Project No: 044513
Project acronym: **MEI**
Project Title: **Measuring eco-innovation**

Instrument: STREP

Thematic Priority: Call FP6-2005-SSP-5A, Area B, 1.6, Task 1

Deliverable 17
Policy brief about measuring eco-innovation and Magazine/Newsletter articles

Due date of deliverable: March 2008
Actual submission date: June 2008

Start date of project: 1-2-2007 Duration: 14 months

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Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	RE
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Policy brief about MEI

In a speech in 2006, Prince Hassan of Jordan, President of the Club of Rome stated: "*The markets of the future are green*." With this statement he is not predicting a flourishing market for some ecological niche markets or other, but expressing the belief that the major markets of the future will have a strong ecological dimension because resources are valuable, energy won't be cheap, and because we will value environmental amenities more than we do now.[1]

This is a clear reflection of a new way of thinking. We need alternative energy resources, processes with greater resource efficiencies, waste management systems and recycling systems and more sustainable systems of water management rather than end-of-pipe pollution control devices. The need for this is especially high in developing countries.

Eco-innovation may thus obtain a broader meaning, making it more relevant for business and consumers. The market for eco-technology is variously estimated at 500 billion euro and (using a broader definition) at 1,000 billion euro in 2005. For eco-technology Berger consultants predicts a global market of 2,200 billion euro in 2020.

[1] Based on http://www.bmu.de/files/pdfs/allgemein/application/pdf/memorandum_oekol_industriepolitik_eng.pdf

Data about eco-innovation output and inputs is poor. To inform data collection, researchers in the MEI project (funded by DG Research of the European Commission) examined various ways to measure eco-innovation. Eco-innovation can be defined narrowly as innovations expressly developed to deal with pollution or more broadly. MEI researchers opted for a broad definition based on environmental **performance** instead of on environmental **aim,** with the environmental performance to be assessed on a life-cycle basis.

As a formal definition, the following **definition for eco-innovation** is proposed[2]**:**

> *Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is* ***novel to the organisation*** *(developing or adopting it) and which* ***results****, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use)* ***compared to relevant alternatives****.* [3]

The innovation does not have to be new to the world (only new to the company developing or adopting it) and should be more environmentally benign than relevant alternatives. The environmental aspects are to be examined on a life cycle basis.

The MEI project focused on the measurement aspects of eco-innovation involved in these transitions-to-be. To assist policy and statistical data collection, the following **typology of eco-innovation** is being proposed.

A. **Environmental technologies**

- *Pollution control technologies including waste water treatment technologies Cleaning technologies that treat pollution released into the environment*
- *Cleaner process technologies: new manufacturing processes that are less polluting and/or more resource efficient than relevant alternatives*
- *Waste management equipment*

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[2] This definition draws on the definition for innovation in the Oslo Manual (OECD 2005) in innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practice.

[3] The definition differs the definition used in the ECODRIVE project which requires that he innovation is to be not only more environmental benign but that it also has to have a positive macro economic effect: "Eco-innovation is a change in economic activities that improves both the economic performance and the environmental performance". This would exclude important innovations such as the catalytic converters and many other end-of-pipe technologies. Our definition is in line with the ETAP definition of environmental technologies being "technologies and processes to manage pollution (e.g. air pollution control, waste management), less polluting and less resource-intensive products and services and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies". In our definition also non-technological innovations are included.

- *Environmental monitoring and instrumentation*
- *Green energy technologies*
- *Water supply*
- *Noise and vibration control*

B. **Organisational innovation** for the environment:
- *Pollution prevention schemes*
- *Environmental management and auditing systems: formal systems of environmental management involving measurement, reporting and responsibilities for dealing with issues of material use, energy, water and waste. Examples are EMAS and ISO 14001.*
- *Chain management: cooperation between companies so as to close material loops and to avoid environmental damage across the value chain (from cradle to grave)*

C. **Product and service innovation** offering environmental benefits:
- *New or environmentally improved products (goods) including eco-houses and buildings*
- *Green financial products (such as eco-lease or climate mortgages)*
- *Environmental services: solid and hazardous waste management, water and waste water management, environmental consulting, testing and engineering, other testing and analytical services*
- *Services that are less pollution and resource intensive (car sharing is an example).*

D. **Green system innovations:**
- *Alternative systems of production and consumption that are more environmentally benign than existing systems: biological agriculture and a renewables-based energy system are examples.*

New materials such as lightweight composite materials could be separated out as an additional category. The present typology subsumes them under product innovations.

Classification of companies

Companies may be categorised too in terms of how they deal with eco-innovation. A possible **categorisation of companies** is:

Strategic eco-innovators: active in eco equipment & services sectors, develop eco-innovations for sale to other firms.

Strategic eco-adopters: intentionally implement eco-innovations, either developed in-house, acquired from other firms, or both.

Passive eco-innovators: process, organisational, product innovation etc that result in environmental benefits, but no specific strategy to eco-innovate.

Non eco innovators: No activities for either intentional or unintended innovations with environmental benefits.

Conclusions about three important methods for measurement

MEI investigated the usefulness of 3 methods for measuring eco-innovation

- Survey analysis
- Patent analysis
- Digital and documentary source analysis

Survey analysis is an important method for monitoring and understanding innovation. The results of the Community Innovation Survey (CIS) have provided us with a much better idea of innovation activities in Europe. While the CIS has provided researchers with extremely valuable information, unfortunately it provides little information about eco-innovation. At the moment environmental issues are not specifically and separately addressed by the CIS. In CIS6 they are addressed together with health and safety issues in question 7.1. CIS also has a question about whether the innovation helped to meet regulation and also asks about process-related effects in terms of reduction in the use of material and energy for new innovations (adopted in the last 3 years). We suggest to add similar questions on waste and pollution effects of product manufacturing and product use.

A concrete suggestion is:

During the three years 2006 to 2008, did your enterprise introduce a product (good or service), process, organisational or marketing innovation with any of the following effects?

Please tick all that apply		*If yes: Was this a major objective for the innovation?*	
	Yes	**Yes**	**No**
Environmental benefits within your enterprise			
Reduced material use per unit output	☐	☐	☐
Reduced energy use per unit output	☐	☐	☐
Replaced energy consumption with renewable energy sources	☐	☐	☐
Replaced materials with safer or less hazardous substitutes	☐	☐	☐
Reduced soil, water, or air pollution	☐	☐	☐
Recycled waste, water, or materials	☐	☐	☐
Environmental benefits obtained by the user of a product (good or service)			
Reduced energy use	☐	☐	☐
Reduced air, water, soil or noise pollution	☐	☐	☐

Improved recycling of product after use	☐	☐	☐
None of the above	☐		

Answers to these questions will be of great benefit in learning about the nature of eco-innovation in companies in various countries and sectors. Combined with questions on organisational issues, it becomes possible to determine whether a company is an eco-innovator in a purposeful manner.

Given the CIS focus on companies, it is illsuited for obtaining information about technologies and specific products from multiproduct firms. Information about specific technologies and products should be obtained through other sources (could be special surveys).

One major problem of surveys in general is that there are normally only few possibilities to link survey data with official statistics or other survey data. Therefore, the survey itself has to provide information on the relevant control variables such as the influence of different policy instruments.

To guide future survey analysis by Eurostat and others, an **optimal set of survey questions was identified**, both for the determinants and for the control variables for eco-innovations.

Determinants (drivers and barriers) of eco-innovation

- Inputs: financial and human resources, R&D expenditure supporting the technological capabilities of a firm;
- Environmental policy framework (e.g. regulatory stringency, different environmental policy instruments such as technology-based standards, emission taxes or liability for environmental damages);
- Existence of environmental management systems, practices and tools;
- Demand pull hypothesis: expected market demand, profit situation in the past;
- Appropriation problem: competition situation (e.g. number of competitors, concentration of the market), innovation cooperation;
- Influence of stakeholders and motivations for environmental innovation (e.g. public authorities, pressure groups such as industry or trade associations);
- Availability of risk capital;
- Availability of high-skilled labour force.

Control variables and impacts

Firm-level attributes (sector, size, stock market listing, employment, value of shipments);
Commercial conditions (scope of the firms' markets, competition, sales, profitability);
Environmental impacts of the facilities' products and production processes by different environmental fields (importance of each impact and change in impacts during the last three years).

The following questions appear useful questions for learning about environmental policy as innovation source and whether the eco-innovation is environmentally motivated or not.

1) Environmental policy as innovation source

a) Did you realise innovations from 20XX to 20XY (new or significantly improved products or production processes) predominantly because of existing or anticipated environmental policy measures?
Yes, No

b) If yes, which of the environmental policy measures were decisive for the introduction of these innovations, please describe the measures in order of their importance:
……………………………………………….

2) How important were each of the following effects of your product (good or service) and/or process innovations introduced during the three-year period 20XX-20XX?
Degree of importance: Not relevant - Low - Medium - High

Reduced materials and energy per unit output
Reduced environmental impacts
Improved health and safety

3) Please answer the following questions if you reported high or medium reduced environmental impacts of your innovation activities in question 2:

a) Do you consider the reduction of environmental impacts as the **main purpose** of your innovation activities?
Yes
No

b) Predominant category of your innovation:
Product innovation
Process innovation
Organisational innovation

Eco-innovation activities may also be analysed through **patent analysis**. Patents are granted for inventions which are novel, inventive (non-obvious) and have an industrial application (useful), involving an exclusive right to exploit (make, use, sell, or import) an invention over a limited period of time (20 years from filing). The standard of novelty and utility imposed on the granting of such a right is not very high. In Europe, the European Patent Office (EPO) grants about 70% of the patents applications. In the US more than 80% of the patents applications are granted. Patents can be obtained for major and minor inventions.

For measuring innovation, patents have emerged as an important indicator, together with research and development expenditures. The main advantage of patents is that they are publicly available for rather long time series and provide detailed technological information. The long time series make patents unique among innovation indicators. Using patent data, it is possible for researchers to collect data in highly disaggregated forms and to subject this to statistical analysis. The cost of processing patents data is lower than survey-based data.

As a measure of invention patents have a close (if not perfect) link to technical invention. Over the last two centuries, there are very few examples of major technical inventions that were not patented. But the value of patents differs greatly. The majority of patents are never used (sleeping patents).

The use of patent data enables researchers to study and to assess different features of innovative processes. Seven attributes of innovative activities that can be evaluated through patent data.

The level of innovative activity
Types of innovation and technological competencies of organizations
Technology strengths of nations
Technology diffusion
Source of invention
Technological spillovers and knowledge relatedness
The degree of novelty

In spite of the wealth of information contained in patents, their use as innovation indicators also contain strong weaknesses and biases which researchers should be aware of. First of all, patent data do not capture all innovations, but a restricted part of it. According to Crepon et al. (2000), the percentage of patented innovations in the French industrial manufacturing sector is on average 30% and differs greatly between sectors. A second limitation is that the value distribution of patents is very skewed. A few patents have large value, whereas many have very low value. Hence the usefulness of simple patents counts is limited, as they put on an equal footing patents of very different values. Different methodologies have been proposed to evaluate the value of patents. For example, one may ask patent owners about the money they earned with their patent, or look at the renewal of patent and at the number of citations. Here the development of the OECD Triadic Patent Family database is of great interest since it provides a database of "high quality" inventions. The use of *patent families* - i.e. filings of the same patent application (which share the same priority date) in different countries – enables the researcher to focus on the most valuable innovations. Indeed, because of the added costs of filing abroad, the less valuable patents are usually filed only in the inventor's home country.

A great problem for eco-innovation research is that patent classification systems do not provide specific categories which cover environmental patents and there is also no widely accepted agreement in the literature as to what constitutes an environmental technology. The practical solution around this problem is to use relevant search terms. Words as "environmental" or "environment" are not good terms; they may not be used in descriptions for being overly broad or may refer to non-ecological aspects. One has to use more specific categories.

For patent analysis we propose the following four-step method:

- Step 1: Choice of relevant parameters (could be the pollutant under consideration, for example, SO_2).
- Step 2. Patent search using keywords – based upon relevant environmental technology aspects – in order to generate a set of *potentially* relevant patents
- Step 3. Screening of the abstracts of the patents generated in order to determine whether it indeed was a relevant patent. Irrelevant patents are excluded.
- Step 4. Retrieval of patent families. These are the patent applications the inventor filed in the countries other than the home country. This helps to exclude patents of minor importance.

For analyzing patents researchers must have an adequate knowledge of the technologies under consideration and carefully screen patents found through a patent search. Citation analysis helps to select relevant patents and eliminate patents that have no commercial application.

The *use* of patent data poses also methodological difficulties. How does one allocate patent data organized by firms or by substantive patent classes into economically relevant industry or product groupings? The OECD Technology Concordance (OTC) presented in Johnstone (2002) may be used to transform IPC-based patent data into patent counts by sector of the economy, but this does not work well for patents used in multiple sectors.

Patents have become an important method for eco-innovation analysis because of data availability. When doing patent analysis and using the results of patent analysis one has to be aware of two important limitations. First, patents measure inventive activity, not real innovation. Second, not all eco-innovations can be usefully analysed through patent analysis. Eco-patents mainly measure inventions that underlie green *product* innovations and *end of pipe technologies*, whose environmental impacts are specific aims and motivations of the inventions. For these kinds of innovations it is acceptable to use patent analysis, provided they are carefully screened (for which one may use the four-step method). For other types of innovation, patent analysis does not appear very suited.

Innovation may also be measured using **documentary and digital sources**. Here one explores innovation announcement sections in trade journals and product information databases. An example is the green car database established by Yahoo. The advantage is that they measure innovation *output* rather than innovation *inputs* (such as R&D expenditures) or an intermediary output measure (such as patent grants). The possibilities for using this method have been examined by MEI researcher Fred Steward.

A real problem is that there are few product databases with environmental information. For specific products, a database of eco-innovation output may be created by sampling the 'new product announcement' sections of technical and trade journals or by examining product information provided by producers. The strengths of the product announcements sampling method are that:

- The indicator is timely: announcements times are close to the date of commercialisation.
- The data are relatively cheap to collect, even without any direct contact with the innovation firms, so students can do it and firms would not be bothered with time-consuming questionnaires.
- From the description, it is possible to infer information about the innovation, for instance whether it is a radical innovation, and what the performance characteristics are.

Some limitations are:

- Adequate journal selection is a necessary precondition in order to ensure measuring innovations in a comprehensive way.
- In-house process innovations are rarely reflected in the technical and trade journals. Direct innovation surveys and patent data are probably superior indicators for this type of process innovation.
- Although such literature-based innovations can be objectively counted, they can only be subjectively valued in importance.

The information from the trade journals may be available digitally. Digital information about products may also be available from the internet – allowing researchers to track the evolution of performance characteristics for selected products. Digital new announcement and consumer information databases are a neglected source of innovation output indicators, which should be used more often. Such research is aided by product disclosure requirements in the EU, which is a positive development. Some systematic and selective exploitation of these could be of value for international comparative monitoring of eco-innovation at European and global levels.

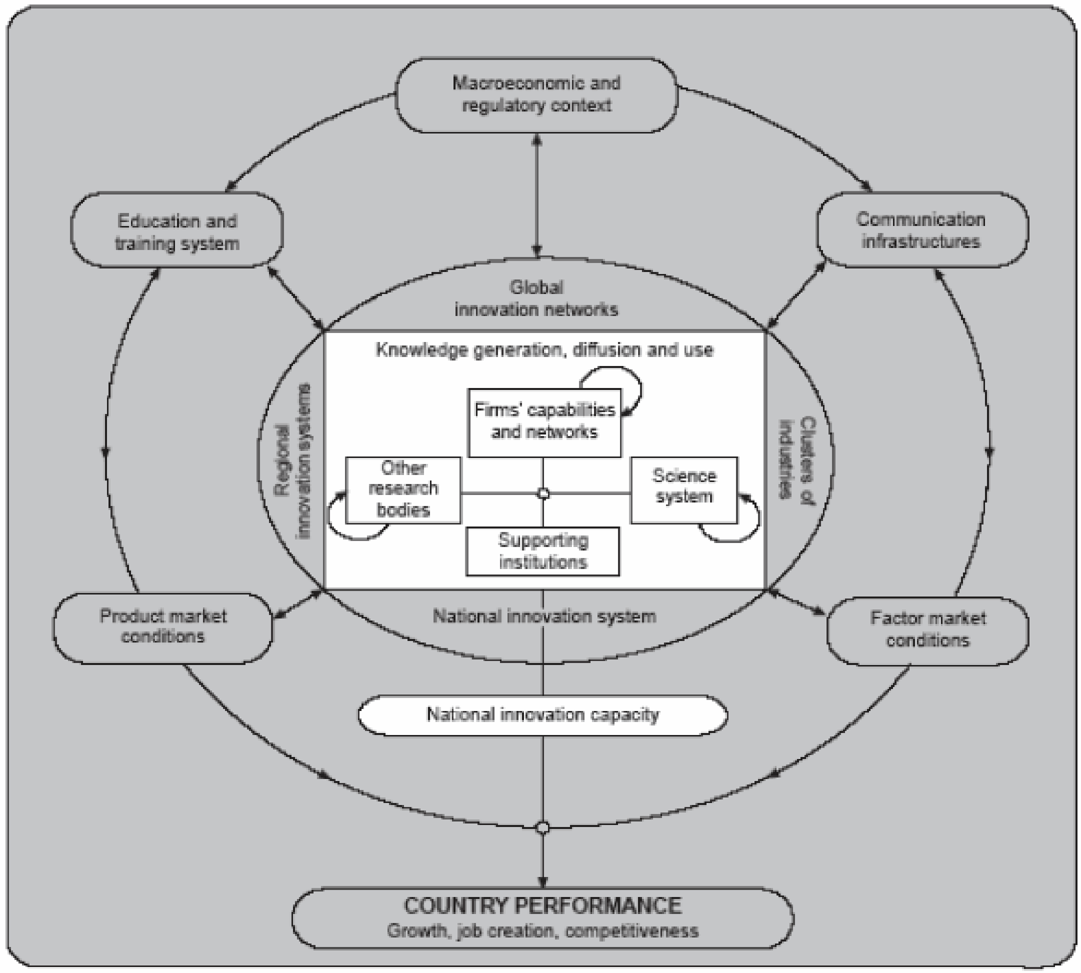
The supra-organisational context as a shaper of eco-innovation

In innovation research much attention has been given to knowledge networks, as places of learning and technology creation. The networks may involve users, suppliers, universities and also competitors. Knowledge may be exchanged through contractual relationships or informally.

Interactive learning processes have been studied in surveys, for instance CIS5 where innovators are asked about information sources (internal, market, universities and public research institutes, and other sources such as conferences, journal, professional and industry associations), and co-operation partner (other enterprises, suppliers, clients, competitors, consultants, universities and higher education institutes, government or public research institutes). Companies are also asked which type of co-operation partner they found the most valuable for their innovation activities.

Innovation research has shown that innovation occurs within a wider context that shapes innovation processes, innovation output and economic and environmental outcomes. It is important therefore to also collect data on contextual factors. This wider context consists of the values, beliefs, knowledge and networks of actors, the technologies in place, the product market conditions, factor market conditions, the education and training system, physical infrastructure and the macroeconomic and regulatory context. A visual representation of this is given in Figure 2.

Figure 2. A systemic view on innovation



Source: OECD (1998)

In MEI six approaches into the systemic and dynamic aspects of innovation have examined:

- The Innovation System Frame
- The National Innovation System concept
- National Innovative Capacity concept
- The technological innovation system concept
- The system innovation approach
- A socio-cultural perspective

Metrics used in these approaches have been examined in terms of their relevance for eco-innovation measurement, with the aim of defining metrics for eco-innovation. This analysis resulted in 23 useful indicators, grouped into 5 categories: the firm, conditions, the linkages, incremental versus radical innovation, overall performance indicators. These questions are largely based on metrics used for innovation though they also include several original metrics.

Table 1: List of proposed eco-innovation indicators

	Indicator	**Data Source**
	The Firm	
1	R&D expenditures for environmental protection in industry.	STATCAN currently collects this information
2	% of firms with EMAS or ISO14001	Numbers collected by German Federal Environmental Agency
3	% of firms with environmental mission statements and/or officers	Would need to survey for this.
4	Managers opinion of eco-innovation	Possibly for inclusion in CIS
	The Conditions	
5	'Green Tax' as a percentage of government budget	OECD data
6	Government expenditures on environmental R&D as: % of total R&D expenditure % of GDP	GBAORD data
7	Uptake of environmental subsidies for eco-innovative activity	Government data
8	Financial support for eco-innovation from public programmes	OECD data
9	Demand for eco-innovative products.	Measure demand using survey techniques.
10	Environmental expenditure in college/university research	National Science Foundation collect this for US. EU source unknown
11	Number of environmental graduates, MScs or PhDs	EIS & IRCE report
12	Waste management costs (landfill tariff etc)	Government data
13	Executive opinion on environmental regulation (Stringency and transparency).	For possible inclusion in CIS
14	Attitudes towards eco-innovation	Eurobarometer data
	The Linkages	
15	Frequency of eco-innovation workshops/conferences and number of people attending.	Web based searches
16	Value of "green funds" made available by financial institutions for innovating companies.	SRI fund service data
17	Managers perception of overall quality of environmental research in scientific	For possible inclusion in the CIS

	institutions.	
	Radical/incremental innovation indicators	
18	Ratio of eco-start-ups to incumbents in the market	Companies house data or European business register.
19	Frequency of new entrants to the market.	Companies house data or European business register
20	Diversification activities of incumbents, investment in smaller operations outside core business.	EUROSTAT entry and exit data
21	Seed and start-up venture capital for eco-innovative firms (investment per 1000 GDP)	IRCE report or interpretation of EVCA data.
	Overall performance indicators	
22	Eco-patents in triadic patent families per million population	US EU and Japan Patent offices
23	Material productivity of eco innovative firms (TMR per capita or GDP)	IRCE report
24	Share of eco-innovative firms as a percentage of all firms (may need to divide into manufacturing and services)	CIS. May need to be reanalysed.

Notes on sources:

CIS: Community Innovation Statistics. Collected by EUROSTAT available from: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1090,30070682,1090_33076576&_dad=portal&_schema=PORTAL

EIS: European Innovation Scoreboard. Collected by the European Commission available from: http://trendchart.cordis.lu/

Eurobarometer. Available from: http://www.gesis.org/en/data_service/eurobarometer/

EUROSTAT: EUROpean STATistics. Available from: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1090,30070682,1090_33076576&_dad=portal&_schema=PORTAL

EVCA: European Venture Capital Association. Available from: http://www.evca.com/html/home.asp

GBAORD: Government Budget Appropriations of Outlays for R&D. Collected by EUROSTAT available from: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1073,46587259&_dad=portal&_schema=PORTAL&p_product_code=KS-NS-06-017

IRCE: Impact of RTD on Competitiveness and Employment. Available from: http://cordis.europa.eu/era/benchmarking.ht

SRI: Socialy Responsible Investment. Available from: http://www.eurosif.org/sri

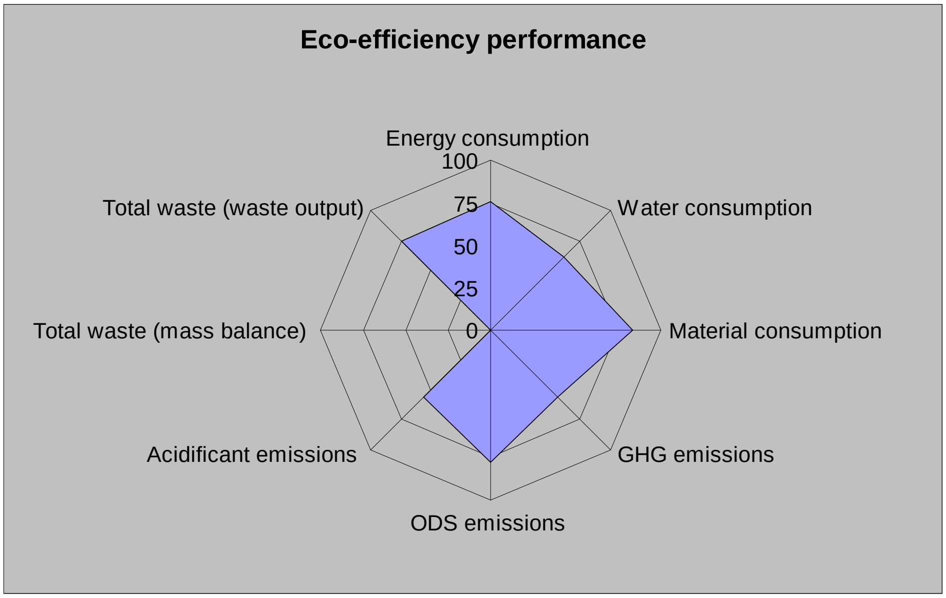
STATCAN: STATistics CANada. Available from: http://www.statcan.ca/

The indicators presented in Table 1 have been designed or adapted through the analysis of current innovation theory and indicators. It should, however, be acknowledged that this list is not proposed as a definitive set of indicators of eco-innovative capacity. These metrics have all been chosen in part because of the practicality of collecting the relevant data. The proposed list of indicators was discussed at the final meeting of the MEI and ECODRIVE (Measuring eco-innovation: ecological and economic performance and derived indicators) projects where the following issues were raised. Concerns were raised over whether or not EMAS or ISO 14001 (indicator 2) are accurate proxies for eco-innovative tendency, as the evidence for the relation between environmental management systems and eco-innovative activity is mixed. Similarly, concerns were raised over indicators 3 and 4, where the link between eco-innovative activity and presence of "environmental officer" or "managers' opinions" of eco-innovation could be questioned. At best, these are likely to be indicative of incremental eco-innovation with the firm, rather than radical eco-innovation. Concerns were also raised on the link between the expenditure on environmental research in tertiary education and the science base contribution to eco-innovation, which is not well established. Further research is needed to develop the evidence base for these indicators. As to "diversification activities" referred to in indicator 20; this may not be driven by a desire to innovate. Questions also arose when considering the ease of recovering these data from EUROSTAT enter and exit data, and their relevance for eco-innovation, given the inability to distinguish between innovation and eco-innovation in those data. The indicators presented here are considered as complementary to indicators currently collected on innovation considered more generally.

A benchmark indicator for eco-innovation based on company data

Environmental benchmarking is a modern evaluation technique aimed at comparing the environmental performance of a company with the best available practices or with a predefined benchmark. The comparison is based on a number of qualitative and quantitative environmental indicators of strategic importance allowing the comparison of several companies active in the same sector. Benchmarking is also a framework within which indicators and best practices are examined in order to determine areas where company performance can be improved.

In MEI possibilities for creating a benchmark indicator for eco-innovation have been analysed by researchers at LEIA, resulting in an actual indicator for use, which has been pilot tested. The indicator is based on company information about innovation and environmental performance obtained from a survey. For innovation input and output indicators are used, financial value indicators and organizational innovation indicators. For eco-efficiency, seven indicators are used to be benchmarked in a polygon. The bigger the polygon area, the better the performance according to eco-efficiency.



Based on the eco-efficiency indicator and innovation indicator an *eco-innovation* indicator is constructed (details of the indicator can be found in the MEI report prepared by LEIA).

Data needs for modelling environment-saving technical change

Economic models are used to determine the effects of environmental and energy policies. In MEI we surveyed **what data are used in economic models** with technical change that saves the environment. Originally technical change was incorporated as an autonomous parameter. Recently, efforts to endogenize technological change have been a major subject for economists. With regard to economic climate change modelling, this approach opens new perspectives for handling prospective issues concerning mitigation policies and emission reductions. The availability of corresponding data is a difficulty for the calibration and estimation of certain parameters in economic models.

The relevant models fall into two categories: bottom-up models and top-down models (an emerging third category is hybrid models). Bottom-up approaches commonly use energy systems as their standard modeling tool presenting a highly disaggregated view of the economy. Actual technologies are incorporated in this type of model. Technological progress is mainly represented through learning-by-doing.

Top-down models treat energy systems in an extremely aggregated manner. They focus particularly on the examination of the entire economy, thus offering a rather macroeconomic view, incorporating continuous, smooth production functions where possibilities of substitution are represented by substitution elasticities. Technical change is modeled primarily via investment in R&D and technological learning.

Data availability is mixed and far from ideal. R&D expenditures are not broken down into environmental R&D and non-environmental R&D. For energy technologies we have good R&D statistics for public R&D but not for private R&D. For non-energy eco-innovation there is no data on R&D or innovation output. The informational basis of E3 models is found to be poor as far as eco-innovation is concerned outside the energy sector.

Measuring the competitiveness of eco-innovation

Better data on eco-innovation is needed also for learning about the *effects* of eco-innovation on the **competitiveness** of nations and sectors. The effects are likely to vary, depending on the type of innovation and context in which it is used. Eco-innovation can contribute to competitiveness and create new jobs. Two important ways are (1) by helping industry to lower costs thanks to lower resource costs, and (2) by creating products that can be sold into the world market. At the same, it may harm competitiveness of manufacturing firms when they are forced to adopt costly technologies.

Also here a measurement problem exists. Like eco-innovation, competitiveness may be measured variously and depends on firm internal capabilities as well as on factors *external* to the firms: rivalry forcing companies to innovate, demand conditions and feedback from users, factor conditions, the presence of related and supported industries, education, skill and intellectual property right protection.

For measuring the competitiveness of sectors, different measures may be used:

Indicators based on trade performance
Indicators based on costs and labour productivity
Single indicators based on input measures for innovation
Systems indicators based on sets of indicators

Of these, relative trade performance (whether you export relatively much compared to other nations) is the best measure. The revealed comparative advantage (RCA) is a better measure for competitiveness. But this is not a perfect measure either because it partly reflects international specialisation. One should thus look beyond RCA. Germany has a flourishing solar and wind power industry, thanks to feed-in law but German consumers and industry are paying more for electricity than they otherwise would. The higher electricity costs may hamper the competitiveness of other sectors, especially of electricity-intense sectors.

For assessing *future* competitiveness data on innovation expenditures, R&D, business startups, and relative patent advantages (RPA) may be used. None of these is a reliable predictor because future competitiveness also depends on institutions, infrastructure, education, the macroeconomy, regulation and education. The quality of these can be measured through the Global Competitiveness Index, the Business Competitiveness Index) and the Competitiveness Scoreboard, provided special attention is given to things that are especially important for eco-innovation.

As a conclusion, for assessing present and future competitiveness one should not focus on single measures, but combine different measures. Competitiveness is difficult to measure and analyse, both in theory and in practice. Different indicators are needed for analyzing something that is heterogeneous and dynamic, depending on both micro factors and macro factors. The conclusion from MEI is that the study of competitiveness calls for a multilayered analysis involving the use of different statistics. In general costs and prices are not good measures because there may be important quality aspects that they do not indicate. The revealed comparative advantage (RCA) is a better measure for competitiveness. But this is not a perfect measure either because it partly reflects international specialisation. One should thus look beyond RCA. Germany has a flourishing solar and wind power industry, thanks to feed-in law, but German consumers and industry are paying more for electricity than they otherwise would. The higher electricity costs may hamper the competitiveness of other sectors, especially of electricity-intense sectors (unless these have found ways to reduce their electricity intensity but there may be a cost involved in that as well). Both effects are difficult to estimate precisely; the only reliable way of estimation would be the application of a computable general equilibrium model.

Looking at data availability, a clear problem for assessing competitiveness is that eco-innovation is not an official category in trade statistics. We have sales information from companies selling certain products but such information is not collected systematically across the EU. Interesting work has been done by Legler and colleagues for so-called *potential* environmental goods. They have calculated RCA and RPA values for product categories which contain a fair share of environmental goods and services.

Besides statistics we also need further case study analysis to determine, for instance, why the Danish have a flourishing wind turbine industry and the Netherlands, historically known for its windmills, has not. Such insights are of great importance to the lead market policy plans of the EU for eco-innovation. The success of such policies will depend on first mover advantages and innovation capabilities.

Final conclusion

Eco-innovations are needed to make a transition towards cleaner production, eco-friendly products, recycling, sustainable mobility and water management, and sustainable energy. Some countries and sectors have traversed further in this direction than others. There is a need for further greening and world wide there is a need for transitions to carbon-low energy systems and sustainable mobility.

Eco-innovation is something multifarious. The typology of MEI may prove helpful in categorizing eco-innovations and create information for each of the categories. According to the experts in MEI, eco-innovation research and data collection should not be limited to products from the environmental goods and services sector (EGS) or to environmentally motivated innovations but should cover all innovations with an environmental benefit.

This has led us to a definition of eco-innovation in which environmental performance instead of environmental aim is the main determinant. Something is an eco-innovative product, process or system if is more environmentally benign than "the relevant alternative". The relevant alternative may be the technology that is in use in a company or the normal technology in a sector (gas or coal burning stations in the case of electricity generation). Eco-innovation does not have to be the most environmentally benign option. It is a relative concept. Whether something is an "eco-innovation" crucially depends on an overall assessment of environmental effects and risks. For this life cycle assessment based on multi-attribute value theory can be used.

Measuring technological change presents a common and well-known problem for innovation output research. In practice, four different types of measures have been used to quantify technological change:

Input measures: R&D expenditures, R&D personnel, researchers, and innovation expenditures (with and without intangible investment such as design expenditures and software and marketing costs);

Intermediate output measures: the number of patents; numbers and types of scientific publications

Direct measures of innovative output: the number of innovations, descriptions of individual innovations, data on sales of new products

Indirect measures derived from aggregate data: changes in resource efficiency and productivity using decomposition analysis.

In the absence of data about R&D and direct measures of innovative output, patents are often used for measuring eco-innovation. An advantage of patents is that they can be counted. They also can be classified according to technological area, sector of use/origin, and innovation property because the patent files contain a description of the invention. As to the technical significance of a patent, it is difficult to assess from patent files (although the description may give an idea of this); one way around this problem is to look at patent citations. A significant patent is likely to be cited more often. For analysing organisational innovation and process changes, patent analysis is not suited.

More efforts should be devoted towards *direct* measurement of innovation output using documentary and digital sources. The advantage is that they measure innovation *output* rather than innovation *inputs* (such as R&D expenditures) or an intermediary output measure (such as patent grants). Little use has been made of this method, primarily because of a lack of funding and absence of product databases with environmental information. Environmental reporting requirements may help to create relevant information, aiding innovation research. Innovation may also be measured *indirectly* from changes in resource efficiency and productivity.

Although some methods are better than others, no single method or indicator is ideal. One should apply different methods for analyzing eco-innovation – to see the "whole elephant" instead of just a part.

Concrete suggestions for combining measures and methods are:

- To assess the value of a patent one could contact inventors and ask questions about the patents, for example to what extent they are spurred by specific regulations, the economic gains for the inventor, etc.
- Patent patterns could be compared with R&D patterns and data about innovation output collected through documentary and digital source analysis (this helps to assess the value of patent analysis and obtain more robust research findings based on multiple data sources)
- Surveys are useful for collecting data not only on eco-innovative activities in companies but also for collecting data on conditions and non-organisational factors, for use in scoreboards about eco-innovative capacities and facilitating factors outside companies
- Information from scoreboards might be combined with information from survey analysis and other sources in econometric studies to analyse the influence of framing conditions (regulation, venture capital, …)

In general the knowledge base for eco-innovation is poor. One reason for this is that eco-innovation is not an official sector. Eurostat is currently drafting a compilation guide for collecting stats on the Environmental Goods and Services Sector (EGSS), so they are also in the process of defining the sector from the activities point of view (the NACE codes). They have defined a "core" industry group (NACE 25.12, 37, 41, 51.57 and 90), but the much larger "non-core" group of industries is yet to be defined. But as explained eco-innovation is best understood as something broader than products and services from the EGSS.

A positive development is that the next Community Innovation Survey (CIS2008) will have a special module on eco-innovation, which in 2010 will produce important information about the nature of eco-innovation and the determinants. MEI researchers contributed to the formulation of questions. Information from this module will be available in 2010.The module is voluntary and will not cover all

Member States. Information will prove to be of enormous value for learning about the nature and magnitude of eco-innovation activities in European companies. A limitation remains that the CIS only provides general information for the company as a whole. It does not give information about specific technologies or products.

Research needs

Research needs are various. One area for future research is the macro-effects of micro-behaviour. Eco-improvements at the micro level do not automatically lead to macro-improvements. The links between micro and macro are complex for the following reasons:

- Cost-saving eco-innovations generate wealth that will be spent on goods and services that have negative environmental impacts, creating environmental burden in a second round. Prime examples are the use of energy-saving lights for outdoor lighting and holiday trips involving airtravel (*rebound effect*)
- Cost-increasing eco-innovation are likely to contribute more to an absolute decoupling but at the expense of a lower economic growth. Exports yield a positive economic effect (this suggests that there is *still an important role for pollution control technology* (end-of-pipe solutions) to achieve an absolute decoupling)
- Many normal innovations qualify as eco-innovations (by being more environmentally benign than relevant alternatives), but environmental gains will be impaired by economic growth produced by those innovations.
- To assess the impacts of eco-innovation one should look at what happens within and across value chains from resource extraction to waste management.
- Micro-behaviour is affected by macro-factors (taxes etc.)

Other topics for research are:

- Measuring the greenness of national systems of innovation (green taxes, education, collaboration, venture capital, subsidy schemes, …)
- Eco-innovation barometer focusing on company beliefs relating to environmental issues (cost or opportunity), environmental strategies, eco-innovation activities and green values
- Lead markets and eco-business (about first mover and second-mover advantages and the role of policy)
- Drivers and institutional barriers of eco-innovation in the field of renewable energies (a comparative study across the EU, based on survey analysis).
- Appraisal of environmental technology innovation systems: competitiveness assessment and Life cycle analysis

Analysis of national road maps of ETAP, identifying best practices and using these for defining comprehensive policy packages which promote and sustain innovative activity across the chain.
Analysis of CIS data about eco-innovation aspects, combined with analysis of framework conditions (assessed outside CIS)
Analysis of when eco-innovation produces a win-win.

The answers to these questions critically depend on new and better data. They also depend on research projects being funded on those issues. The growing attention from policy makers to eco-innovation should be backed up with support for data collection and research.

More information about the MEI project can be found at http://www.merit.unu.edu/MEI or obtained from Dr René Kemp (UNU-MERIT) project leader of the MEI project
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About MEI
MEI stands for Measuring eco-innovation. It is a project for DG Research of the European Commission (Call FP6-2005-SSP-5A, Area B, 1.6, Task 1). The project has been carried out in collaboration with Eurostat, the European Environment Agency (EEA) and the Joint Research Center (JRC) of the European Commission.

Research partners
UM-MERIT (NL) (coordinator, project leader René Kemp)
ZEW (FRG)
DTU (DK)
ICL (UK)
LEIA (ES)

In collaboration with
Eurostat
European Environment Agency (EEA)
Joint Research Center (JRC)

Project officer: Dr Michele Galatola of DG Research, European Commission

Messung von Umwelt-Innovationen (Published in German Magazine Okologischer Wirtschaften)

Umweltinnovationen stehen derzeit weit oben auf der Agenda europäischer und deutscher Politiker. Darin äußert sich die Hoffnung, Wirtschaftswachstum und Umweltschutz unter einen Hut zu bringen, und mögliche Konflikte zwischen wirtschaftlichen und ökologischen Zielen zu entschärfen. Denn Umweltinnovationen versprechen einen Sekundärnutzen in Form von verbesserter Wettbewerbsfähigkeit, umweltverträglichem Wachstum und der Schaffung von Arbeitsplätzen. Sowohl die Lissabon-Agenda der Europäischen Union als auch das Memorandum „Ökologische Industriepolitik“ des Bundesumweltministeriums zeugen davon, dass umweltpolitische Maßnahmen neben der Qualität von Luft, Wasser und Boden auch einen Beitrag zur Verwirklichung dieser ökonomischen Ziele leisten sollen.

Projekthintergrund

Vor diesem Hintergrund sollte das europäische Forschungsprojekt „Messung von Umwelt-Innovationen“ (MEI), das zu Beginn dieses Jahres abgeschlossen wurde, den Stand der Forschung auf diesem relativ jungen Forschungsgebiet zusammenfassen, und operationale Indikatoren zur Messung von Umweltinnovationen vorschlagen. Im Rahmen von MEI wurden Konzepte, Definitionen, Typologien und Indikatoren für Umweltinnovationen entwickelt. Im Projekt wurde Stärken und Schwächen verschiedener Meßmethoden, wie Patentanalysen, Befragungen oder bibliometrischer Analysen, analysiert und bewertet.
Das Projekt wurde im Auftrag der Generaldirektion Forschung der Europäischen Kommission durchgeführt, in Kooperation mit dem Statistischen Amt er Europäischen Gemeinschaft Eurostat, der Europäischen Umweltagentur (EEA) und dem Joint Research Center (JRC) der Europäischen Kommission. Im Projektkonsortium vertreten waren unter anderem das Innovationsforschungsinstitut MERIT der Universität Maastricht, das Zentrum für Europäische Wirtschaftsforschung (ZEW) sowie das Imperial College London.

Definition von Umweltinnovationen

Es existieren verschiedene Definitionen von Umweltinnovationen. Eine dieser Defintionen besagt, bei Umweltinnovationen handle es sich um „new and modified processes, equipment, products, techniques and management systems that avoid or reduce harmful environmental impacts” (Kemp and Arundel, 1998, Rennings and Zwick, 2003). In dieser Definition wird die Umweltinnovationen an ihrem Umweltbeitrag – im Vergleich zu herkömmlichen Alternativen - gemessen.

Oft wird der Begriff Umwelttechnologien synonym zum Begriff der Umwelttechnologien verwendet. Der Begriff Umwelttechnologien ist jedoch enger begrenzt und umfasst solche Maßnahmen, deren Umweltbeitrag beabsichtigt ist. Man könnte auch von sogenannten intendierten Umweltinnovationen sprechen, in Abgrenzung von nicht-intendierten Umweltinnovationen, die lediglich aufgrund einer erwarteten Kostenersparnis (z.B. geringerer Verbrauch von Energie oder Material) durchgeführt werden.

Die Diffusion von Umweltinnovationen führt zu einem relativen Rückgang der Umweltbelastung (Umweltbelastung pro Outputeinheit). Zu einem absoluten Rückgang müssten auch Faktoren wie die Nachfrage nach Gütern oder das allgemeine Wirtschaftswachstum beitragen, das tendenziell die relativen Rückgänge überkompensieren kann. Kostensparende Innovationen beispielsweise sind mit positiven Wohlstandseffekten verbunden, d.h. das zusätzliche Einkommen wird für andere Konsumgüter ausgegeben, womit wiederum Emissionen und Ressourcenverbrauch verbunden ist (rebound effect).

In der Definition von Umweltinnovationen wird ein Unterschied gemacht zwischen Technologien, die der Vermeidung von Umweltbelastungen dienen, und solchen, bei denen die Umweltfreundlichkeiten eher ein Nebeneffekt des eigentlichen Innovationsziels war. Die erste Kategorie lässt sich als „intendierte Umweltinnovationen“ bezeichnen, die zweite als “umweltfreundliche normale Innovationen”. Der Begriff Umweltinnovationen sollte breit angelegt sein und auch die letztere Kategorie umfassen, die von ihrer Anzahl und ihrer Umweltwirkung her sehr bedeutsam ist. Die breite Definition, für die sich letztlich das MEI-Konsortium entschieden hat, lautet:

> **Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is <u>novel</u> to the firm or user and which <u>results</u>, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) <u>compared to relevant alternatives</u>.**

Drei wesentliche Elemente der Definition sind: Erstens muss ein Produkt, Prozess oder eine organisatorische Maßnahme lediglich für den Betrieb neu sein. Dieses Merkmal ist wesentlich für die Definition des Oslo Manuals (OECD/Eurostat 2005), an der sich die empirische Innovationsforschung orientiert. Eine Innovation verlangt keine vorhergehenden Forschungs- und Entwicklungsaktivitäten, sondern kann beispielsweise auch in der Übernahme neuer Technoligen von anderen Firmen bestehen. Das Oslo Manual betrachtet die Innovation aus der Firmenperspektive. So ist die Adaption einer neuen Technologie bereits als Innovation einzustufen, auch wenn es sich nicht um eine Marktneuheit handelt. Zweitens muss keine Absicht hinter der Umweltverbesserung stehen (wir schauen lediglich auf die Wirkung) und dass wir die Innovation mit relevanten Alternativen vergleichen.

Der Begriff Umweltinnovation hängt stark von der Umweltbewertung ab, für die als methodisches Tool Lebenszyklusanalysen empfohlen werden. Dies mag bei einer Breitenbefragung von Umweltinnovationen zu Problemen führen, weil die Bewertung eines Interviewten nicht unbedingt auf einer Lebenszyklusanalyse basiert. In diesen Fällen muss ein Kompromiss hinsichtlich der Informationsgrundlage gemacht werden. Lebenszyklusanalysen sind bislang für eine Reihe von Produkten durchgeführt worden, sie führen jedoch keineswegs immer zu eindeutigen Ergebnissen.

Es gab einen breiten Konsens im Projektteam, dass die Datensammlung und Indikatorenforschung sich keinesfalls auf die beabsichtigten Umweltinnovationen begrenzen soll. Umweltschutz als Motivation ist zwar eine wichtige Determinante für Umweltinnovationen, aber darüber hinaus sollten nicht die zahlreiche “normalen” Innovationen ignoriert werden, die ebenfalls positive Umwelteffekte erzeugen, aber aus anderen Gründen wie beispielsweise Kostensenkung durchgeführt werden. Zwar wird dann die Grundgesamtheit auf alle Innovationen ausgeweitet, aber es steckt auch in den meisten Innovationen ein Umweltpotential, das untersucht und gemessen werden sollte.

Typologie von Umweltinnovationen

Im Projekt MEI wurde auch eine Typologie von Umweltinnovationen entwickelt. In Anlehnung an das Oslo-Manual (das zwischen Produkt-, Prozess- und organisatorischen Innovationen unterscheidet) wurde eine Einteilung vorgenommen in:

- Umwelttechnologien,
- organisatorische Innovationen,
- Produkt- und Dienstleistungsinnovationen sowie
- grüne Systeminnovationen.

Der Begriff Umwelttechnologien bezieht sich auf Prozesse und Messtechnologien (wie beispielsweise Sensoren zur Identifizierung toxischer Substanzen). Unter diese Kategorie fallen sowohl additive als auch integrierte Prozesstechnologien, einschließlich Abfalltechnologien, grüne Energietechnologien, Wasserwirtschaft sowie Lärmdämmung.

Organisatorische Innovationen sind Maßnahmen, Methoden und Managementsysteme, die sich (auch) mit Umweltfragen befassen. Umweltmanagementsysteme wie EMAS oder ISO 14001 sind bekannte Beispiele, aber auch punktuelle Maßnahmen wie die Durchführung von Lebenszyklusanalysen oder die Publikation von Umweltbereichten würden unter diese Kategorie fallen.

Umweltfreundliche Produkt- und Dienstleistungsinnovationen umfassen auch nicht-technische Neuheiten. Hierzu zählen auch Consulting-Angebote für Firmen, technische Planungsbüros und ähnliche Dienstleistungen. Auch Dienstleistungen wie beispielsweise Car-Sharing würden unter diese Rubrik fallen.

Grüne Systeminnovationen gehen als einzige Kategorie deutlich über den Innovationsbegriff des Oslo-Manuals hinaus. Sie sind auch nicht überschneidungsfrei mit den ersten drei Kategorien, denn sie können sowohl Produkte, Prozesse oder organisatorische Maßnahme umfassen. Es geht um alternative Systeme von Produktion und Konsum, die umweltfreundlicher sind als bestehende Systeme. Systeminnovationen erfordern ein weites Spektrum an Änderungen von Produktionstechnologien, Wissen, Organisationen, Institutionen, Infrastrukturen und möglicherweise von Konsumentenverhalten. Beispiele sind die ökologische Landwirtschaft oder ein Energiesystem, das auf erneuerbaren Energien basiert.

Wichtig ist festzuhalten, dass Umweltinnovationen keinesfalls allein technischer Natur sind, sondern auch Dienstleistungen oder organisatorische Maßnahmen umfassen. Darüber hinaus ist zu bemerken, dass alle neuen Prozesse mit einer gesteigerten Ressourceneffizienz (im Vergleich zu ihren Vorgängern) als Umweltinnovationen zu bezeichnen sind. Windenenergie als eine neue Umwelttechnologie ist eine Umweltinnovation, denn sie führt im Vergleich zu fossilen Energieträgern zu verringerten Umweltbelastungen. Dass es eventuell noch umweltfreundlichere Alternativen gibt – wie die Solarenergie – spielt keine Rolle. Auch neue Kohlekraftwerke mit steigenden Wirkungsgraden sind als Umweltinnovationen zu bezeichnen.

Es gibt jedoch auch eine Reihe von Umwelttechnologien, die relativ schwer in die genannte Typologie eingeordnet werden können. Zu diesen Technologien zählt die Nanotechnologie, die Kernfusion und die Biotechnologie. Sind diese als Umwelttechnologien zu bezeichnen? Wie weiter oben gesagt, ist dies im Einzelfall auf der Basis einer Lebenszyklusanalyse zu bestimmen. Ein Problem hierzu sind freilich die Nicht-Kommensurabilität von Umweltaspekten, d.h. der Vergleich von Äpfeln und Birnen. Weiterhin besteht auch ein Problem der Unsicherheit über potentielle Umweltschäden, da beispielsweise nicht alle Risiken von Nanotechnologie, Kernfusion und Biotechnologie bekannt sind. Bis zu einem bestimmten Grad gilt dies jedoch für alle Technologien.

Der Begriff Umweltinnovationen verlangt insofern eine klare Bewertungsgrundlage der Umweltwirkungen und Risiken von Technologien. Hierfür wird eine Lebenszyklusanalyse vorgeschlagen. Für Methoden wie beispielsweise Breitenbefragungen mag dies zu Unschärfen führen, da bei einer Abfrage von Umweltinnovationen nicht klar ist, ob jeweils eine Abgrenzung auf der Basis von Lebenszyklusanalysen getroffen wurde.

Umwelteffekte des “normalen” technologischen Fortschritts

“Normale” Technologien, die nicht dem Umweltschutz dienen, sind nicht eigens in der Typologie enthalten. Sie mögen unter verschiedenen Kategorien auftauchen, beispielsweise in Umwelttechnologien, in Produktinnovationen oder als Teil von neuen technologischen Systemen gebraucht werden, wie es beispielsweise bei der Biotechnologie der Fall ist. Finanzielle Anreize für die Produktrücknahme etwa können als Teil des Produktionsketten-Managements angesehen werden. Neue Dienstleistungen wie das grüne Leasing fallen unter die Dienstleistungsinnovationen.

“Normale” Technologien sind ein wichtiger Teil des allgemeinen Technologieportfolios, besonders dann wenn ihr Name eng mit einer ganzen Ära verbunden ist wie z.B. die Dampfmaschine, der Stahl oder heutzutage die Informations- und Kommunikationstechnologien. Vielleicht wird ja eine künftige Epoche nach der Nano- oder Biotechnologie benannt.

Die folgenden Technologien verfügen über große Umweltschutzpotentiale:

1. Biotechnologie
2. Informations- und Kommunikationstechnologien
3. Energietechnologien (erneuerbare Energien, Wärmetauscher, Brennstoffzellen)
4. Neue Materialien

Grundsätzlich ist die Entwicklung dieser Technologien nicht von Umweltschutzaspekten getrieben, sondern durch kommerzielle Interessen und durch Wissenschaft. Dennoch können nebenbei positive Umweltwirkungen anfallen, oder es fallen negative Umweltwirkungen an. Informations- und Kommunikationstechnologien sind ein gutes Beispiel. Mit Computersystemen verbundene Sensoren ermöglichen es Unternehmen, Produktionsprozesse ressourceneffizienter zu gestalten. Beispielsweise indem weniger Papier für die Produktion benötigt wird. Diese Perspektive ist vielleicht zu optimistisch. Denn wir haben in den vergangenen Jahren keineswegs das papierlose Büro erhalten. Informations- und Kommunikationstechnologien beschleunigen zudem Kontakte über weite Entfernungen und stimulieren damit den Luftverkehr, und computerbasierte Produktionsmethoden verkürzen die Produktionszyklen. Tabelle 1 zeigt positive und negative Umweltwirkungen von Informations- und Kommunkationstechnologien.

Tab. 1: Umwelteffekte von Informations- und Kommunikationstechnologien (IKT)

	Positive Wirkungen	**Negative Wirkungen**
1 Direkte Effekte	Umweltmonitoring	Umweltwirkungen der Produktion und des Gebrauchs von IKT-Produkten, z.B. Elektronikschrott
Indirekte Effekte	Verbesserte Effizienz, Dematerialisierung und Virtualisierung, z.B. durch intelligente Logistik	Proliferation elektronischer Geräte, beschränkte Substitution, z.B. e-shopping zusätzlich zu shopping trips
Strukturelle Wirkungen und Verhaltenseffekte	Veränderung von Lebensstilen und Strukturen, z.B. grüner Konsumerismus, Wachstum der sauberen Industrien	Stimulierung von Wachstum und Materialisierung, z.B. Wachstum von Fernreisen

Dies legt nahe dass normale Technologien generell nicht als Umwelttechnologien bezeichnet werden sollten. Wieder Informations- und Kommunikationstechnologien noch Biotechnologie noch Nanotechnologie sind insgesamt gesehen grün. Nur manche Zusammenstellungen von bestimmten Arten dieser Technologien sind grüner als andere.

Umweltindustrien

Eine breite Definition des Begriffes Umweltinnovation hat auch Implikationen für das Verständnis der Umweltindustrie. Man könnte argumentieren, dass zur Umweltindustrie alle Unternehmen zählen, die ihre Produkte (im Vergleich zu herkömmlichen Alternativen) umweltfreundlicher produzieren. Dies würde allerdings Probleme bei der Datensammlung bereiten, da der Begriff des Umweltindustrie von Eurostat und der OECD bereits folgendermaßen definiert ist: Umweltindustrien bezeichnen "activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products and services that reduce environmental risk and minimize pollution and resources" (European Commission, 2006).

Laut der Studie von Ernst & Young für die Europäische Kommission aus dem Jahre 2006 zählen die folgenden Sektoren zur Umweltgüter und – Dienstleistungen Industrie:

Abfallbehandlung und Recycling
Abwasserbehandlung
Luftreinhaltung
Generelle Öffentliche Verwaltung
Privates Umwelt-Management
Altlastensanierung & Reinigen von Böden und Grundwasser
Lärmschutz
Umweltforschung & Entwicklung

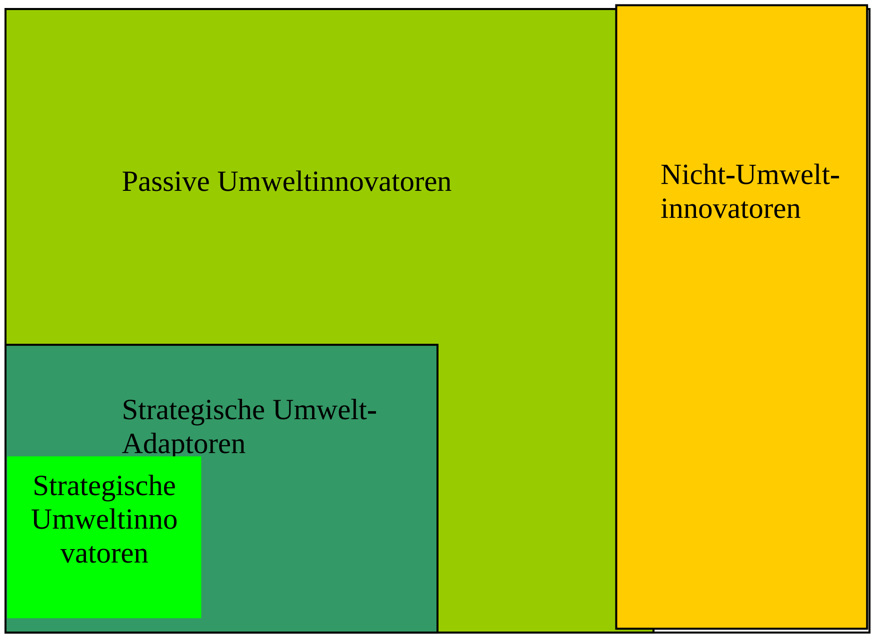
Umweltmonitoring & Instrumentierung
Wasserangebot
Recycelte Materialien
Erneuerbare Energien
Naturschutz
Ökologische Bauwirtschaft

Die Umweltindustrie mag anhand ihrer Umsätze oder ihrer Umweltschutzmaßnahmen gemessen werden, oder nach beiden Kriterien je nach Forschungsfrage. Wichtig ist jedenfalls festzuhalten, dass Umweltinnovationen keineswegs auf die Umweltindustrie beschränkt sind, sondern über alle Sektoren verteilt sind. Jedes Unternehmen, das ein Gut, eine Dienstleistung, einen Produktionsprozess oder eine organisatorische Maßnahme mit Umweltvorteilen einführt, ist ein Umweltinnovator. Vor diesem Hintergrund erscheint es vorteilhaft, verschiedene Typen von Umweltinnovatoren zu unterscheiden.

Nach einem Vorschlag von Arundel et al. (im Druck) können alle innovativen Firmen zu folgenden sich gegenseitig ausschließenden Kategorien gezählt werden, abhängig davon wie sie innovieren (entwickeln Innovationen für andere, Anwendung von Innovationen die andere entwickelt haben, in einer strategischen oder passiven Weise). Graphik 1 zeigt die verschiedenen Typen von Umweltinnovationen.

Strategische Umweltinnovatoren: entwickeln Umweltinnovationen für andere Unternehmen.
Strategische Umwelt-Adaptoren: Implementieren zielorientiert Umweltinnovationen, die entweder selbst oder von fremden Unternehmen entwickelt wurden.
Passive Umweltinnovatoren: Implementieren Umweltinnovationen ohne spezifische Umweltinnovations-Strategie.
Nicht-Umweltinnovatoren: Keine Aktivitäten bezüglich Umweltinnovationen vorhanden.

Graphik 1: Mögliche Verteilung von Firmen bezüglich ihres Umweltinnovationsverhaltens



Welcher Anteil an Umweltinnovationen außerhalb der Umweltindustrie produziert wird, ist bislang nicht gemessen worden. Die Ernst & Young Studie gibt einen Anteil der Umweltschutzindustrie von 2,2 Prozent am Bruttosozialprodukt an. Wie aus seiner anderen Europäischen Studie herauszulesen ist, könnte der Anteil an intendierten (Strategische Innovatoren und Adaptoren) und nicht-intendierten Umweltinnovationen (Passive Umweltinnovatoren) ungefähr gleich hoch sein, und der Anteil an Nicht-Umweltinnovationen zwischen 20-30% liegen (Rennings und Zwick 2003, Johnstone 2007). Aus diesem Zahlenverhältnis wird jedenfalls klar, dass sich die künftige Umweltinnovationsforschung über die klassische Umweltschutzindustrie hinausgehen sollte.

Zusammenfassung

In Projekt MEI wurden verschiedene Definitionen des Begriffes Umweltinnovationen diskutiert, und eine breite Definition zur Verwendung empfohlen. Engere Definitionen können zusätzlich verwendet werden. Aus unserer Sicht ist die Definition von Umweltinnovationen relevant und anwendbar, so dass mit ihr von Seiten statistischer Ämter und in Forschungsprojekten gearbeitet werden kann.

In MEI wurde auch eine Typologie von Umweltinnovationen entwickelt, die die folgenden Kategorien umfasst:

1. Prozessinnovationen
2. Produktinnovationen
3. Organisatorische Umweltinnovationen
3. Grüne Systeminnovationen

Damit lehnt sich die Typologie sehr weitgehend an das Oslo-Manual an, lediglich die Systeminnovationen werden zusätzlich hinzugefügt.

Weiter wurden im Rahmen des Projektes verschiedene Methoden der Innovationsforschung wie Patentanalysen und Breitenbefragungen analysiert, und auf ihre Stärken und Schwächen hinsichtlich de Messung von Umweltinnovationen bewertet. Weitere Informationen zum Projekt MEI sind unter der folgenden Website zugänglich:

www.merit.unu.edu\MEI

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Meten van eco-innovatie (In Dutch Newsletter Milieu en Economie)

Eco-innovatie wordt gezien als sleutel voor duurzame ontwikkeling in de vorm van schone groei. Maar wat is eco-innovatie? Hoe bijzonder zijn eco-innovaties? Hoe mee je het; is er een beste methode om het te meten? Deze vragen stonden centraal in het project "Measuring eco-innovation" (MEI) gefinancierd door DG research van de Europese Commissie.

Onderzoekers van MERIT (Nederland), ZEW (Duitsland), ICL (Engeland), DTU (Denemarken) en LEIA (Spanje) bogen zich over definitiekwesties en meetmethoden.

Gepleit wordt voor een brede definitie op basis van het milieueffect en niet het milieuoogmerk. Het gaat erom dat de innovatie minder milieubelastend is dan "relevante alternatieven"(bekeken over de product levenscyclus). Een typologie is ontwikkeld bestaande uit 4 categorieën:

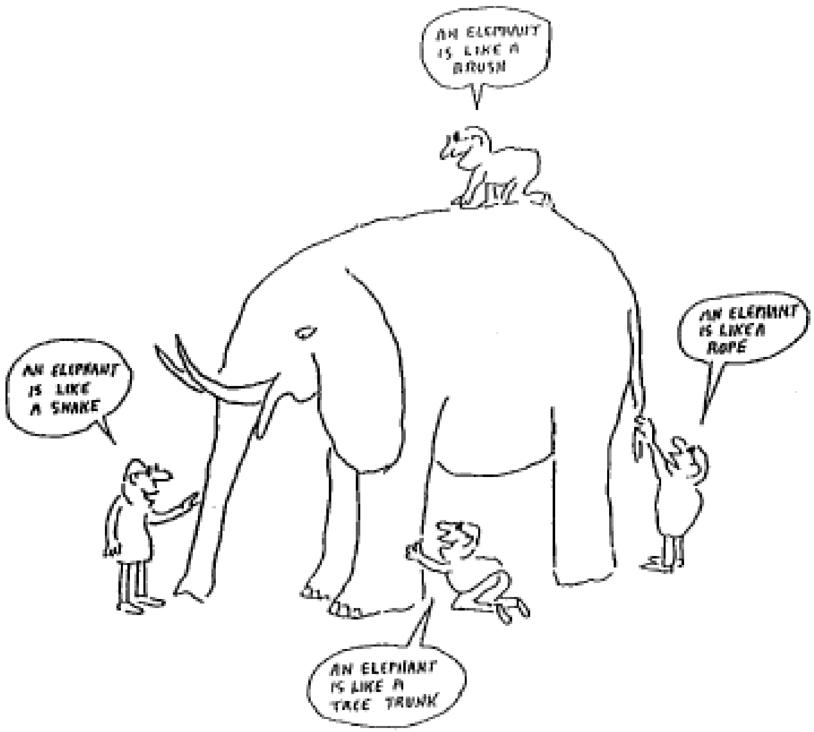
1. milieutechnologie
2. milieu-organisatorische innovaties
3. schonere producten en milieudiensten
4. groene systeem-innovaties

Bedrijven kunnen ook worden gecategoriseerd op basis van eco-innovatie: als actieve (eco)innoveerder, strategische toepasser, passieve innoveerder en niet-innoverend.

Met Eurostat is samengewerkt om vragen op te stellen over eco-innovatie voor de Community Innovation Survey (CIS). Het gaat hierbij om vragen voor een eenmalig module van de CIS in 2008 waarvan de resultaten volgend jaar beschikbaar zullen komen voor 10 landen waaronder waarschijnlijk Nederland.

In het MEI project zijn 3 methoden bekeken om eco-innovatie te meten: patent analyse, enquêtes (survey analyse), en analyse van schriftelijke en digitale bronnen. De belangrijkste bevinding is dat alle drie de methoden waardevol zijn maar elk hun specifieke beperkingen en bias hebben. De meeste innovaties zijn niet gepatenteerd en blijven dus buiten beeld in een patent-analyse.

Het exclusief gebruik van een methode leidt er toe dat bepaalde het zicht ontnomen wordt op bepaalde typen eco-innovatie (zoals incrementele innovaties en niet-technologische innovaties). Het gevaar ligt op de loer dat een onvolkomen beeld ontstaat, net als bij de blinde mannen die een olifant betasten en onafhankelijk van elkaar constateren dat het lijkt op een boomstam, een slang, een touw of een borstel.



Gekeken is ook naar methoden om de competitiviteit te analyseren van eco-innovatieve produkten. Relatieve export-gegevens zijn te verkiezen boven andere methoden maar dergelijke cijfers zijn niet voorhanden voor het overgrote deel van eco-innovaties. Eco-innovatie is geen officiële categorie in de NACE nomenclatuur, het doorsnijdt bestaande sectoren. Het is dus zaak meer cijfers te verzamelen over eco-innovatie en de factoren die van invloed zijn op de ontwikkeling en verspreiding daarvan. Suggesties en aanbevelingen daartoe zijn te vinden in het eindrapport van het MEI project (te vinden op www.merit.unu.edu/MEI) Het rapport beargumenteert dat eco-innovatie meer is dan milieutechnologie. Veel normale innovaties zijn feitelijk eco-innovaties. Innovatie is dus vaak goed voor het milieu. Maar over de precieze effecten tasten we nog in het donker.

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