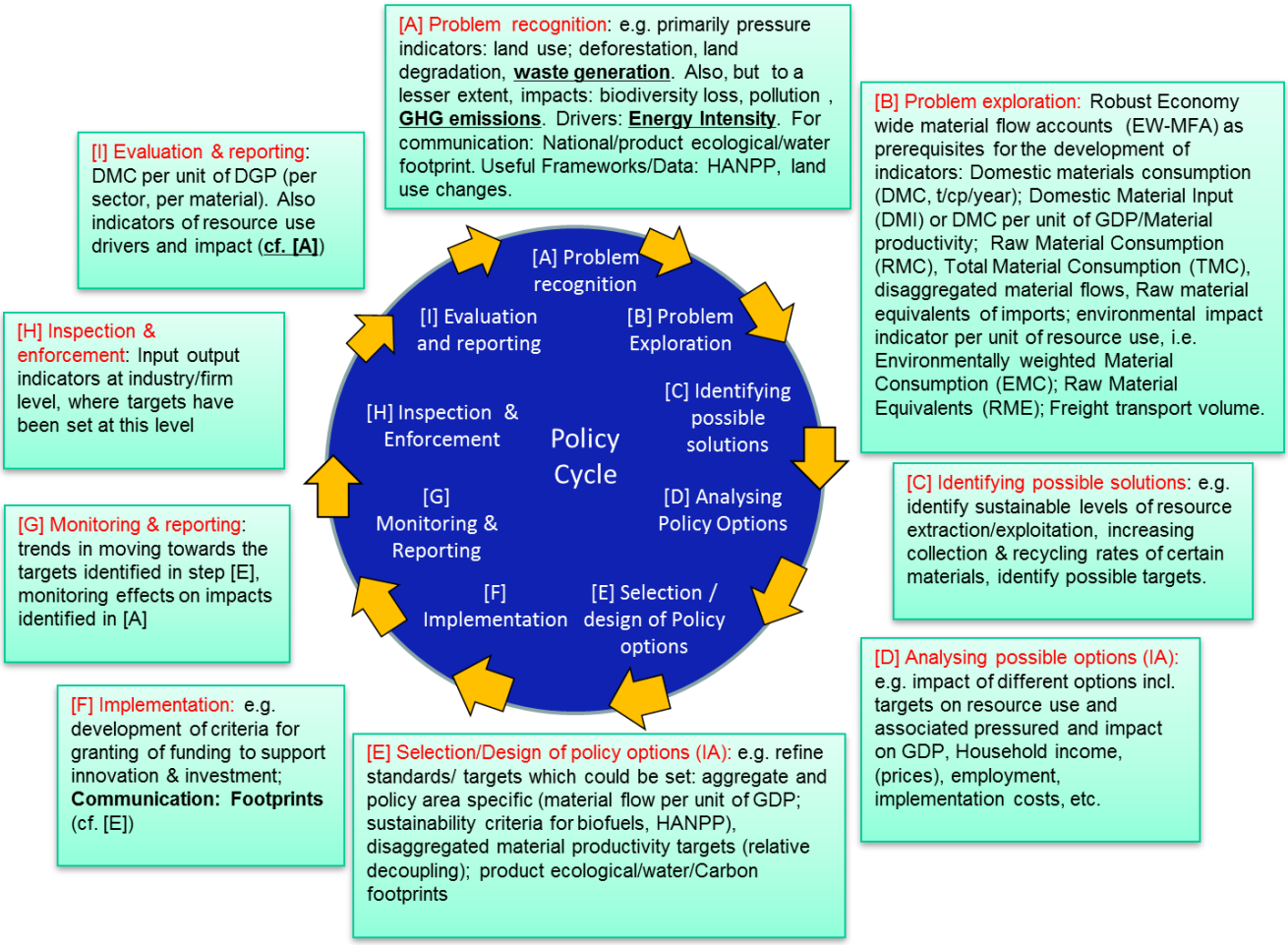
Leonardo provided an overview of the policy cycle analysis undertaken, and its relevance in the context of resource efficiency. Leonardo presented the policy areas investigated (biodiversity, agriculture, fisheries, resource efficiency, waste, climate change, cohesion policy and energy efficiency), the framework of the policy cycle and the questionnaire approach used to collect feedback from policy makers. He then presented some preliminary findings on the use of environmental and sustainability indicators in the context of resource efficiency policy. He illustrated a range of higher tier strategic orientations (EU Flagship initiative, Resource Efficient Europe Roadmap 2050), as well as horizontal and sectoral policies, in which resource efficiency indicators and targets would be particularly useful. He then presented the main findings on the use of resource efficiency indicators at present. The consultation with policy makers revealed that data is a real constraint, but progress in formalising data collection at EU level has allowed relying on Domestic Material Consumption (DMC) and material flow analysis. Promising indicators worth further development included Environmentally Weighted Material Consumption (EMC), Raw Material Consumption (RMC), Total Material Consumption (TMC) and (at least for some resource categories) Total Material Requirement (TMR). Some attempt to set targets in the area of resource efficiency in Germany and Finland were briefly presented. Leonardo suggested that future opportunities for developing new sustainability indicators in the area of resource efficiency may be offered by the regulation on EU Environmental and economic accounts, the new accounts proposed by the European Parliament, and the increasing need for policy relevance criteria. As for the actual use of indicators, several are available/have been used in the earlier stages of the policy cycle (eg problem recognition/identification), but far less in later stages (e.g. monitoring) – see Figure 1 below.

Leonardo concluded with a range of policy recommendations, including the following:

- more work should be carried out on resource/ecological thresholds, which should be the yardstick for setting targets/limits;
- the Environmentally Weighted Material Consumption indicator should be developed further, while already taking measures on identified priority materials;
- the macro-monitoring of resource use should move from domestic material consumption (DMC) to raw material consumption (RMC) and in a second step consider total material consumption (TMC) and total material requirement (TMR), at least for selected material categories where more robust data could be available;
- further work on product life-cycle associated indicators is needed (e.g. Raw Material Equivalents);
- targeted policies on specific resources may require special indicators;
- the role of the Index for Environmental Pressures in monitoring resource efficiency policy should be considered; the ultimately objective should be to take a multi-criteria approach rather than deal with impacts in isolation.

The full presentation is available here.

Figure 1: Environmental and Sustainability indicators used in the context of resource efficiency



Discussion

With regard to the presentation on residential energy efficiency and consumption, a the participants noted that, when assessing how consumer behaviour need to change, one should fist consider their environmental effects and how costly different measures would be. Another participant stressed that the survey primarily showed which energy saving actions households takes least frequently, but the analysis should provide clearer guidance on how this should be addressed.

With regard to the presentation on environmental and sustainability indicators in resource efficiency policy, a participant noted that some of the data used for material flow analysis is not extremely robust and cited the example of waste production, which is based on surveys. Another participant suggested that, as long as we are not confident with the data used for DMC, it will be too early to envisage an indicator as complex as TMR. He mentioned an analysis which had estimated the degree of uncertainty of DMC to lie at about 10 per cent while for TMR it had been estimated at 50 per cent. Leonardo responded that it is true that robustness of the data has not so far been sufficiently emphasised and, while common methodologies for data collection have been published by OECD and Eurostat, it would be beneficial to investigate whether data collection

methods could be further harmonised and improved. Leonardo agreed that efforts in the medium term should focus on relaxing the heavy reliance of TMC on the DMC indicator. In addition, in the long term other indicators may become available, and TMR may be used for example only for specific material categories (e.g. rare metals).

CLOSING OF THE DAY

Lucas thanked all the speakers and the participants for the interesting presentations and discussions throughout the day. He pointed out that all the presentations will be made available online in the In-stream website and encouraged interested participants to get in touch with presenters to let share their views on the research outcomes presented, to ensure the future analysis and recommendations can be further improved.

For further information on the project or additional comments, please visit the IN-STREAM website http://www.in-stream.eu/ or contact the project coordinator Lucas Porsch or workshop and policy analysis coordinator Samuela Bassi:

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