Blueprints for an Integration of Science, Technology and Environmental Policy (BLUEPRINT)

STRATA Project

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Contents

Executive Summary

Introduction and general approach

Over the past decades, environmentally oriented innovations have emerged in all areas of the economy due to ecological pressures and corresponding responses from regulation and markets. Rate and direction of environmentally benign technological and organisational progress however differs depending on the type of innovation. While pollution problems have been countered quite successfully through the use of cleaner processes on the production side, product integrated environmental innovations still suffer from poor market incentives. Most changes consisted of "the picking of low-hanging fruits".

The intention of this Blueprint is to support framework conditions being able to integrate environmental considerations into all phases and all kinds of innovations: processes, products, organisations and entire systems. Concerning phases, we are especially interested in a better co-ordination of the invention, market-introduction and diffusion of innovations. Concerning innovation type, we would like to broaden their scope especially towards new or substantially modified products, organisations and systems.

This final policy paper has been worked out by the core members of the Blueprint network, but it is based on discussions held in a series of five workshops in Brussels from January 2002 to April 2003. More than 100 network members contributed to these workshops and took part in the discussions. An earlier version of the report was also presented and discussed at a conference in Brussels in September 2003.

Instrument-oriented approaches focusing on economic instruments and system-oriented approaches focusing on transition programmes are often seen as alternative perspectives to the problem. We see them more as complementary. Both attach great importance to the use of market based instruments.

Our synthesis is a procedural approach with a focus on core-instruments. It can be characterised by the following features.

- A key driver for environmental innovations, particularly in the more advanced economies, is government policy. Regulation can strengthen both technology push and market pull effects. This peculiarity makes the field fundamentally different to other regulated sectors such as automobiles and chemicals, where market forces largely control demand. Market demand for green products is not overall well developed.
- Environmental innovations require close co-operation and dialogue between government, regulatory bodies, industry and stakeholders. This process should

empower regulatory bodies to operate in the broader interest of consumers, environment and supplier competitiveness over the long-term.

- Most environmental innovations are oriented towards system improvement instead of system innovation. A focus on system innovation is desirable for future policy initiatives.

Proposed directions for a policy framework are:

- Public policy should be more oriented towards system innovation offering sustainability benefits giving the constraints and barriers for this type of change.
- Stimulate experiments with a focus on system innovations:
  Support programmes should be targeted at broad technology areas that are likely to deliver the required performance outcomes at a competitive cost. This should be done without favouring specific technologies or stifling radical innovation. System innovations can be stimulated through R&D programmes with a focus on system innovation in specific areas.
- Innovation policy should not only be concerned with promoting innovations, but also with the anticipation and assessment of general innovations, considering both potential positive and negative side effects.
- Accelerate market diffusion through a mix of policy measures:
  Many policy instruments have a role to play in environmental policy: regulation, standards, subsidies, covenants, eco-labels, tradable permits, taxes, support of R&D etc. Market-based instruments appear very attractive, not as magic instruments (silver bullets) but as core-instruments, not as a substitute for regulation but as a supplement to standards. Policies should be continuously assessed and adapted, e.g. subsidies for specific solutions should be given on temporary basis.
- Improve context factors:
  - Set long-term policy objectives for environmental and resource management. If objectives are formulated qualitatively as rules of continous improvement, these rules should be specified very exactly.
  - Government should also engage in dialogue on the design of market-pull signals and other enabling measures (such as large-scale demonstration).
  - Agreements between government and investors on policy and market conditions can keep investment risk at a level that attracts private sector capital for environmental innovations.

Policy Areas

For developing target-oriented transition programmes with core-instruments as outlined above, we have discussed several policy programmes and instruments which have been recently initiated at the European or Member State level, and which are relevant for the issues discussed here. Many of them form a useful basis for further initiatives.

Examples for policy measures being candidates for core-instruments that have been discussed at our workshops are:

- Market-based instruments,
- Regulatory instruments,
- Environmental Management Auditing Systems.

Examples for policy programmes that were discussed at our workshops are:

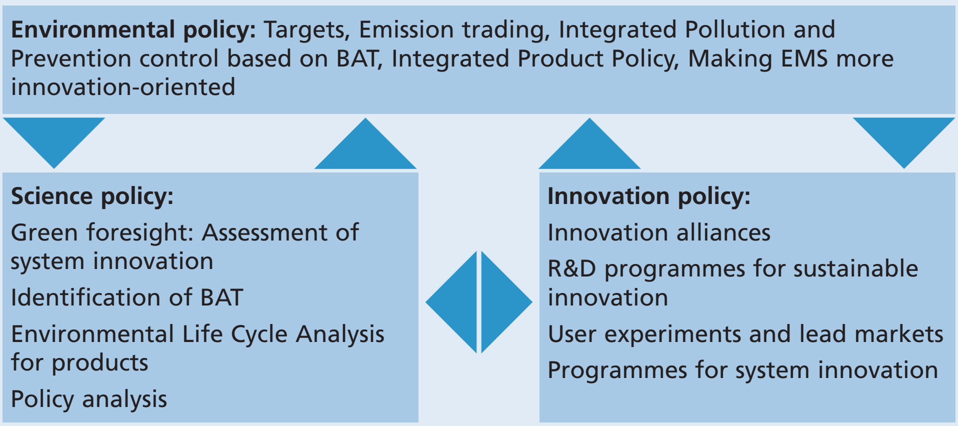
- The Cardiff Process,
- The Seville Process,
- Integrated Product Policy.

Other policy areas having been identified as relevant for innovation and environmental policy during our workshops have been:

- Green technology foresight,
- Lead markets for environmental innovations.

Figure 1 visualises the Blueprint proposals for the policy issues as described in section 5. Within this scheme there are a number of finer links, such as green foresight influencing R&D programmes and programmes for system innovation in which user experiments are an element. All of this would influence policy targets that would feed back into innovation agendas and competitive strategies of industry. The idea is to create virtuous circles of learning, innovation and policy adaptation, the outcomes of which would inform sector policies.

Figure 1: Co-ordination of European environmental, science and innovation policy



The Blueprint

Up to now transition programmes for clean technology and system innovation have only been launched on the national level. We argue that they should be transferred to the European level to exploit its heterogeneity in terms of institutional ways of dealing with environmental problems from which we can learn a great deal. Transition can be fostered by policy initiatives and further research. Policy initiatives concerning transition management should:

1. Internalise external costs by market-based instruments such as emissions trading. Without this environmental innovations have a hard time in the market place.
2. Phase out support of unsustainable practices and technologies (support in the form of subsidies or lax standards). Perverse incentives for improvement of the environment and public health should be eliminated. Bad policies (i.e. bad for the environment and health such as coal subsidies) should be stopped. A very useful perhaps obvious solution is contradiction monitoring of policies, to identify conflicting policies.
3. Support innovation for high-risk, high-(social) benefit projects, and accept technological and economic failure. The trend towards reducing the share of government support for R&D projects, to increase the commercial viability, has a detrimental effect on high-risk, high-social benefit projects and worsens the free rider problem (of innovation support for projects that would be done anyhow).
4. Stimulate system innovations through R&D programmes with a focus on system innovation in specific areas (such as intermodal travel and underground transport). These programmes are not a substitute for policies to internalise the external costs, either through the use of regulation or economic incentives. These will remain necessary but should be combined with specific policies for system innovation.
5. Utilize possibilities embedded in general purpose technologies (also called generic technologies such as ICT). General purpose technology (GPT) is an important source for achieving environmental benefits. GPT is probably a more important source of environmentally beneficial innovation than cleaner technology RTD programmes.
6. Exploit heterogeneity at the local level strategically for system innovation. Local experiments may serve as “breeding spaces” and “testing places”. Special circumstances at the local level may afford appropriate niches in which new technology and practices can be tried and tested.
7. Learning should be made an important government objective in its own right. Innovation, and the benefits from innovation at the point of use, is often tied up with “learning by doing”. Some things you can only learn by engaging in experience with new technology and new administrative arrangements.

These suggestions are not exhaustive but constitute in the view of BLUEPRINT members useful pointers for a co-ordinated approach.

Fields of further research

The suggestions have important implications for EU research, which should be more oriented towards systemic solutions. More research is also needed on policy issues. Comparative research is needed to find answers to questions such as:

- Consensual vs. confrontational approaches: Are consensual approaches better suited to promote innovation than confrontational approaches?
- Qualitative vs. quantitative targets: Are experiences with quantitative targets promising, or should qualitative rules like "continuous improvement" be preferred? If qualitative targets are chosen, how should they be specified?
- What are experiences with policy integration and co-ordination in different countries?
- What are the experiences with core-instruments and how are they linked with transition strategies?

Beyond such a comparative analysis, several new questions have been raised during the conference:

- System Innovations are often seen as superior concerning sustainability impacts, compared with incremental inovations. Until now this has mainly been a belief and has not been empirically verified. Thus it has to be answered which role both incremental and systems innovations play for a sustainable development path, and if these types of innovation differ regarding their impacts on employment and competitiveness. Environmental technologies should be considered as well as general purpose technologies.
- The long-term prespective in setting targets is crucial, but costs and benefits to society induced by political targets have to be assessed by improved assesment methods, e.g. tools for Sustainability Impact Assessment.
- The parameters involved in the formation of environmental lead markets should be further investigated, including examination, together with industrial representatives, of the potential for specific industrial sectors to benefit from European lead markets as a step towards a stronger presence on the international market.
- Global and social dimension of innovations should be analysed. It is important that environmental technologies are affordable for poorer countries; needs of developing countries should be considered in programmes supporting sustainable technologies.
- The role of science policy is the improvement of analytical tools such as green foresight, life cycle analysis, cost benefit analysis, models and tools for sustainability impact assessment. Best available technologies have to be identified, and technologies going beyond BAT have to be detected.

- Research programmes should not only focus on technical innovations but also support organisational and institutional changes. E.g. demonstration for societal experiments (e.g. living without a car, sustainable neighbourhoods) would be very beneficial.

Introduction

Over the past decades, environmentally oriented innovations have emerged in all areas of the economy due to ecological pressures and corresponding responses from regulation and markets. Rate and direction of environmentally benign technological and organisational progress however differs depending on the type of innovation. While pollution problems have been countered quite successfully through the use of cleaner processes on the production side, product integrated environmental innovations still suffer from poor market incentives. Most changes consisted of "the picking of low-hanging fruits".

Basic or radical innovations are rare, especially concerning their diffusion from niche to mass markets. Examples are renewable energy systems or new mobility concepts. Environmental policy has been unsuccessful in changing behaviour and bringing about societal transformations, involving a change in both technology and behaviour. There is a consensus that the existing trajectories in transport, energy, and agriculture have to be left. Alternatives should be explored.

The intention of this Blueprint is to support framework conditions being able to integrate environmental considerations into all phases and all kinds of innovations: processes, products, organisations and entire systems. Concerning phases, we are especially interested in a better co-ordination of the invention, market-introduction and diffusion of innovations. Concerning innovation type, we would like to broaden their scope especially towards new or substantially modified products, organisations and systems.

Section 2 defines key terms and describes the general approach of the Blueprint project to reach these targets. Section 3 discusses economic impacts of environmental innovations. Section 4 describes policy implications, particularly for the level of the European Union. Section 5 gives an outline how the different streams of policy implications can be linked or co-ordinated.

The core members of the Blueprint network have worked out this final policy, but it is based on discussions held in a series of five workshops in Brussels from January 2002 to April 2003. More than 100 network members contributed to these workshops and took part in the discussions. Several members from the European Commission participated in each workshop. The discussions were summarised in synthesis reports (see website http://www.blueprint-network.net, see also list of workshop presenters and discussants in Annex 2). Large parts of this final Blueprint policy paper refer to these reports. An earlier version of the report was presented and discussed at a conference in Brussels in September 2003 (see photo on next page). We received comments from around 50 conference participants, and we are especially grateful for the invited comments from:

- Alistair Fulton, (Environmental Resource Management, UK),
- Andrew Dearing, (European Industrial Research Management Association, France),
- Cindy Foekehrer, (Eurochambers, Brussels),
- Don Litten, (DG Joint Research Centre, European Commission),
- Eduardo Morere-Molinero, (DG Environment, European Commission),
- Frans Berkhout, (SPRU Science Policy Research Unit, Sussex Unversity, UK),
- Frans Vollenbroek, (DG Enterprise, European Commission),
- Frieder Rubik, (IÖW Institute for Ecological Economic Research, Germany),
- Giulio De Leo, (Lombardia Agency for the Environment, Italy),
- Hugo Brouwer, (Ministry of Economic Affairs, Netherlands),
- Klaus Kögler, (DG Environment, European Commission),
- Marialuisa Tamborra, (DG Research, European Commision),
- Matthias Weber, (Research Center Seibersdorf, Austria).
- Michael Massey, (Department of Trade and Industry, UK),
- Niels Hendrik Mortensen, (Environmental Protection Agency, Denmark),
- Vera Calenbuhr, (DG Joint Research Centre, European Commission)

Discussing the Blueprint report during the final conference (from left to right): Cindy Foekehrer (Eurochambers, Brussels), Klaus Rennings (Blueprint co-ordinator, Centre for European Economic Research ZEW, Mannheim), Hugo Brouwer (Ministry of Economics, Netherlands), Niels Henrik Mortensen (Environmental Protection Agency, Denmark), Marialuisa Tamborra (European Commission, DG Research)

General approach

Key definitions

The definitions of the terms innovation, environmental innovation, sustainable innovation, innovation system, system innovation, and the distinctions between these terms are crucial for the understanding of the Blueprint approach. Thus we start this report with some key definitions.

Innovation

In accordance with the OECD Guidelines for Collecting and Interpreting Technological Innovation Data (OECD, 1997), we distinguish between technical and organisational innovations. Technical innovations are divided into product and process innovations:

- Process innovations occur when a given amount of output (goods, services) can be produced with less input.
- Product innovations require improvements to existing goods (or services) or the development of new goods. Product innovations in machinery in one firm are often process innovations in another firm.
- Organisational innovations include new forms of management, e.g. total quality management.

Environmental Innovation

We use the following definition of environmental innovation (Kemp and Arundel, 1998, Hemmelskamp, 1997, Rennings, 2000): Environmental innovations consist of new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms. Environmental innovations may be developed with or without the explicit aim of reducing environmental harm. They also may be motivated by the usual business goals such as profitability or enhancing product quality. Many environmental innovations combine an environmental benefit with a benefit for the company or user.

Sustainable Innovation

Sustainability is not clearly defined in a way, which makes it difficult to define sustainable innovation. Drawing on the 3 pillar concept of sustainable development, sustainable innovations could be defined as new or modified processes, techniques, practices, systems and products with a net positive impact concerning their environmental, economic and social effects. In the short-term there often is a conflict between the three goals. Sustainability requires wider system changes, captured in the term system innovation (see below).

Innovation System

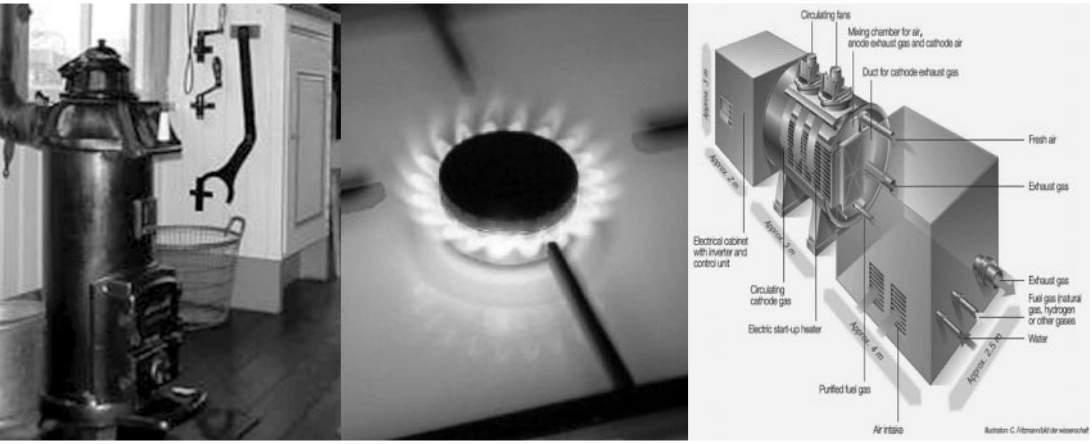
An innovation system is constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge (Lundvall, 1992). A further distinction is between national, sectoral and regional systems of innovation.

System Innovation

System innovations consist of a set of innovations combined in order to provide a service in a novel way or offering new services. System innovations involve a new logic (guiding principle) and new types of practices.

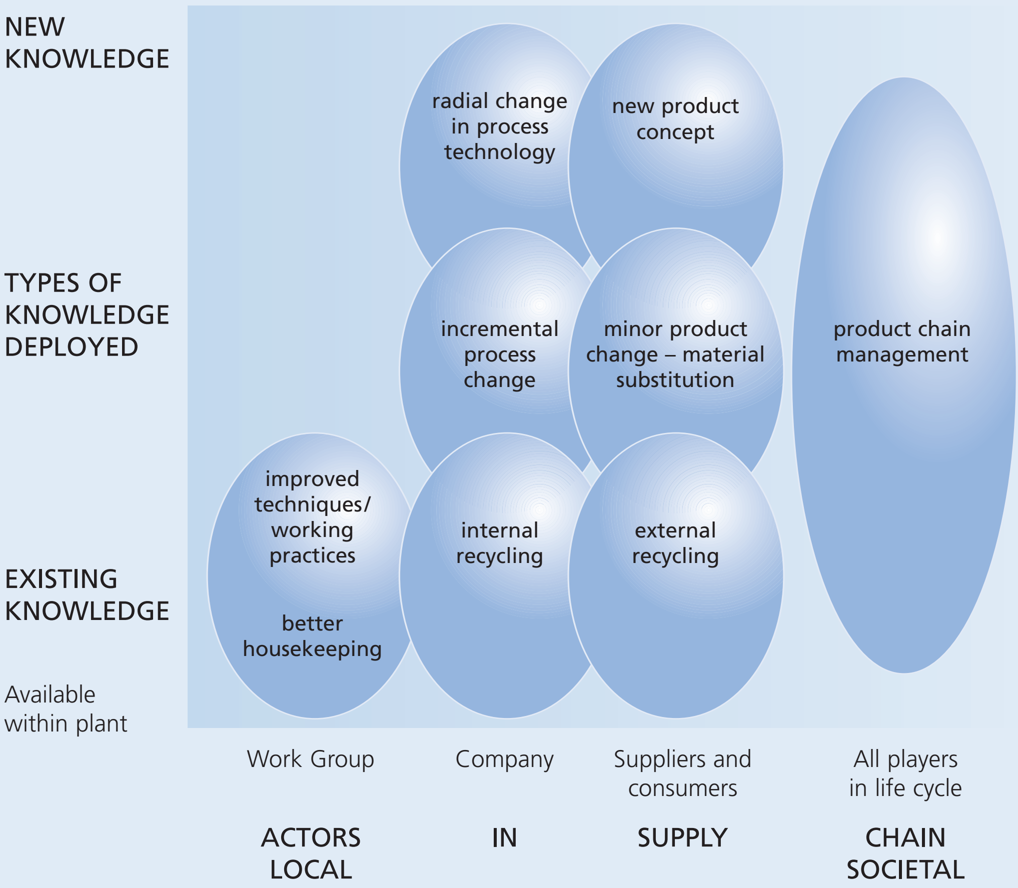
Environmental system innovations are system innovations that give rise to a step change in eco-efficiency (Butter, 2002). Sustainable system innovations offer economic, environmental and social benefits. An example is the shift from coal to natural gas as a fuel for residential heating in the Netherlands which brought environmental benefits in terms of lower pollution and user benefits in terms of greater comfort (see Figure 2).

Figure 2: Sustainable System Innovation: from coal to natural gas to hydrogen



A much-discussed example of a sustainable system innovation in energy is also the hydrogen economy. Other examples of sustainable system innovation are: novel protein foods as a substitute for meat, high precision farming, integrated mobility, underground freight transport using pipelines and closing of material streams. Sustainable system innovations combine private benefits with social benefits. They may bring new risks (as with biotechnology but also hydrogen), besides initial costs. A taxonomy of environmental innovations, considering the dimensions of knowledge changes and action involved, is illustrated in Figure 3.

Figure 3: Taxonomy of cleaner environmental responses



Source: Clayton et al. (1999).

Why integration and co-ordination?

The need for integration or co-ordination of environmental and innovation policy can be explained by market failure and by an overall failure of co-ordination. Generally, the neoclassical arguments for support of innovation are as follows:

- The public good nature of knowledge causes an appropriability problem (innovators are unable to appropriate the full social and economic benefit from innovation).

- Other companies and society benefit from positive externalities from innovation.
- The benefits of innovation are uncertain.
- Market entry barriers cause too little competition.

These arguments have to do with the incentives for innovation leading companies to underinvest in R&D and innovation. First-mover advantages and patents however compensate for this.

Concerning market failure of environmental innovations, a peculiarity stems from the fact that they produce positive spillovers in both the innovation and diffusion phase (Rennings, 2000). While positive spillovers due to the invention and market introduction are quite normal as described above, environmental innovations create positive spillovers also in the diffusion phase. They occur due to a smaller amount of external costs compared to competing goods and services on the market.

In other words: The innovator creates or adopts a new process, product or organisational measure which improves environmental quality. While the whole society benefits from this innovation, the costs have to be born by the innovator alone. Even if the innovation can be successfully marketed, it is difficult for the innovator to appropriate the profits of the innovation if the corresponding knowledge is easily accessible for imitators and if the environmental benefits have a public good character.

In the following this peculiarity of environmental innovations will be called the double externality problem. The double externality problem reduces the incentives for firms to invest in environmental innovations. Thus **the need for policy measures stimulating these kinds of innovations can be explained by market failure from an economic perspective.**

Such regulatory stimuli are usually set by environmental and/or innovation policy. The question is if a better co-ordination and/or integration of these policies improves the overall result concerning our areas of interest. This question can be further subdivided and specified as follows:

- Can better integration or co-ordination of innovation and environmental policy improve the rate and direction of environmental innovations?
- Can it speed up the innovation process, especially in the diffusion phase?
- Can it open up the scope of innovations towards products, organisations and systems?

From a systems perspective environmental problems are not just market failure problems that can be rectified by introducing "the right incentives" but rather problems of coordination, the inability to deal with system failure.

- Smith (1997) identifies four types of system failures:
- Failures in infrastructural provision and investment: Inadequacies in the technology infrastructure from which companies draw for innovation. Markets are a poor mechanism for providing even an approximately optimal technology infra-

structure, not just because of the public good aspects of it but also because it is impossible to determine the value of the components of the technology infrastructure. Governments historically have assumed an important role for providing good infrastructures. The current trend towards liberalization and privatization may cause deficiencies in infrastructures.

- Transition failures: Problems of adapting to transitional changes or contributing to it.
- Lock-in failures: The "lock-in" of the socio-economic system to particular technological paradigms. Lock-in does not occur only because of changeover costs, but also because the knowledge and mental models of the dominant actors lead them to look for solutions within the current paradigm. User practices and consumer lifestyles are an important source of lock-in too.
- Institutional failures: Institutions created for past problems creating barriers to the solutions of new problems.

The idea of system failures has to do with innovation-relevant structures - what Lipsey and Carlaw (1998) call the "facilitating structure" and what Tassey calls the "technology infrastructure". The system perspective looks at structure and the market perspective at incentives. The systems perspective does not deny the importance of markets as a coordinating device. Market competition always has been seen as very important for innovation. However, in a system perspective the market constitutes only one element in the context of innovation and diffusion. Institutions and networks are other constituting elements and their functioning also influences the process of technology advance. There is a need for government to respond to externalities as in the market failure approach but in addition also to alter the structural conditions under which technology advance occurs (Hauknes and Nordgren, 1999).

Possibilities for system coordination however are limited. It may be easiest to achieve "increased coherence" (Smith, 2002). Sociotechnical systems cannot be engineered in the same way as materials can be engineered. They defy control because they are collective outcomes, not collective choices. Innovations are part of trajectories and shaped by social, organizational and techno-economic factors that make up a functional system. Innovations cannot be stipulated beforehand, elicited by legal fiat and moulded by will, either the public will or the will of companies.

System-oriented vs. instrument-oriented approaches

Approaches for a better integration or co-ordination of environmental and innovation policy can take the perspective of single policy instruments or of the entire system. Both approaches will be described in this section, followed by a synthesis.

The instrument-oriented approach: Focus on single instruments

The comparative asessment of single policy instruments has been a major area of research in environmental economics over the past decades. Concerning innovation, the traditional economic view holds that market-based instruments like taxes and tradable permits are superior with regard to fostering innovation. These instruments are argued to be the environmental policy instruments with the highest dynamic efficiency (innovation efficiency). Their advantage is that they give permanent incentives for further, cost-efficient emissions reductions. (Rennings, 2000). They are also more cost-efficient. Negotiated environmental agreements (covenants) have been proposed to deal with the inefficiency of regulations but the ones adopted did not provide a spur for innovation because they were not technologically challenging (Kemp, 2000).

However, several exceptions and modifications to the rule have been made recently. Firstly, it is argued that policies of command-and-control have been in practice much more flexible and innovation forcing as has been recognised in theoretical assessments (Ashford, 2002). For example, the innovation efficiency of standards has been improved substantially by "technology forcing" in a command-and-control regime (rules of permanent reductions or long-term standards going beyond existing technologies). Another approach is a strategy of repeated negotiations in a regime of voluntary agreements. A continued process of negotiations after each monitoring phase can increase the innovation efficiency of voluntary approaches.

On the other hand, the innovation efficiency of taxes may be watered down in the political process. Total environmental costs for industry are normally higher under a tax regime than under alternative regimes of command-and-control or negotiated agreements (because firms have to pay for residual emissions and pollution). This may lead to a tendency to impose relatively low taxes with low innovation impacts. It is important to note that it is exactly the innovation-friendly attribute of taxes (charging firms for residual emissions) which may lead to this counter-effect (low tax level with low impacts). The acclaimed superiority of tradeable permits regimes so far has not been brought out by the experiences of tradeable permits systems. For instance, the study by Burtraw (2000) into the innovation effects of the most important tradeable permit system, the SO2 trading system in the US, established that the system caused very little innovation. The main innovations were organisational.

"Instrumentalism" in environmental policy as described above, i.e. the assumption that the choice of policy instruments determines the policy success, has been criticized by Blazejczak et al. (1999). They found empirical evidence in a series of case studies that specific instruments (taxes, permits) are overestimated in the discussion while important elements of successful environmental policy are neglected such as long-term goals and targets, the mix of instruments, different policy styles and actor constellations. These other factors also have to be taken into account.

Summing up, the conclusion can be drawn that there is no general consensus concerning the superiority of single policy instruments in the literature. Nor is it agreed that the analysis and comparison of single policy instruments is a useful approach to draw a realistic picture of the problem, given the situation that in most cases several instruments from several policy areas affect innovation decisions simultaneously, and given the situation that regulation is only one factor affecting innovation decisions, among many others (SRU 2002).

A system-oriented approach: Transition management

System-oriented approaches take a broader view of the innovation process. They take not only incentives (such as prices) into account, but also characteristics of technological development paths (called technological trajectories, systems or regimes) and behavioural or organisational aspects. Technical change is driven by short-term economic gains rather than longer-term optimality (Kemp and Soete, 1992). Competition from existing technologies, the need for change at several levels, and need to gain profits create barriers to system innovation. The barriers are not easily overcome through a change in the structure of economic incentives. They require an orchestrated effort over an extended period.

Most policies based on a system perspective of innovation are oriented towards improving the national system of innovation, not the fostering of specific system innovations. One reason for this is that policy authorities lack a model for managing system innovation. There are several pitfalls in managing transition processes, the policies have to be adaptive in order to prevent lock-in to suboptimal solutions.

A model for transition management is offered by Kemp and Rotmans (2001). It was developed for the 4th National Environmental Policy Plan outlining Dutch policy towards sustainability. Transition management is an example of policy co-ordination, using markets co-ordination and long-term policy goals. It consists of a deliberate attempt to work towards a transition in a stepwise, adaptive manner, using dynamics in technology, markets and governance, exploiting windows of opportunity.

Transition management tries to modulate dynamics. It works with dynamics not against them. The basic steering philosophy is that of modulation, not over-specification or planning-and-control. Transition management, in the way described below, joins in with ongoing dynamics and builds on bottom-up initiatives. Ongoing developments are exploited strategically. Transition management for sustainability tries to orient dynamics to sustainability goals. The goals are chosen by society but not the functional systems: the systems to satisfy these goals are worked towards in a bottom-up/top-down manner through adaptive policies. The goals and policies to further the goals are constantly assessed and periodically adjusted.

Policy actions are evaluated against two types of criteria: 1) the immediate contribution to policy goals (for example in terms of kilotons of CO2 reduction and reduced vulnerability through climate change adaptation measures), and 2) the contribution of the policies to the overall transition process. This means that under transition management policies have a content goal and a process goal. Learning, maintaining variety and institutional change are important policy aims and policy goals are used as means for change. The adaptation of policies brings flexibility to the process, without losing a long-term focus. Transition management thus has a long-term orientation, is reflexive and adaptive. A schematic view of transition management is given in figure 2.

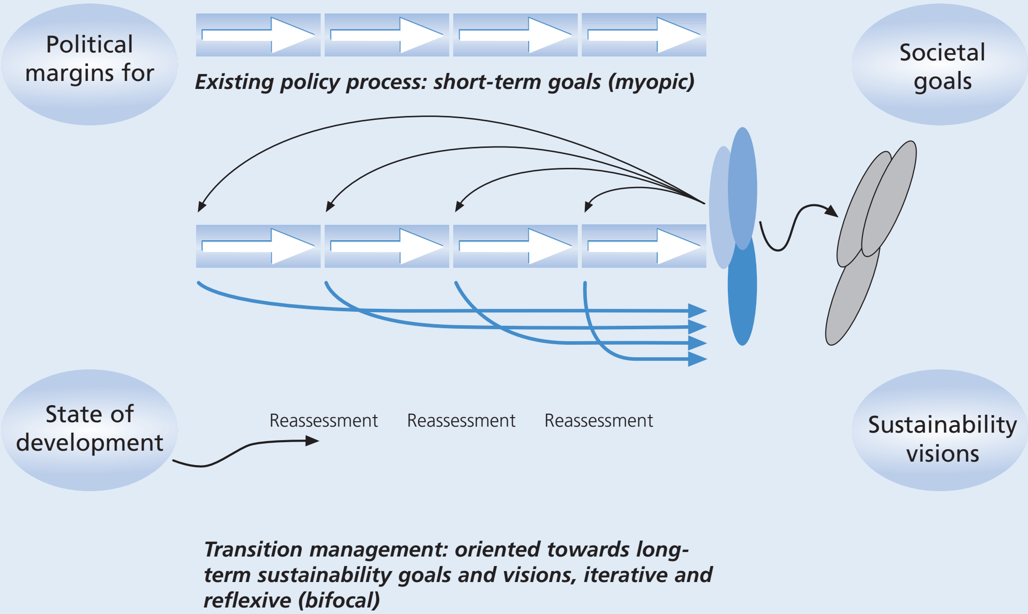
Transition management breaks with the old planning-and-implementation model aimed at achieving particular outcomes. It is based on a different, more process-oriented philosophy. This helps to deal with complexity and uncertainty in a constructive way. Transition management is a form of process management against a set of goals chosen by society. Societies' problem-solving capabilities are mobilised and translated into a transition programme, which is legitimised through the political process.

Transition management should not be seen as constituting a radical break with past policy. Within transition management there is a need for specialised (what critics call fragmented) policies. It puts these policies in a different, longer-term perspective and tries to better align specific policies. Mathematically one could say that transition management = current policies + long-term vision + vertical and horizontal coordination of policies + technology portfolio-management + process management (see Figure 4, also Kemp and Loorbach, 2003).

Transition management offers an integrative framework for policy deliberation and the choice of instruments and individual and collective action. Transition management is not so much about instruments but more about different ways of interacting, the mode of governance, and goal seeking. Innovation and learning are important aims for transition management. This requires a greater orientation towards outsiders, a commitment to change and clear stakes for regime actors.

Through transition management the transition endeavour to more sustainable systems is institutionalised. There is no guarantee of success (in the sense of achieving transition goals) because transitions are the outcome of the interplay of many factors and developments. Transition management helps to increase the chance of achieving a transition towards more sustainable systems, in energy, transport, agriculture and food, and helps to achieve greater sociotechnical diver-

Figure 4: Current policy versus transition management



Source: Kemp and Loorbach (2003)

sity. The end-state is not fixed but open-ended. The Dutch Ministry of Economics speaks of a "Journey to the South" in which the travel means are not predetermined (see Boxes 1 and 2). To avoid lock-in to suboptimal solutions different technology paths are pursued.

Within policy, different transition paths are pursued in order to avoid early lock in. The goals are set by industry. In the biomass transition, Friends of the Earth is quite active in creating societal support for it.

Box 1: Transition management in the Netherlands

In 2001, 5 Dutch ministries adopted the new governance approach of transition management, which was presented in the fourth National Environmental Policy Plan (NMP4). The NMP4 constituted a discontinuity in Dutch environmental policy plans by looking 30 years into the future (instead of 4 years). The title "A world and a will"(Een wereld en een wil), highlighted the worldwide focus and emphasized determination and will-fullness. A central message of the NMP4 is that past policy has not been futile but that a different approach was needed for dealing with problems that required system innovation. These problems were: loss of biodiversity, climate change, depletion and overexploitation of natural resources, public health threats, nuisances impairing liveability, external safety, and future risks. It was argued that the problems required a different policy approach: a long-term, integrated approach addressing problems of uncertainty, complexity, and interdependence.

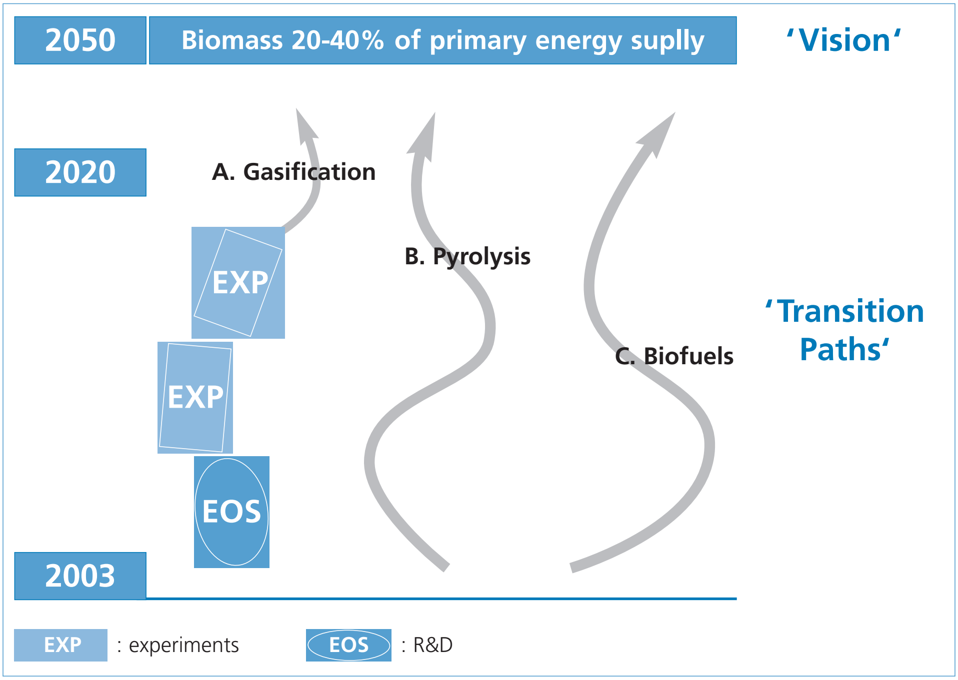
One of the ministries that adopted transition management was the Ministry of Economic Affairs responsible for industry and energy. This ministry has been most active since 2001 in developing transition policies for the transition to a sustainable energy-supply system in 2050 (see: www.energietransitie.nl). In 2001, the Ministry of Economic Affairs started a consultation process with various stakeholders (companies, researchers, NGO's) about possibilities for system innovation. Based on these conversations and an intensive scenario-study, they selected five 'robust elements' or subprojects in the transition to a sustainable energy system, with a time-horizon of 2030:

- Biomass International
- Sustainable Industrial Production
- Policy Renewal
- New Gas Services
- Toward a Sustainable Rijnmond

In 2002, the Ministry started the Project Implementation Transition management (PIT) that had to investigate whether the selected subprojects would meet enough support, enthusiasm and commitment from the relevant stakeholders to create a climate in which they would be willing and able to work together. The project was initially financed with 35 million euros and supported by an 8-person staff. Main conclusions from this phase were that the transition-approach proved to be appealing to the majority of the stakeholders and they would be willing to invest (time and money) and commit themselves to such a process under the condition that the transition management approach would be made more concrete and the government would support it both financially as well as process-wise. The government had to act as a partner committed to a transition whose policies had to be consistent and predictable instead of erratic.

Implementation of phase 2 started in 2003. The objectives of this phase were to develop a long-term vision on energy in general and for each of the subprojects, supported by all relevant actors, to have these actors committed to the process, to map the barriers and necessary preconditions for the transition, to set up plans for knowledge-development and –sharing and communication, to chart international developments and finally to develop transition-experiments (to be started in 2004).

Box 2: The Dutch vision for biomass



Small working groups were part of the final Blueprint conference. Here the group on Transition Management discusses the transferability of the Dutch approach to the European level.

Target-setting

Both instrument-oriented and system-oriented approaches agree that complex systems cannot be steered by a central plan or institutions. Decentral development without co-ordination bears however the risk that the system takes an unacceptable or unsustainable development path. This dilemma can be overcome by defining long term targets for the outcomes or the performance of the system (Kemp and Rotmans, 2002, Rennings, 2000).

Such targets are demanded by many societal actors, especially by industry to ensure stable policy framework conditions for investments. For example, the Union of Industrial and Employers' Confederations of Europe (UNICE, 2001) identifies a need to move towards the objective of sustainable development not by successive incremental adjustments but by a "thorough rethink of processes/products, involving radical techological innovation. To promote such innovation, it is necessary to set stable and clear environmental objectives for the long term, accompanied by a predictable and supportive policy framework".

Targets can play an important role for stimulating innovations. Their nature can be however extremely different. They can be based on consensus building running the risk of wearing towards the lowest common denominator, or they can be formulated in a technology forcing manner (as e.g. the Californian initiative for zero emissions vehicles). A dilemma can be seen in the requirements that targets should be long-term oriented without losing flexibility, including the option of learning and revision.

Targets have recently been widely used in European policy making, e.g. for CO2 reduction, fuel efficiency, share of renewable energies or the amount of national R&D budgets as a percentage of GDP.

The importance of targets and indicators for sectoral innovation systems can be illustrated by the example of European forestry. It is a good model of what is required for other sectors (see Box 3 and Table 1).

Box 3: Best practice case: Indicators and targets in the European forest industry

The discussion on sustainability in forestry in Europe in the 19th and 20th century concentrated on economic sustainability, although multifunctionality was also considered. The understanding of economic-sustainability lies in the simple assumption that wood, as the primary source of income must not be over-used (sustainable yield). The main indicator for forest policy is growing stock, for which various measurement systems were developed and a data reporting system was institutionalised. Other goods and services provided by forests are seen as joint products "in the wake" of timber production. Ecological and social aspects became more relevant in several regions due to the growing need for avalanche and erosion protection already in the early 20th century, firmly establishing the multifunctionality concept ot the sector. The modern concept of sustainability in forestry, with a balance of economic ecological and social aspects started with the Bruntland Report and Rio 1992.

Several international policy processes exist today whose explicit aim is the promotion and implementation of SFM. In Europe the main forestry policy process is the Ministerial Conference on the Protection of Forest in Europe (MCPFE), comprising 44 European states. The European states defined, through the MCPFE, SFM for Europe as "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems." (Preamble D, MCPFE Resolution H1)

The definition of SFM is operationalised through Pan-European Criteria and Indicators for SFM. A set of six criteria, representing policy goals, 27 quantitative as well as descriptive indicators was developed by the MCPFE in the years 1993-1995 to form a coherent set of tools to assess and assist further progress in sustainable forest management. The European states represented in the MCPFE agreed upon this set of criteria and indicators for SFM in 1998 (Resolution L2). The indicators were recently updated (see SEQARABIC for the criteria and the most important concept areas for indicators). As a result of this process, several countries are now annually reporting on SFM indicators and have already included the definition of sustainable forest management into their national law. This allows for a balanced view of the situation and development of forestry in these countries over time. Changes in the sector are made visible and society can react on that changes by continuous innovation to keep sustainable forest management balanced.

Source: Kubeczko and Rametsteiner (2003).

Table 1: Sustainable Forest Management-criteria and concept areas as defined by the Ministerial Conference on the Protection of Forest in Europe

CRITERIA OF PAN-EUROPEAN SUSTAINABLE FOREST MANAGEMENT	Concept Areas (one quantitative indicator was developed for each concept area)
Maintenance and Appropriate Enhancement of **Forest Resources** and their Contribution to Global Carbon Cycles	1. Land use and forest area 2. Growing stock 3. Carbon balance
Maintenance of **Forest Ecosystem Health and Vitality**	
Maintenance and Encouragement of **Productive Functions of Forests (wood and non wood)**	1. Wood production 2. Non-wood production
Maintenance, Conservation and Appropriate Enhancement of **Biological Diversity in Forest Ecosystems**	1. Forest ecosystems variety 2. Threatened species 3. Biodiversity in production forests
Maintenance and Appropriate Enhancement of **Protective Functions in Forest Management (notably soil and water)**	1. Soil erosion 2. Water conservation
Maintenance of **other Socio-Economic Functions and Conditions**	1. Significance of the sector in the economy 2. Recreational services 3. Provision of employment 4. Public participation 5. Cultural values 6. Research and education 7. Public awareness

Source: MCPFE (2000)

Synthesis: Targeted transition strategies using core-instruments

We understand instrument-oriented and system-oriented approaches as complementary rather than alternative perspectives to the problem. Both attach great importance to the use of market-based instruments.

The strength of instrument-oriented approaches is that even if all system components are taken into consideration, prices and costs are still the most important success factor in economic systems. In particular, economic instruments of environmental policy can be regarded as core-instruments due to their strength of changing price and cost structures.

The weakness of simple instrument-oriented approaches is however that they are too narrow and ignore many important context factors being crucial for innovation-decisions, such as strategies, orientation, actor constellations and learning processes.

The strength of system-oriented approaches is that they take all context factors into account, which are relevant for innovation decisions. The risk of the approach is a tendency to more general, vague and soft policy measures due to its higher degree of complexity. Policy recommendations often refer to soft factors such as improved information, learning, communcation and networking. These measures are useful but their effectiveness depends largely on a back-up with strong core-instruments. If such a back-up is missing and relative prices are distorted, the main lesson learned in the end may be that economic incentives are still too weak to drive innovations in the direction which is socially desirable (due to the importance of economic impacts we dedicated one workshop, see Hitchens 2003, and one section of this final Blueprint to this question).

Two recent policy documents show that the complementarity of approaches is increasingly recognised. The concept of innovation-oriented environmental policy developed by the German Council of Environmental Advirsors (SRU, 2002), and the task force "Innovation and Growth in the Environmental Sector" in the UK (Hitchens, 2003) agree upon the necessity of both strong economic incentives and procedural context factors such as facilitation, co-operation and negotiation.

In general, it is widely agreed that innovation policy is better suited for stimulating invention, while environmental policy mainly influences the diffusion of existing innovations (Kemp, 2002). Innovation policy can offer a field for experimentation with alternative solutions to a problem. It can also help to cut the innovation costs in the phases of invention and market introduction, e.g. by financial support for pilot projects. And in the diffusion phase it may help to improve the performance characteristics of environmental innovations. At least in the diffusion phase, however, environmental policy is responsible for internalising external costs imposed by competing, non-ecological products or services. It may be difficult to reach the earlier innovation phases (invention and market introduction) through environmental policy, except though technology-forcing stringent regulation. But as long as markets do not sufficiently punish environmental harmful impacts of processes and products, competition between environmental and non-environmental innovation is distorted.

Our synthesis is a procedural approach with a focus on core-instruments. It is in line with the reports mentioned above and can be characterised by the following features.

- A key driver for environmental innovations is government policy. Regulation can strengthen both technology push and market pull effects. This peculiarity makes the field fundamentally different to other regulated sectors such as automobiles and chemicals, where market forces largely control demand. Market demand for green product is not overall well developed.
- Environmental innovations require close co-operation and dialogue between government, regulatory bodies, industry and stakeholders. This process should empower regulatory bodies to operate in the broader interest of consumers, environment and supplier competitiveness over the long-term.
- Most environmental innovations are oriented towards system improvement instead of system innovation. A focus on system innovation is desirable for future initiatives.

Proposed directions for a policy framework are:

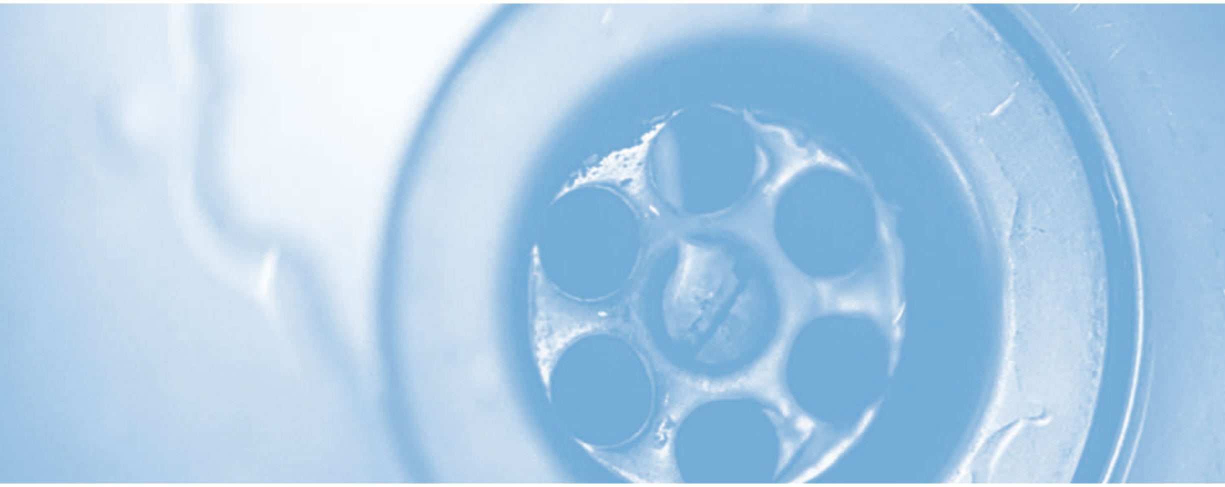
- Public policy should be more oriented towards system innovation offering sustainability benefits giving the constraints and barriers for this type of change.
- Stimulate experiments with a focus on system innovations:
  Support programmes should be targeted on broad technology areas that are likely to deliver the required performance outcomes at a competitive cost. This should be done without favouring specific technologies or stifling radical innovation. System innovations can be stimulated through R&D programmes with a focus on system innovation in specific areas.
- Innovation policy should not only be concerned with promoting innovations, but also with the anticipation and assessment of general innovations, considering both potential positive and negative side effects.
- Accelerate market diffusion through a mix of policy measures: Many policy instruments have a role to play in environmental policy: regulation, standards, subsidies, covenants, eco-labels, tradable permits, taxes, support of R&D etc. Market-based instruments appear very attractive, not as magic instruments (silver bullets) but as core-instruments, not as a substitute for regulation but as a supplement to standards. Policies should be continuously assessed and adapted, e.g. subsidies for specific solutions should be given on a temporary basis.

- **Improve context factors:**

  - Set long-term policy objectives for environmental and resource management. If objectives are formulated qualitatively as rules of continous improvement, these rules should be specified very exactly.

  - Government should also engage in dialogue on the design of market-pull signals and other enabling measures (such as large-scale demonstration).

  - Agreements between government and investors on policy and market conditions can keep investment risk at a level that attracts private sector capital for environmental innovations.



Economic Impacts of environmental innovations

A key question which arises is what is likely to be the economic impact of policies to promote environmental innovations. In the following sections, we summarise the research findings on the impact of environmental innovation and regulation on industrial competitiveness and employment. While the effects of future regulation are unknown, economies have already adjusted favourably to quite considerable regulatory changes.

Environmental regulation and competitiveness – The Porter-Hypothesis

Environmental regulation traditionally was seen as bad for business, as something that impairs companies' competitiveness. The consensus on this was challenged by business professor Michael Porter (1991) saying that: "The conflict between environmental protection and economic competitiveness is a false dichotomy. It stems from a narrow view of the sources of prosperity and a static view of competition. Strict environmental regulations do not inevitably hinder competitiveness advantage against foreign rivals; indeed they often enhance it". Porter does not say that regulations are good per se for business; only certain types of regulation will spark innovative responses. The article sparked a hot debate among economists, business people and government. In policy circles, the thesis of a positive relation between strict environmental regulation, innovation and competitiveness became very popular in the in the nineties but is still controversial.

The difficulty is in measuring the Porter hypothesis of the importance of regulation (properly designed and implemented) as a driver for competitiveness enhancing innovations. It is one of many drivers, including public policy on expenditure on basic research, education and skills, subsidies to R&D etc.

This raises the question whether regulation can be a stimulus. If regulation was better implemented and enforced and more stringent, could this transform an industry? Analysis of the U.S. regulatory history does provide evidence for this (Ashford 1985; Strasser 1997), but European consensus-driven regulation has historically been less technology forcing (Gouldson and Murphy, 1998).

Empirical studies however widely agree that the effects of environmental regulation on competitiveness (measured commonly as rate of GDP growth or employment growth) are rather small (Hitchens, 2003). This is because environmental costs tend, on average, to be a small share of total costs. Differential costs are smaller because other countries are regulated too, and multinational enterprises don't even bother to exploit lax environmental regulations when locating new plants in such countries. Their environmental performance is more similar to that of their home plant.

This is not to say that there is no trade-off between environmental regulations and economic growth (as conventionally measured by not counting the environmental benefits). Environmental policy does reduce GDP. The importance is in the form of regulation, incentive based policies keep environmental compliance costs down. The form of regulation is therefore an important policy consideration.

Even in the event that there is a significant depressing effect on GDP or productivity growth as a consequence of environmental regulation, it would be insufficient to conclude that regulatory policies should not exist. The reason is that policy is not only fundamentally concerned about the rate of technical change and corresponding growth rates, but also about it's direction. There is a clear link between environmental regulation and improved health or better aesthetic amenities, which often does not show in measured GDP.

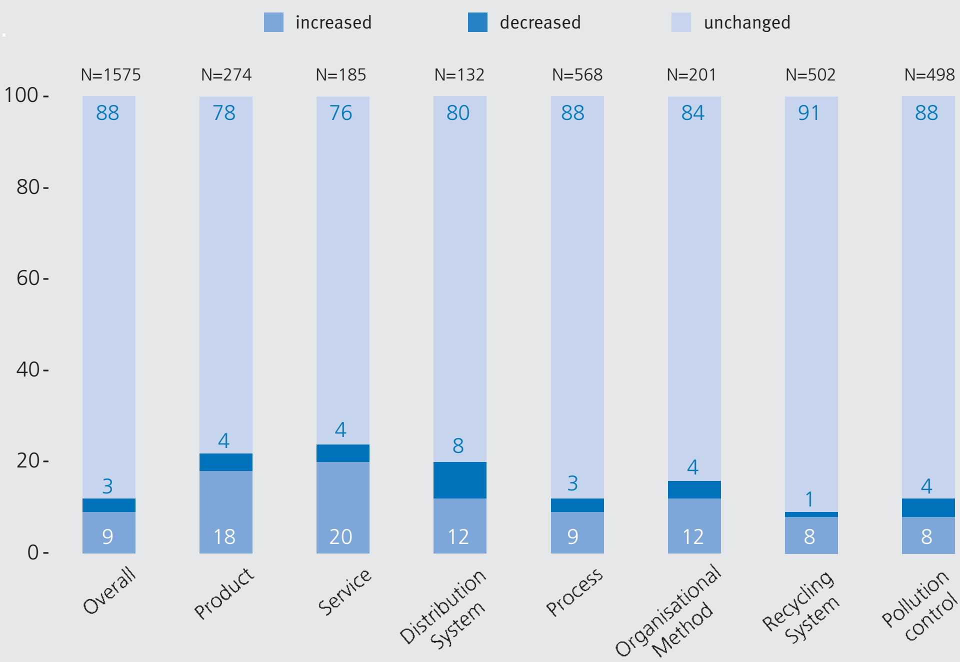
Hence, environmental regulation is consistent with economic growth as is quite evident from the current rate of economic growth in developed countries. As regards the trade-off effect, there is a trade-off effect implying that more money spent on environmental R&D investments is less money that will be spent on things that would be GDP producing, for measured GDP. This effect can be interpreted as opportunity cost effect or crowding out effect of environmental innovation (Löschel, 2002). In addition it also depends on the type of trade-offs- what environmental benefits are being given up in exchange for a faster rate of growth of measured GDP. On the other hand to say that there is no trade-off is to imply that money spent on environmental regulation could be simultaneously spent on other things which can not happen. Opportunity costs considerations suggest that innovation offsets may be small.

Employment impacts of environmental innovations

Unemployment is one of the most pressing political problems in Europe. Thus environmental regulation in general and programmes for environmental innovations in particular have often to be justified by not counteracting goals of labour market policies. In this context, empirical studies found only small quantitative effects of environmental innovations on employment but quite substantial effects on workplace quality and qualification (Rennings and Zwick, 2002, Getzner and Ritt, 2002).

In a large-scale survey in five European countries with more than 1500 firm interviews, overall 88 % of the respondents had no notable effect on employment due to a specific environmental innovation that had been introduced in the years from 1998 to 2000 (see left column in Figure 5). In 9 % of the cases the number of long-term employees increased due to the innovation, while in 3 % of the cases it decreased. Regarding the distribution of employment effects by innovation type, it becomes apparent that product innovations and service innovations have a sizeable above-average positive employment effect (18 % and 20 % of all firms reported positive effects). Furthermore it is interesting that the employment effect of recycling innovations is positive in almost all cases. Innovations in logistics have the highest shares of negative employment changes. Positive direct effects on the firm level can however be compensated by indirect crowding out effects as mentioned above. Overall it can be concluded that **environmental innovations have small but positive effects on the firm level.**

Figure 5: Employment effects of environmental innovations



Source: Rennings and Zwick (2002)

Substantial impacts of environmental innovations on workplace quality have been observed in another European study, both at companies which were directly affected by the changes in production technologies and as a result of structural changes in the economy and changes in intermediate demand structures (Ritt and Getzner, 2003). More sustainable methods of production also lead to changes in the organisation of work, in terms of increased labour market flexibility and changes in work processes. Depending on how measures are implemented in practice, this can have positive or negative effects on the quality of employment. Involving employees in the practical implementation of integrated environmental protection can enhance the positive effects on employment quality, meaning that more attention is paid to the needs of the employees.

In general, the direct and indirect effects of environmental innovations tend to increase the demand for skilled employees and decrease the demand for less skilled workers. The need for unskilled workers to adapt will therefore be intensified. Measures to promote the necessary adjustment through retraining schemes or job creation schemes targeting specific groups can be of assistance here.

Research up to now did not strictly distinguish between incremental and radical changes. While an improvement of a specific process in a firm seems to have small economic and ecological effects in most cases, the question is if this holds true for radical innovations or system innovations, e.g. the introduction of new energy systems. As far as such radical changes have already been introduced to markets (e.g. renewable energies), they seem not to show fundamental differences in their economic characteristics in the short run. However the long-term impacts of radical system changes cannot yet be foreseen.

Policy Implications

For developing target-oriented transition programmes with core-instruments as outlined above, we have discussed several policy programmes and instruments which have been recently initiated at the European or Member State level, and which are relevant for the issues discussed here. Many of them form a useful basis for further initiatives.

Examples for policy measures being candidates for core-instruments that have been discussed at our workshops are:

- Market-based instruments,
- Regulatory instruments,
- Environmental Management Auditing Systems.

Examples for policy programmes that were discussed at our workshops are:

- The Cardiff Process,
- The Seville Process,
- Integrated Product Policy.

Other policy areas having been identified as relevant for innovation and environmental policy during our workshops have been:

- Green technology foresight,
- Lead markets for environmental innovations.

Our workshop discussions concerning these issues are summarised in the following sections.

Attaching economic value to the environment – A European wide emissions trading scheme

Economic instruments are important in helping to co-optimise the environment with the economy. They are a cornerstone policy fitting the Blueprint.

After more than 10 years of negotiations, harmonised standards of energy and fuel taxes have now been introduced in the European Union (Umwelt, 2003). Although there are still a lot of exceptions, the minimum standards are an important step in the right direction since they reduce market distortions within the European common market.

While energy taxes have been in the center of public debate over the nineties, the discussion of the current decade can be expected to be dominated by the introduction of a European emissions trading system. Emissions trading has gained increasing importance in the context of the Kyoto process (Hemmelskamp, 2002). However, the superiority of market-based instruments in pulling innovation still needs to be demonstrated in practice.

The discussion on how to design an emission trading system in Europe is controversial and implementation is still lacking. First experiences in Europe have been made in Denmark and the UK, for example. Both examples show that the practical implementation of emission trading systems is handicapped by several problems. These problems refer to both, the given institutional environment, based on the actual regulative and institutional framework, as well as to the concrete form in which emissions trading is implemented, i.e.:

- high monitoring costs, high transaction costs and verification requirements,
- difficult policy implementation due to a need of horizontal policy integration,
- only large emitters can be efficiently covered,
- various direct and indirect inter-relationships with other framework conditions exists,

In existing trading systems in the US, especially in the SO2 trading system, innovation incentives of emission trading were limited to cheap technological or organisational solutions. Radical regime shifts and system innovations were not supported. They mainly depend on the emission targets underlying the emissions trading system. This emphasises the importance to align policy instruments to societal.

Emission trading can be a cornerstone for environmental policies and in particular for climate policy. It has proved not to be a clearly superior instrument and is thus no magic instrument. It fosters the diffusion of existing technologies. Incentives for further, more long-term oriented innovation efforts can hardly be discovered in existing emissions trading schemes. They depend largely on the underlying environmental targets. Emission trading is thus an attractive addition to other instruments already used in existing policy actions. It should be combined with other (not only environmental) policy instruments; such as innovation policy, especially it should be aligned to long-term policy targets.

An alternative to tough market based instruments is often seen in voluntary approaches or so-called "soft" instruments. The Dutch type of negotiated agreements (covenants) is often cited as a model for such new co-ordination mechanisms in this context. The potential of "soft" regulatory approaches is however mainly limited to the exploitation of win-win-potentials, and additional measures are needed in cases where no win-win-situation exists (Rennings, 2003). Experiences with negotiated agreements are better in small countries than in big countries, and they are better at the national level than at the international level (both probably due to co-ordination problems).

Strengthening the demand for greener products – a more focused Integrated Product Policy

Integrated Product Policy (IPP) became part of the political agenda in the late 90s (Rubik, 2002). Recently the European Commission published a Green Paper (2001) and a Communication on IPP (2003). These Reports were intended to stimulate discussion by presenting some proposals for IPP. Some of the main characteristics of IPP are described in the Green Paper:

- Integration refers to consideration of the whole life-cycle of a product from the cradle to the grave,
- co-operation with stakeholders and application of different instruments;
- the term product includes both material products and services;
- similar to the concept ot transition management the policy is based on a governance philosophy of facilitation rather than direct intervention.

The implementation strategy of the Commission is concerned with strengthening the environmental orientation of both supply and demand. A series of proposals and possible actions are listed referring to both sides, e.g. concerning the price mechanism, greener consumption and business leadership in greener prodcution. The Communication specifies that in "principle, IPP will complement current legislation by triggering, on a voluntary basis, further improvements in those products whose characteristics do not necessarily require legislation" (European Commission, 2003).

The questions in the Blueprint context is how far IPP can contribute to innovation. The impact on innovation, and especially on radical innovation processes, is up to now somewhat weak. It seems that firms have a limited ability to strategically deal with green product and service innovation. Life-cycle thinking, among which life cycle analysis is the most famous but not the most widespread assessment tools, have been used for years by few large corporations and, to some extent, by governments (Rubik, 2002). Empirical evidence shows however that these life-cycle approaches, when used, have a more retrospective than prospective role, meaning that the related tools are used to prove the rationale for product changes and, in some cases, to slightly correct existing artifacts and patterns.

The new Communication does not offer instruments or strategies with substantial innovation incentives. While instruments using the price-mechanism can be regarded as potentially powerful and to stimulate innovation, they are rejected in the context of IPP. The new Communication does not see a realistic chance for reduced VAT rates for products with the EU eco-label due to disagreement among Member States. It is also not intended to revise public procurement, instead a better application of existing potentials for greener procurement is suggested (European Commission, 2003).

Main elements in the strategy of the EU Commission are the stimulation of "continuous improvements" of products and pilot projects to indentify priorities. The term "continuous improvment" remains somehow vague, it neither includes quantitative targets nor a specification what is meant with these improvements and how they should be measured.

To stimulate product and system innovations, IPP should be aligned with transition strategies (including quantitative targets or a better specified rule of continuous improvement) and with core instruments (such as reduced VAT rates). Holistic views, overall sustainability goals, and learning processes through experiments in niches (e.g. in the pilot project envisaged by the Communication of the European Commission) are to be the starting point.

Integrating innovation managers in environmental management systems

The EU Commission has introduced the Environmental Management Auditing Scheme (EMAS) to promote environmental management systems in firms. A recent large-scale survey of German EMAS firms found that EMAS has a positive influence on environmental process and product innovations as well as on environmental organisational innovations (Rennings et al., 2003).

Innovation effects of environmental management systems are benefits with a generally qualitative nature, i.e. they can not be easily transferred into quantitative figures such as the costs of these systems. Thus the environmental benefits of these innovations were not measured in quantitative figures, e.g. tons of CO2 emission reductions.

The scope of these innovations stimulated by the management system depends on the maturity of EMAS (age of EMAS, re-validations, beforehand experience concerning the organisation of environmental management, ISO 14001 validation).

The organisational scope of EMAS in the facility is an important factor of success in inducing environmental innovations within the facility. The R&D department plays a central role in this matter and it should participate in further development of EMAS in order to achieve improved linkage between product-related and strategic issues.

Similar to innovation effects, learning processes in firms are also an important impact of EMAS with a qualitative nature. It could be shown that facilities wich have reported significant learning processes by EMAS are particularly successful in economic terms (Rennings et al., 2003). Thus EMAS fits very well to transition strategies focusing on learning strategies. In addition, environmental reports as required by EMAS contribute to the diffusion of environmental innovations.

Many firms plan to quit the systems after "picking the low-hanging fruits" in the first EMAS years. Firms are often frustrated by missing rewards from private and public markets. They demand, for example, privileges regarding public procurement processes, in the form that participation in integrated environmental protection programmes such as EMAS should be a precondition (or at least a criterion) of approval as a supplier to the public sector and of participation in public tenders. Thus it would be highly efficient concerning a wider diffusion of environmental management systems to implement measures of IPP as outlined in section 5.2.

Identify and disseminate best technologies – Integrated Pollution and Prevention Control

Before technologies can be improved by innovation, it is necessary to know the existing best available techniques (BAT). In Europe the IPPC Bureau in Seville is responsible to define BATs for different processes and sectors. IPPC is the abbreviation for Integrated Pollution and Prevention Control.

IPPC has a community legislation which literally tries to bring together the whole environment, from the use of raw materials, use of natural resources to preventing environmental hazards. In the so-called "Seville Process", IPPC acts as an information exchange centre. 32 countries (member and non-member states), industries and environmental NGOs constitute the information exchange bureau (Litten, 2002). The sub committee (Technical Working Groups) is assigned the task of determining the following:

- Review the current performance with respect to key relevant environmental issues,
- Identify techniques used to achieve the "best" current performances,
- Examine economic and technical conditions under which the techniques are applicable and
- Analyse whether it is the right environmental decision and whether it is economically viable for the sector.

Economic viability is not a question for every individual operator, the concept of BAT is not what can everybody achieve, but what can the sector achieve. There has to be upfront acceptance that there may well be casualties in the exercise in implementing this.

BAT serves as a benchmark and is used to judge the performance of an existing installation or a proposal for a new installation, thus assisting in the determination of an appropriate "BAT-based" condition for the installation (Hitchens, 2003). IPPC permit conditions must be based on the best available techniques and not prescribe the use of a specific technique/technology. IPPC does not prescribe best technology, but identifies the environmental performance, which is consistent with BAT.

Potential impacts of BAT and IPPC are (Litten, 2002):

- BAT reference documents (BREFs) have been accepted by all major state congresses and continue to provide common reference information across the Europen Community,
- It is an open, transparent and knowledgebased approach as industry operators, regulatory authorities and other interested parties share access to BREF,
- Readers of BREF and those involved in the preparation are made aware of the challenges for the future BAT (for e.g. What can be done at what cost and at what environmental trade-offs),
- The exercise exposes the issues to everybody, sometimes broader environmental issues exposed outside the boundary of IPPC permitting,
- Desirable action may be identified in raw materials supply chain,
- It considers all environmental media in an integrated way.

Ultimate impacts of BAT will depend on how IPPC is implemented, e.g. legislation must be implemented and enforced by the authorities, as pointed out in Recital 13, which is a message to the industries that environmental aspects should be taken into consideration by the operator. A clear driver for industry to achieve BAT standard at lower cost is to set performance targets rather than technological targets.

As knowledge and technology are expected to grow, BAT too is expected to change, hence BAT is dynamic. IPPC focuses on processes, knowledge by the regulator of Best Available Techniques and takes account of the appropriateness of implementing some techniques by considering local conditions.

Such a policy falls short of the innovation stimulating conditions considered by Porter (see section 4.1). However, BAT does not hinder innovation since it does not prescribe a specific technique (Hitchens, 2003). It is no more than the provision of information based on which parties could bargain. Indeed BAT is no more than a list of available techniques and as a dynamic list provided a stimulus to equipment producing companies and engineers to improve their technologies and methods. While regulators must enforce legislation they must be flexible in how they do this.

While a direct incentive towards environmental innovation is not part of the Seville process, it has to be recognised that there are important indirect contributions. First it must be recognised, there are huge environmental gains resulting from the principal concern of the IPPC Directive, namely the diffusion of BAT.

For commercial reasons, incentives towards environmental innovation are signaled to machine and equipment producers to produce recognised BATs now and in the future. Hence plans to review BREFs are a continuing stimulus. Such future environmental improvements tend to go hand in hand with a productivity enhancement of the equipment, process or technique.

Nonetheless the process does not stimulate radical change, probably because choice of BAT is subject to economic viability, and is therefore not sensitive to systems change. Although in practice economic viability is not usually a major constraint.

The information exchange itself (TWG) is an important forum for indicating areas where R&D is required. Stakeholders share ideas, in an international meeting, where precise regulatory rules are not discussed, and this makes it easy to share ideas. Visions of how a process can become successful are discussed. A major, though understandable, problem area faced by TWGs is a reluctance by industry to share cost and performance data on new processes.

Member state implementation is important as a driver for innovation. Not part of the Seville process but a necessary part of compliance with IPPC, innovation is stimulated by the need to meet BAT emission standards as cheaply as possible without necessarily adopting a recognised BAT.

It can be concluded that the Seville Process is an important policy for the diffusion of environmental technologies and best practice environmental methods (Hitchens, 2003). It is an indirect stimulus to innovation, and an important source of information to identify areas for R&D. It is not a disincentive to environmental innovations.

Understanding trends and desirable sustainable futures: Green technology foresight

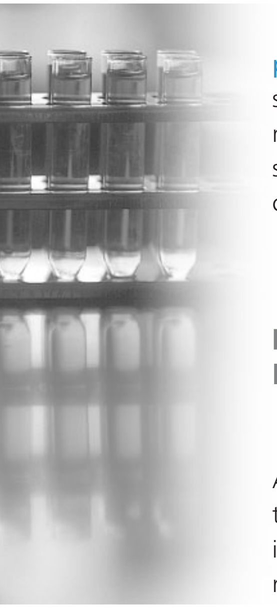
Environmental policy making is often accused of short-termism, since it tries to face stringent environmental problems. Radical innovations could more easily develop within a long-term regulatory scenario where key environmental targets are clearly set together with the related specifications for defined sectors. Scenarios could be developed through a multi stakeholder process in order to improve consistency and effectiveness once they are published and advertised (Bartolomeo, 2002). An important tool for scenario development is also green technology foresight.

Green technology foresight studies are still in an early phase of development, thus it seems to be too early for a final assessment. Pioneering countries have been especially the Netherlands and Denmark. According to these experiences, the methodology of green technology foresight studies is basically influenced by conventional technology and expert-oriented approaches, using i.a. delphi methods. Innovative methods have been developed by using problem-oriented and back-casting approaches as well as societal demand pull/technology push approaches and life cycle assessment (Borup, 2003). The studies are however criticised for being non-surprising ("delphi-studies only repeat what is already known from experts") and too technocratic ("they should start thinking about societal futures without technological fixations").

Concerning the integration of environment and innovation policy it is important to clarify the goals of a foresight. Do they want to give normative recommendations which technologies should be adopted to achieve certain environmental targets (factor x goals or greenhouse gas commitments)? Or do they want to make positivistic statements about successfull technologies of the future? While conventional studies mainly answer the latter question, green technology studies should address both questions in different scenarios (market scenarios vs. regulation scenarios).

Several recommendations can be made concerning a better co-ordination of environmental and innovation policy:

- It is necessary to include more non-technical innovations in green technology foresight.
- Foresight studies should not only be based on consensus but also show dissent (since future problems and technical solutions are created by conflicts, not by agreements).



For policy integration it is further important to consider the precautionary principle. The question is if this principle, tending to risk averse decisions and pessimistic views about technology impacts, creates conflicts with the general optimistic and technology-friendly character of foresight studies. This must not neccesarily be the case. The precautionary principle can be used complementarily to exclude unacceptable solutions.

Paving the way for competitive technologies: Lead markets for environmental innovations

The response of consumers to new products is a crucial factor for their success. And the success of new products, creating new markets, are of paramount importance for innovation. It is expected that the market's impact on innovation to grow in the future, and the majority of managers expect that markets will become more receptive for introducing new products (ITT, 2003). In this context innovation policy needs a deeper understanding why innovations are adopted by pioneer countries and diffuse from country to country. These processes are the issue of the "lead markets" concepts. It explains competition between different innovation designs, early adoption in lead markets and the following global diffusion (Beise, 2001).

The lead markets approach has also been applied for environmental innovations (Beise and Rennings, 2003), emphasising the important role of regulation for innovation and the international diffusion of environmental technologies. While environmental innovations are still largely driven by regulation, they will only be accepted in the long run if market conditions are improved and if they are sufficiently demanded by customers (see section 5.2).

National markets vary in their receptiveness for a given innovation. Lead markets are not necessarily the countries that developed a new technology. Others may adopt it first due to specific conditions. The price and cost structure of a national market can be encouraging for certain types of innovation. For example, automation technologies develop faster in countries with relatively high labour costs, and energy saving innovations in countries with higher energy prices. Concerning environmental innovations, these price and cost structures largely depend on regulation.

While lead markets are characterised by a globally dominant innovation design, they can also benefit from the diversity of consumers, regions and types of innovations. Diversity typically increases the number of innovative solutions. The diversity of consumer preferences and regulatory approaches within the Euoprean Community thus offers attractive conditions for environmental innovators. It is important to understand the reasons why particular national markets in Europe become lead markets. This may improve the management of European diversity (ITT, 2003).

Main factors for national markets to become lead markets are the following:

1. They are in advance of a global trend (in income structure, demographic trend, regulations, liability rules, standards, etc).
2. They demonstrate a high degree of competition and therefore are likely to experiment and to react to market needs.
3. They have gained a high reputation concerning problem-solving innovations in the past and are therefore intensively watched by other countries.

Regarding the integration of environmental and innovation policy, the lead markets approach can be regarded as an appealing concept for policy makers since it promises a double dividend or what is discussed as innovation offset in the discussion of the Porter hypothesis (see section 4.1). While explanations for technology diffusion are elaborated and already operational for empirical validation, a corresponding approach for the diffusion of regulation (being crucial for lead markets of environmental innovations) is not yet well developed. It would be beneficial to explain "lead policy markets" by a more socio-technical approach.

A further question is whether lead markets are beneficial in all cases for the pioneering country, or if the followers have advantages in terms of costs and benefits since they save investments in R&D, market introduction etc.

The Innovation Directorate of European Commission has "proposed to further investigate the parameters involved in the formation of lead markets, including examination, together with industrial representatives, of the potential for specific industrial sectors to benefit from European lead markets as a step towards a stronger presence on the international market" (ITT, 2003). This proposal can also be supported for lead markets of environmental innovations.

Integrating the environment into sector policies – Strengthening the "Cardiff Process"

The need for an integrated, cross cutting approach to minimise possibly deteriorating effects of sectoral policies such as energy, industry or agriculture has been acknowledged in the European Community as well as in several OECD countries since the early 1970s. It has been renewed more recently, and gained additional momentum in the late 1980s, as a result of the upcoming debate on sustainable development. Today, the need for more integrative approaches is determined by high-level political strategies such as the Sustainable Development Strategy of the European Union and the Cardiff Process, but also by international obligations such as the Rio Convention.

The Cardiff Euopean Council in 1998 "invited all relevant formation of the Council to establish their own strategies within their respective policy areas, and requested identification of indicators for monitoring progress with the environmental integration strategies in different sectors". Successive European Councils specified nine key sectors and asked them to present their integration strategies at the Gothenburg Council in June 2001. In response to this mandate, sectoral Councils and their respective DGs have launched a series of internal and external meetings, documents, and studies which are commonly referred to as the 'Cardiff process' (Hertin and Berkhout, 2002). The overall aim of these activities is to develop sectoral integration strategies, i.e. a process through which non-environmental policy sectors assess the environmental implications of their decision-making, set out an action plan to reduce negative and enhance positive environmental effects, and evaluate the success of the process.

Building on the development of the environmental integration and sustainable development within EU policy areas, the Vienna Summit in 1998 invited these Councils to continue their work with a view to submitting comprehensive strategies to the Helsinki Summit. It also invited other formations of the Council – Industry, Internal Market and Development – to further develop this work and drew attention to the environmental dimension of employment and enlargement of the EU. The Helsinki European Council in 1999 focused on the overall progress on the integration of environmental concerns and sustainable development into Community policies.

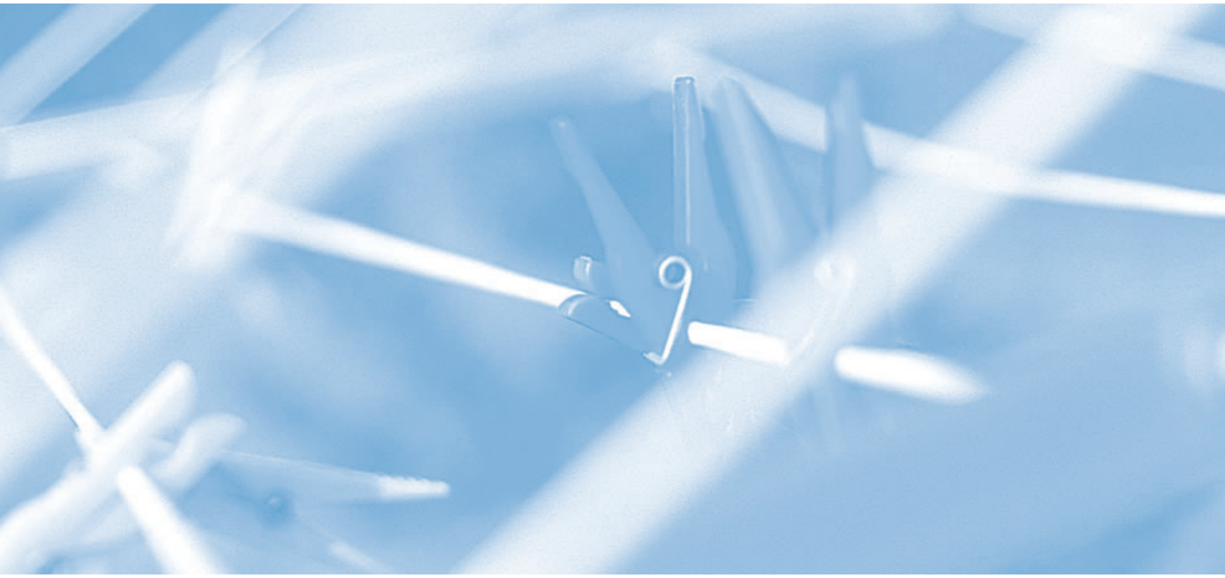
The commitment undertaken by the European Commission to develop a strategy aimed at integrating sustainable principles in all European policies led not only to the requested "European Union Strategy for Sustainable development " (Euopean Commission, 2001) but also the VI Environmental Action Programme and the EU contribution to the World Summit on Sustainable Development in 2002. The Commission took into consideration means of implementation for its policy proposals for 2002, in order to have a solid foundation to achieve sustainable development in the EU which further contributes to global sustainable development.

The definition of European Union Strategy for Sustainable Development proposed in the Gothenburg Summit is the result of the combination of two strategic objectives: on the one hand, the commitment requested by the Helsinki European Council, and on the other, the purpose of complementing the Lisbon European Council, which sets the objective "to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion". The EU Strategy Sustainable Development pushes forward an integrated approach for policy-making, that takes into account the environmental, economic, and social dimensions. The Gothenburg Summit agreed also to carry out an annual inventory of the progress at each spring summit. The first review was made by the Barcelona Summit in 2002, underlining the need for a better assessment of the economic, social and environmental effects of EU Policy-making. This was reiterated by the Brussels Summit in Spring 2003, which also called for a new impetus of the progress.

The policy integration process at the EU level can be seen as a learning process for Councils and that this process needs patience and persistence (after all the history of improvements in environmental policy has been long term). There is, nevertheless, a need for guidelines on how to integrate and co-ordinate policies rather than by asking for this to be undertaken independently by different councils. Currently this need to incorporate environmental concerns into policy is seen as a burden, and as a one way burden from environmental to other policies, it necessarily lowers the strength of the environmental policy priority. A two way mechanism of harmonization might allow more to be achieved.

Where the work of co-ordination of policy is actually undertaken, the methodology for the integration of environmental policy concerns can learn from the Technical Working Groups (TWGs) which are so important in the production of BREFs for BAT, during the Sevilla process. This successfully brings together the often conflicting goals of different interest groups. This is important, because in the place of such a model in order to overcome the barriers to co-ordination e.g. that the process is time consuming, lacks accountability, involves joint targets.

The essential question is whether the Cardiff process is a potentially useful basis for further integration or co-ordination of environmental and inovation policy. Up to now innovation aspects do not play a major role in the process. It seems that it would be important to improve the coherence between the sectoral integration strategies by mutual adaptation and an overarching environmental strategy in terms of a transition programme as outlined below. It could be started for priority sectors with the potentially highest impact concerning environmental and sustainability aspects (energy, transport, agriculture).



How to co-ordinate the different policy areas?

The final and (due to the term integration in our project title) central question is: how to integrate or co-ordinate these different policies? In other words: Should the Seville Process be linked with the Cardiff Process, EMAS with IPP, transition strategies with market-based instruments, green technology foresight with lead market concepts etc.? And if yes, how should this be organised?

Subsidiarity and policy co-ordination

Our final Blueprint meeting took place in Limerick, inspiring us to start this section with the following:

"This Blueprint was born by frustration,
about the lack of policy integration.
We discovered it is too complicated,
if all policies are integrated.
Better to think of co-ordination!"

This Limerick, our introductory statements concerning market failure and system failure, and practical experiences with policy integration (as for example the Cardiff Process) make us somehow skeptical concerning practicability and potentials of integration strategies.

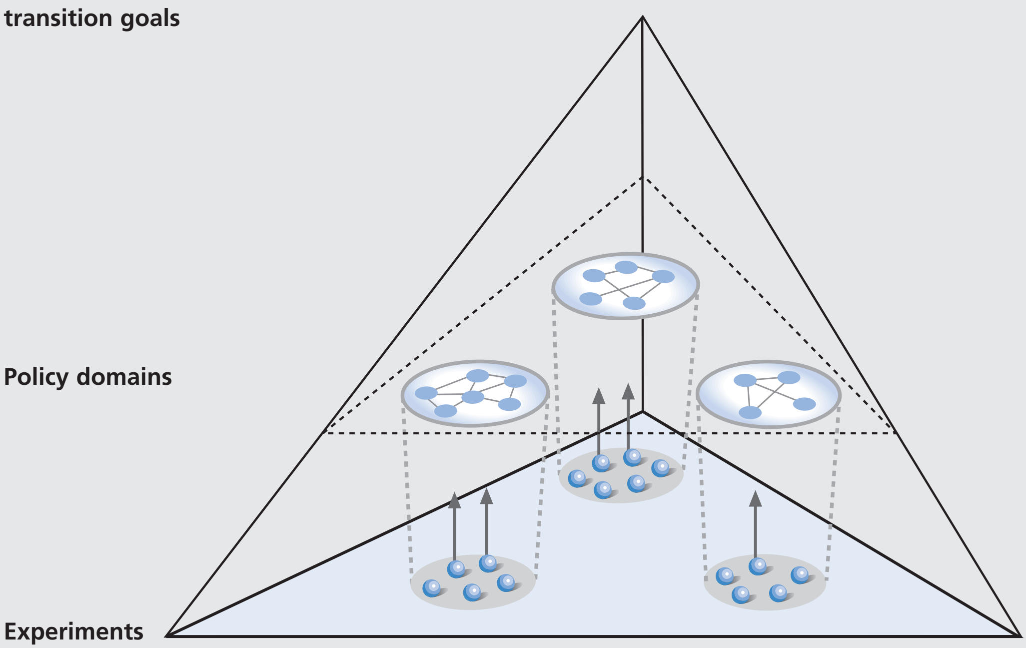
There are a number of reasons why co-ordination is preferable to integration. It reduces complexity, increases flexibility, allows to implement feedbacks and learning mechanisms easier, benefits of specialisation and responsibility of each actor involved. As a general rule, decisions should be made as decentrally as possible. Responsibilities and corresponding co-ordination needs on higher levels, especially on such a high degree of centralisation as the EU level, have to be justified by market failure or system failure on lower levels (see section 2.2). This refers to the subsidiartiy principle as a basis for European policy making. Under the subsidiarity principle, institutional solutions must act on as low a level as possible, i.e. priority must be accepted for decentralised solutions, due to the informational, motivational and monitoring advantages involved (Rennings et al., 1999). If decision-making powers are to be shifted to a higher level, "good reasons" have to be adduced.

Areas of policy co-ordination

Several co-ordination efforts are necessary for a target-oriented, efficient environmental and innovation policuies. Co-ordination efforts can belong to the following types (see Figure 6):

1. Top-down co-ordination
2. Bottom-up co-ordination
3. Horizontal co-ordination

Figure 6: Vertical and horizontal co-ordination within the Blueprint vision



Examples of co-ordination mechanisms of each type would be as follows:

Ad 1: Top-down co-ordination: Target setting

An important top-down measure is the formulation of over-arching, long-term policy targets. Recent developments in environmental and innovation policy have shown that innovation efforts were in many cases related to such targets.

Targets concerning CO2-reduction, fuel efficiency, shares of zero emission cars, renewable energy or organic agriculture have been main drivers of environmental innovation activities.

Thus it would be useful to review existing targets in priority areas (e.g. energy, transport and agriculture). Additional targets for the European Union in the areas of transport (e.g. share of low emission cars or alternative mobility services) and agriculture (e.g. share of organic food) could be a strong regulatory push for environmental innovations. Another useful target would be to establish Europe as a lead market for renewable energies and sustainable transport technologies.

Ad 2: Bottom-up co-ordination: Experiments at the local level

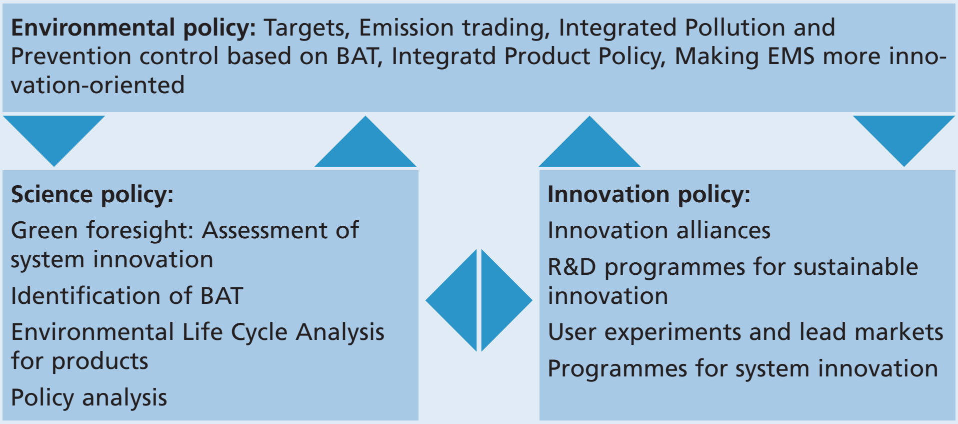
An example of bottom-up co-ordination is experimenting at the local and regional level. The heterogeneity in European regions should be exploited strategically for system innovation. Local experiments may serve as "breeding spaces" and "testing places". Special circumstances at the local level (in the form of a particular sustainability problem, special competences on the part of local economic actors, alternative life style constituencies and political configurations) may form a window of opportunity for sustainability solutions. Lessons learned should be used to inform programmes for system innovation which – as we know – require a great deal of learning and involve change at many levels.

Ad 3: Horizontal strategies: Special programmes for diffusion of environmental innovations

It seems to be agreed that innovation policies are better suited for stimulating invention while environmental policy can support the diffusion of environmental innovations. The crucial phase is often missing acceptance of environmental goods and services in mass markets after pilot or niche markets have already been established. Especially in the diffusion phase environmental and innovation policy should co-operate closely, e.g. with R&D programmes for specific sectors which help to adapt already existing environmental innovations to the conditions of mass markets. An example would be specific programmes for the further diffusion of low emission cars and alternative mobility concepts.

Figure 7 visualises the Blueprint proposals for the policy issues as described in section 5.

Figure 7: Co-ordination of European environmental, science and innovation policy



Within this scheme there are a number of finer links, such as green foresight influencing R&D programmes and programmes for system innovation in which user experiments are an element. All of this would influence policy targets that would feed back into innovation agendas and competitive strategies of industry. The idea is to create virtuous circles of learning, innovation and policy adaptation, the outcomes of which would inform sector policies.

The Blueprint: From separate policies to co-ordinated approaches to meet long term goals

Thus far sustainability goals have been pursued through environmental policy, laying down specific requirements for products and processes, and through subsidies policies for the use and development of environmental technologies. Past policies led to a considerable greening but the progress is often viewed to be insufficient from a sustainability point of view (Weaver et al., 2000). The possibilities for a further greening of existing trajectories should be exploited but one should also explore the possibilities of system changes that may lead to greater benefits. Support for the latter type of change is warranted because the time scale of system innovation is 25 years or more and beyond the mutual coordination possibilities of individual actors who have a short-term orientation.

Up to now transition programmes for clean technology and system innovation have only been launched on the national level. We argue that they should be transferred to the European level to exploit its heterogeneity in terms of institutional ways of dealing with environmental problems from which we can learn a great deal. Transition can be fostered by policy initiatives and further research. Policy initiatives concerning transition management should (Kemp, 2002):

8. Internalise external costs by market-based instruments such as emissions trading. Without this environmental innovations have a hard time in the market place.
9. Phase out support of unsustainable practices and technologies (support in the form of subsidies or lax standards). Perverse incentives for improvement of the environment and public health should be eliminated. Bad policies (i.e. bad for the environment and health such as coal subsidies) should be stopped. A very useful perhaps obvious solution is contradiction monitoring of policies, to identify conflicting policies.
10. Support innovation for high-risk, high-(social) benefit projects, and accept technological and economic failure. The trend towards reducing the share of government support for R&D projects, to increase the commercial viability, has a detrimental effect on high-risk, high-social benefit projects and worsens the free rider problem (of innovation support for projects that would be done anyhow). Public policy – both innovation policy and environmental policy – should also be more oriented to encouraging outsiders as the source of innovative solutions. Empirical evidence supports that assertion that incumbent companies are unlikely to come up with radical solutions (Ashford, 2002).
11. Stimulate system innovations through R&D programmes with a focus on system innovation in specific areas (such as intermodal travel and underground transport). These programmes are not a substitute for policies to internalise the external costs, either through the use of regulation or economic incentives. These will remain necessary but should be combined with specific policies for system innovation. Such policies should be time-limited and flexible in order not to create "white elephants". Furthermore, different options should be explored.
12. Utilize possibilities embedded in general purpose technologies (also called generic technologies such as ICT). General-purpose technology (GPT) is an important source for achieving environmental benefits. GPT is probably a more important source of environmentally beneficial innovation than cleaner technology RTD programmes. The utilization of GPT may require organisational and institutional adaptation, apart from technological reconfiguration. Environmental benefits from general purpose technology do not occur automatically and should thus be explicitly required and incorporated in all RTD programmes.
13. Exploit heterogeneity at the local level strategically for system innovation. Local experiments may serve as "breeding spaces" and "testing places". Special circumstances at the local level may afford appropriate niches in which new technology and practices can be tried and tested.

14. Learning should be made an important government objective in its own right. Innovation, and the benefits from innovation at the point of use, is often tied up with "learning by doing". Some things you can only learn by engaging in experience with new technology and new administrative arrangements.

These suggestions are not exhaustive but constitute in the view of BLUEPRINT members useful pointers for a co-ordinated approach.

Fields of further research

The suggestions have important implications for EU research, which should be more oriented towards systemic solutions. More research is also needed on policy issues. Comparative research is needed to find answers to questions such as:

- Consensual vs. confrontational approaches: Are consensual approaches better suited to promote innovation than confrontational approaches?
- Qualitative vs. quantitative targets: Are experiences with quantitative targets promising, or should qualitative rules like "continuous improvement" be preferred? If qualitative targets are chosen, how should they be specified?
- What are experiences with policy integration and co-ordination in different countries?
- What are the experiences with core-instruments and how are they linked with transition strategies?

Beyond a comparative analysis, new questions have been raised during the conference:

- System Innovations are often seen as superior concerning sustainability impacts, compared with incremental inovations. Until now this has mainly been a belief and has not been verified. Thus it has to be answered which role both incremental and systems innovations play for a sustainable development path, and if these types of innovation differ regarding their impacts on employment and competitiveness. Environmental technologies should be considered as well as general purpose technologies.
- The long-term prespective in setting targets is crucial, but costs and benefits to society induced by political targets have to be assessed by improved assessment methods, e.g. tools for Sustainability Impact Assessment.
- The parameters involved in the formation of environmental lead markets should be further investigated, including examination, together with industrial representatives, of the potential for specific industrial sectors to benefit from European lead markets as a step towards a stronger presence on the international market.

- Global and social dimensions of innovations should be analysed. It is important that environmental technologies are affordable for poorer countries; needs of developing countries should be considered in programmes supporting sustainable technologies.
- The role of science policy is the improvement of analytical tools such as green foresight, life cycle analysis, cost benefit analysis, models and tools for sustainability impact assessment. Best available technologies have to be identified, and technologies going beyond BAT have to be detected.
- Research programmes should not only focus on technical innovations but also support organisational and institutional changes. E.g. demonstration for societal experiments (e.g. living without a car, sustainable neighbourhoods) would be very beneficial.

Eduardo Morere-Molinero (European Commission, DG Environment) invites Blueprint network members to give comments to the Environmental Technology Action Plan (ETAP) of the Commission

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