

Assessing innovation dynamics induced by environmental policy:

Report of Workshop at the European Commission, Brussels on 21 June 2006

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Executive Summary

A workshop was held on 21 June 2006 to discuss the results of investigations for the project *Assessing innovation dynamics induced by environmental policy*. This report summarises the presentations and discussions of that workshop.

The project was undertaken for the European Commission, DG Environment, by Institute for Environmental Studies (IVM), Institute for European Environmental Policy (IEEP), Policy Studies Institute (PSI) and Netherlands Environmental Assessment Agency (MNP). The objective of the study was twofold. Firstly, it was to analyse (using specific case studies) how different environmental policy instruments induce innovation and to provide an analysis of the dynamics of this innovation. Secondly, it was to investigate how instrument design may influence the characteristics of this innovation. The workshop gave an opportunity for the discussion paper and case study authors to give presentations on the results of their respective investigations, and receive comments from the workshop participants.

- The methodological discussion paper was presented, defining the concept of eco-innovation and outlining a simple model of technical change, distinguishing between 'technology push' and 'market pull', and identifying the relative roles of different actors (business, investors, consumers, government). The four types of policy instruments were also described.
- Results from the automotive CO₂ emissions case study were presented and contrasted the US and Japanese (mandatory) policy approaches to reducing car emissions with the EU voluntary approach. The mandatory approaches of Japan and the US were differentiated by relatively unambitious standards in the latter since the mid-1980s, leading to little innovation since then. All approaches had stimulated incremental, rather than breakthrough, innovation.
- Results from the office appliances case study showed that there had been substantial amounts of eco-innovation in the sector. The mandatory public procurement of energy-efficient appliances in both Japan and the US had spurred on eco-innovation and contributed to market wide changes and improvements in efficiency ratings.
- Results from the solar photovoltaic (PV) case study outlined the development of PV technology and policy various approaches of Japan, Germany and the UK. Japan and Germany had invested far more than the UK, and achieved far greater PV deployment. Japan appeared to have been the most successful in stimulating a domestic PV manufacturing capability through its policy support across the innovation chain.
- Results from the pulp and paper case study showed that environmental policies had a lesser effect on eco-innovation in the sector than competition and market demands, but that incremental innovation, driven largely by market forces, had led to substantial environmental improvement. Where policy had had an effect, it seemed to be more due to its characteristics, such as stringency, rather than the choice of instrument or policy design.
- Results from the hazardous chemicals case study showed that a range of policy approaches had been successful in reducing environmental impacts, and that less hazardous substitute chemicals showed strong learning curve effects. The regulation-induced development of 'closed-loop' systems in Germany seemed to have been most successful in generating successful new environmental technologies.

Discussions followed the case study presentations. A further presentation was given making links with a related European funded project *Policy Pathways for the Development and Adoption of Clean Technologies*, which found that certain policies could be used to target different stages of the innovation cycle. The final presentation summarised work being carried out in the OECD to identify the factors which lead to successful innovation support.

Introduction

The workshop on the Innovation Dynamics project was held in Brussels on the 21 June 2006 at the premises of the EU Committee of the Regions. The workshop was chaired by Paul Ekins of the Policy Studies Institute in London and was attended by a range of experts on environmental policy and innovation from throughout Europe (participants list provided in Annex I). The workshop was split into four areas (the detailed agenda of the workshop is provided in Annex II):

1. Presentations on the background to the study by the Commission and IVM
2. Presentation by Paul Ekins of the results of the methodological discussion paper, followed by an open discussion of the methodological approach taken, initiated by Mark Hayden of the European Commission.
3. Presentation by project partners Frans Oosterhuis and Onno Kuik of IVM and Patrick ten Brink of IEEP of the results of the draft case studies and providing feed-back on the draft case study reports.
4. Discussion of the overall themes and findings, including exploring implications from other relevant recent studies.

The main aim of the workshop was to give feedback on the methodological paper and draft case studies, exploring the central question of the project: how to better encourage eco-innovation through the implementation of environmental policy. The two main aims of the project were

- To assess the extent to which environmental policy instruments induce innovation and to analyse the dynamics of this innovation; and
- To analyse how instrument design influences this. It is important to note that these were the two main aims of the project.

It was not intended that the study investigate any other elements involved, or carry out a policy evaluation or assessment (for example, by comparing policy goals with the actual results achieved).

The methodological and case study papers were made available to participants on the Commission website prior to the workshop:

<http://ec.europa.eu/environment/enveco/activities.htm>

1. Background presentations

Robin Miège of DG Environment (DG ENV) gave a short presentation on the role of his department and how the innovation dynamics project fits into the policy context, in particular the Lisbon agenda and how to feed into the impact assessment of specific policy measures, noting two schools of thought: those who perceived environmental policy merely as a cost to business; and those who considered that it could act as a stimulus to innovation and growth. The debate, and any conclusions formed, were obviously relevant to the Lisbon Strategy for growth and jobs. Robin Miège argued that there is a need to provide greater clarity both in relation to the costs of environmental policy (the focus of a previous research project in his department) and to the policy/innovation debate (i.e. whether and how environmental policy can foster growth-enhancing innovation), which was the focus of this project. There was also a need to identify which types of policies are more innovation friendly. In terms of the policy/innovation issue it was desirable:

- That innovation is looked at in the widest possible sense: incorporating broad views of eco-innovation (innovation that leads to a reduction in environmental impact), especially products and processes which may not have been classed traditionally as environmental technologies.
- To get a holistic view of the innovation process, for example looking at policy measures and how they promote social or systems innovation, in order to help design and implement policies in the future.

That when opting for a specific measure careful consideration should be given to whether the design of the instrument either fosters or hinders innovation

Frans Berkhout of IVM gave the second presentation in this part of the workshop, introducing the broad aims and objectives of the project and explaining the approach taken. The objective of the project was given: to analyse using case studies how environmental policy shapes or influences the innovation process, with the case studies chosen to illustrate different innovation drivers of different types of technologies in different economic sectors. Berkhout outlined the structure of the project, the outputs of which were to be a literature review, case studies, an expert workshop and report, and a final report. Key issues in relation to the project were considered to include:

- The appropriate sharing of the risks of innovation between government and the private sector;
- The appropriability of innovation benefits – the extent to which firms can (or cannot) reap the full reward for the risk they take in innovatively developing new products or processes;
- The direction and quality of innovation, rather than just its existence *per se*.

2. Methodological discussion

Paul Ekins of the Policy Studies Institute presented the main points of the methodological discussion paper to the workshop participants. Innovation was taken to mean any change in technology, management procedure or behaviour, and eco-innovation was innovation that led to environmental improvement. The focus of the project was on the stages/cycles of innovation, on the influence of different types of policy instruments on these stages, and on such potentially generic concepts such as learning curves. Innovation was perceived to be normal and pervasive in a modern industrial economy, but it could have positive or negative impacts on the environment and was driven largely by financial motives and incentives. Possible types of eco-innovation included the fitting of end-of-pipe technologies or changes in processes or products. Of considerable interest was whether policy-induced eco-innovation could result in economic as well as environmental benefits (the 'Porter hypothesis').

Mark Hayden from DG Economic and Financial Affairs (DG ECFIN) was the discussant for the methodological paper and focused on the following themes:

1. There can be difficulties associated with going beyond case study results and summarising common rules to apply to the general policy process. A common methodological approach by the case studies would have helped in this regard (note: not all case studies used the agreed methodological framework).
2. There are assumptions in the methodological paper which are too implicit. There is a need to justify explicitly why eco-innovation requires special attention, over and above the 'normal' innovation policy support process.
3. Should we look to use a typology to index the types of innovation that have occurred, or focus on the end result, namely, the reduction in environmental pollution?
4. The issue of uncertainty in the baseline was unsatisfactorily addressed. A Casablanca approach ("it's a crazy world, anything can happen") should not be used. The approach may be better based on constructing a baseline using current trend rates, and assessing the extent to which extraneous events may potentially have an influence on the baseline.
5. There should be a stronger link between the findings of the literature review and the case study results.

After the discussant an open discussion was held with workshop participants on the methodological paper (including Mark Hayden's comments). The resulting discussion has been summarised as follows:

1. When discussing the costs associated with end of pipe technologies, consideration should be given to the social benefits of the measure, as well as the private cost to the firm.
2. Comments indicating that 'firms hate regulation' should be backed up with evidence, since that has not been the experience of the Environment Agency in the UK.
3. The distinction between 'market based mechanisms' (such an emissions *trading* based approach) and pure 'regulation' (such as an emissions *standard* based approach) need to be clearly defined so as to prevent any misunderstanding.
4. Consideration should be given to fostering a capability for innovation and entrepreneurship in Europe, as well as stressing the role of incentives in

encouraging eco-innovation. Taking a systems approach to define transition strategies towards sustainability was also recommended.

5. The methodology of the project would have benefited by distinguishing clearly between its answers to the 'whether' and 'how' innovation questions. The 'whether' question relates to whether eco-innovation has been successfully achieved. The 'how' question relates to how the innovation (i.e. the dynamics of the process and the interventions that influenced it) is achieved. The objectives of the research did not address this issue explicitly. Policy makers are likely to be more interested in the 'how' question than the 'whether' question.

3. Case study discussions

The authors of the case studies presented their respective reports¹:

1. Car fuel economy / CO₂ emissions – *Onno Kuik from IVM*
2. Energy efficiency of electr(on)ic appliances – *Frans Oosterhuis from IVM*
3. Solar Photovoltaics – *Patrick ten Brink from IEEP*
4. Emissions from pulp and paper production – *Onno Kuik from IVM*
5. Substitution of chemical substances – *Frans Oosterhuis from IVM*

3.1 Car fuel economy

Onno Kuik gave his presentation based on his case study investigation. The case study addresses innovation dynamics induced by environmental policy in the automotive industry. It examines car fuel efficiency programs in the EU, the US and Japan. It concludes that existing programs have not yet succeeded in promoting radical and breakthrough technologies, but that the European and Japanese programs have had more success in stimulating incremental innovations than the US program.

The discussion on his presentation centred on the following issues:

1. David Gee of the European Environment Agency (EEA) asked whether the objective of the US CAFE policy was to achieve eco-innovation or fuel security? This relates to the success of the policy when one evaluates it, he argued. It was argued that the US CAFE programme was designed to increase fuel efficiency during the OPEC oil crisis era (which it achieved with a 50% increase in fuel efficiency), rather than induce eco-innovation for environmental reasons. He also argued that an important element of evaluation should be an assessment of the monitoring, enforcement, and penalty regimes attached to each of the policies surveyed (although, as noted in the Introduction, such an assessment was not part of this project).
2. Greg Nemet of UC Berkeley, building on the previous point, suggested that the case study may present an opportunity to study the counterfactual baseline. This is because the fuel efficiency improvements to 1985 may have been a result of the energy crisis/high oil prices, rather than the CAFE programme in itself. This is likely to have been the case if the fuel economy data shows that the fuel economy standards were ever exceeded in the period to 1985, before the oil price fell.
3. Frans Berkhout of IVM suggested that manufacturers might respond strategically to the Top Runner Programme, limiting their innovation in order to reduce the rate at which standards were tightened.
4. Sandy Rowden of the Environment Agency (UK) asked the question as to how the flexible standard of the Top Runner Programme may be applied to Integrated Pollution Prevention and Control (IPPC) permits or other regulatory regimes in the UK. It was suggested that this may be a field for further research and learning.

¹ Draft case studies and presentations available at <http://ec.europa.eu/environment/enveco/activities.htm> (accessed 19/7/2006)

5. Stephen White of DG ENV was interested as to why eco-innovation was studied in isolated markets. Car manufacturing is a globalised industry, therefore surely eco-innovation in one market would be diffused into all other markets.
6. Paul Ekins believed that the headline result was that **stringent standards** seem to be driving the innovation process. It was also suggested that a further area of study could centre on the question that Greg Nemet of UC Berkeley made, by looking at the effect prices had during the 1970s and attempting to distinguish which were the driving factors – policy or prices.

3.2 Energy efficiency of electr(on)ic appliances

Frans Oosterhuis presented the results of his case study. This case study addresses the innovation dynamics induced by environmental policy in the energy efficiency of office appliances. The aim of the paper is to look at the role of public policy in stimulating the development and diffusion of more energy efficient office appliances. In particular, it investigates the specific (actual and potential) contribution of public procurement to this market transformation. The Japanese and USA approaches, involving mandatory public procurement were highly successful at encouraging eco-innovation, in contrast to the less stringent policies in Europe.

The discussion on his presentation centred on the following issues:

1. Jakub Wejchert of DG ENV was interested in the ranking list and criteria used to rank 'good' and 'bad' policy instruments when asking industry experts. He argued that this could be a subjective measure. He was referred to the actual expert survey questionnaire that had been used in the case study.
2. Gjalt Huppes of Leiden University suggested that the best performing ICT units were probably the most expensive ones. This may explain why industry is keen on green procurement plans as they allow them to profit maximise in the most efficient way.
3. Olivier Debande from the European Investment Bank suggested that one possible method of measuring innovation dynamics would be to use the number of patents or inventions generated in the targeted sector, rather than presenting an empirical analysis of the impact of policy on innovation. The measurement of innovation arose as a topic in a later discussion during the presentation by Nick Johnstone of the OECD, who explained the various benefits and limitations of different proxy eco-innovation indicators.
4. It was evident to Paul Ekins that there had been **substantial effectiveness of mandatory public procurement**, and that there were obvious lessons for the European Union and its Member States. This finding was one of the most surprising of the investigation since this relatively simple instrument had a **transformative** effect on the market. It was noted that the UK is currently undergoing a public procurement policy review.

3.3 Solar Photovoltaics (PV)

Patrick ten Brink gave his presentation based on his case study investigation. The IEEP paper examines innovation in solar photovoltaics in three sections: 1. a description of the technology, 2. innovation in PV, and 3. the impact of supportive

policy. The paper concludes that the Japanese and German approaches have been successful, while the UK approach has failed, in encouraging the uptake of PV. The UK approach failed as it looked to encourage renewables as a whole and for the most cost-effective one to be chosen, which is not PV. The Japanese approach was initially the most successful, though overtaken recently by Germany given the more significant ambitions for PV deployment of the latter. Interesting insights included the fact that the instruments to support PV changed over time as the technology and its costs developed – the latest support rates are less than half of those earlier, and also include a dynamic element (5% reduction per year). However, the complexity of studying the PV market was raised, as cost reductions and innovations can occur at any stage in the supply chain (note: PV systems do not only involve modules but also the related power support systems).

The discussion on his presentation centred on the following issues:

1. David Gee of the EEA critiqued the paper as it gave the impression one must choose between either solar PV or other forms of renewables. He argued that in Germany, for example, support is given to both solar and wind technologies. Patrick ten Brink clarified that is simply a case of if one wishes to support PV one needs to have PV specific support as promoting renewables as a whole would likely not lead to PV uptake given current prices and that clearly one can support a portfolio of different technologies at the same time.
2. Jakub Wejchert of DG ENV suggested that it would be interesting to take a broader approach, comprising systemic analysis of support packages (i.e. using different instruments), targeted across a number of industries . By looking at policies which incorporate such support packages, such as the Barcelona Sun City example, one may gain a fuller understanding of the effect that policies can have (rather than looking at one technology in one industry).
3. Greg Nemet from UC Berkeley praised the approach of looking at systems rather than simply PV modules. He also speculated over the extent to which R&D spending is a substitute for market deployment as a source of innovation in the PV sector. This was likened to the UK approach which can be characterised as holding back on deployment, and spending funds on R&D until the price has become sufficiently competitive before deploying on a full scale basis.
4. It was apparent to Paul Ekins that it is possible to give innovation policy support across all of the stages of the innovation process. He was struck that the jury is still out on the benefits of PV in terms of price competitiveness. It was noted of importance that most of the German systems being installed are actually manufactured in Japan. So although Germany may have a larger generating capacity of PV, it may have been the **Japanese policy** which has been most **successful in encouraging innovation**, since it seems that Japanese financial support has been steadily replaced by funds from German taxpayers resulting from the PV deployment in Germany.

3.4 Emissions from pulp and paper production

Onno Kuik gave his presentation based on his case study investigation. This paper addresses the innovation dynamics induced by environmental policy in the pulp and paper industry. It is suggested that the main drivers for innovation in the pulp and

paper industry are competition and market demands (with environmental policies also playing a role). With respect to the types of policy instrument most conducive to innovation, the paper suggests that it is not primarily the type of instrument (economic, command-and-control, voluntary) that matters, but much more its design characteristics (intensity, flexibility, dynamic properties).

The discussion on his presentation centred on the following issues:

1. Fred Steward of Brunel University was interested in this case study, the subject of which is a good example of a mature sector. He felt that in any mature sector there must be an increasing scope for 'disruptive' forms of innovation, such as innovations in the nanotechnology and biotechnology sectors which are looking for alternatives to wood-based paper. It was suggested that such 'disruptive' forms of innovation could be incorporated into the framework of analysis in the case study.
2. David Gee of the EEA highlighted a recent report undertaken by Hilden on the Finnish pulp and paper sector which may add to the influences on innovation identified by the case study. This includes the influence of public perception and public demand which can be driven by groups such as Greenpeace, the way the permitting system could be a spur to innovation (authorities implementing the system failed to appreciate this element in the past), and the extent to which the Finnish system is especially successful in diffusing technologies.
3. Nick Johnstone of the OECD Environment Directorate was interested in the sunk costs associated with the pulp and paper industry (note: Onno Kuik stated that capital equipment in this sector can have a lifespan of up to 30 years and can cost up to \$500m). Nick Johnstone linked this with research undertaken in the USA which investigated the effect of the regulatory framework on entry and exit within industries with sunk costs. The research suggested that no matter what the regulator does, because there will be much lobbying and negotiations undertaken as a part of the permitting process, regulators tend to favour existing actors over potential new entrants. The indirect impact this can have on the innovation process can be potentially huge since the vehicle on which innovation and new ideas enter the sector is generally through new entrants to the market. He was interested in the extent to which these types of stakeholder relationships can affect innovation rates, and speculated whether such an analysis using the sunk cost method could be incorporated into the case study.
4. Robin Miège was interested in the potentially conflicting sentences in the presentation where on one hand it was stated that more innovation is likely where environmental performance and competitiveness are present, yet on the other hand it was argued that there was no clear difference between the instruments surveyed. What were the conclusions for policy makers?
5. Paul Ekins was interested by the forces of normal innovation. This highlighted a **conflict** between determining the **causal factor** behind the innovation. Was it resulting from normal business activity, or was innovation resulting from the implementation of the policy? It is almost impossible to distinguish between the policies since the underlying driver towards innovation seems rather strong.

3.5 Substitution of chemical substances

Frans Oosterhuis presented the results of this last case study, which addresses the substitution of hazardous chemical substances for other chemical substances which have a lower environmental impact, or by other technical or organisational measures. The case study focuses on chlorinated solvents in Sweden, Denmark, the USA and Germany. While a number of policy approaches seem to have been successful in driving eco-innovation, it seems that the German example of regulation-induced 'closed-loop' processes had done most to generate new competitive advantage for exports.

The discussion on his presentation centred on the following issues:

1. David Gee of the EEA suggested that the externalities of the substances should be addressed, as such an analysis is lacking at present. It was proposed that a differentiation between public and private costs could also improve the robustness of the investigation. He believed that the treatment of the Swedish experience of substitution in the chemicals sector did not tell the full story, since Sweden has been innovating for over three decades in this sector. Mr Oosterhuis agreed that the selected case (trichloroethylene) was not necessarily representative and that other elements of the Swedish chemicals policy might have been more cost-effective. Finally, it was suggested that the Massachusetts example warranted special attention since the regulatory approach undertaken was innovative as it mandates information gathering rather than substitution. This provides an interesting 'regulatory information hybrid' type of policy.
2. Gjalte Huppel of Leiden University suggested that a broader analysis of process innovations in respect of chemicals might be needed, because the innovation may take place outside the chemicals sector, for example in the metals industry, car manufacturing industry or coatings industry.
3. Fabio Leone from DG ENV's Chemicals Unit commented that there should probably be more case studies incorporated into the investigation. This would help to resolve a contradiction in the text between a) the chemical industry being characterised as not reacting to the presence of risk unless a policy is in place and b) where innovations in the chemicals industry can, through learning curve effects, result in substantial reductions in cost.
4. Paul Ekins was very interested in the prominence of **taxes** as an **important policy choice**, when compared to all other case studies where taxes were not found to be implemented that often. The evidence of learning curves across a number of chemicals, and the ability to steepen the learning curves by increasing funding for R&D in the chemicals sector may have implications for other areas of the economy – for example where there is an attempt to substitute away from the dominance of fossil fuels. He also agreed with David Gee's point regarding the niceties of the Massachusetts example where every two years firms are **mandated to find out information on existing technologies**, as a result of which a number of them are deployed. There are similarities with the climate change agreements which have been enacted in the UK, where firms have been asked to engage in a process which makes them consider their energy use patterns and scope for improvement in efficiency. In both cases, successful cost effective outcomes were achieved.

3.6 Discussant responses

Gjalt Huppel of Leiden University and Carlos Montalvo of TNO were the nominated discussants for the case studies.

Gjalt Huppel gave his comments on the presentations and findings of the case studies. He argued that the individual case studies had a difficult task, as they were not representative in any way, yet had to take into account the entire autonomous socio-economic dynamical system. His comments centred on each of the case studies. For the automotive case, he found the Sport Utility Vehicles (SUVs) 'loophole' phenomenon interesting – where USA regulations make light trucks and SUVs exempt from fuel efficiency standards. This was contrasted with fuel taxes which are present in Europe and Asia, with the resulting differences in fuel economy being cited as an example of where policy reduced environmental impact. For the office appliances case Gjalt Huppel argued that the baseline drive for energy efficiency in PCs was strong, and that unless special elements of the sector required special targeting, specific eco-innovation measures are not needed (over and above the normal innovation policy process). For the PV case study he argued that if we want to improve the environment we must first assess the costs, and that the costs of PV are so prohibitively high they negate considering PV as a serious option. For the pulp and paper case it was suggested by Gjalt Huppel that narrow definitions in the regulation for products or processes can tempt industry to reclassify operations so as to escape the regulation.

Carlos Montalvo decided not to comment on ground covered by the above debate. He believed that the problem which had been raised many times regarding assessing the counterfactual, or baseline, need not be such a large concern and could be carried out through the use of logic models or programme theory. By assessing the objectives of the programme, the activities undertaken and the outcomes achieved, one can effectively assess the measures introduced. It seemed to him that this method had in fact been undertaken by the case study investigations by default, rather than being explicitly identified. It was suggested that a possible area for future research was systemic innovation, systemic instruments and systemic impact assessments.

4. Results from the POPA project - Policy Pathways for the Development and Adoption of Clean Technologies

Patrick ten Brink of IEEP presented a summary of the results of a two year European co-funded project on 'Policy Pathways for the Development and Adoption of Clean Technologies' (POPA-CTDA) that involved institutes from across Europe and was led by the Netherlands Organisation for Applied Scientific Research (TNO). The project aimed to assess the barriers and drivers for innovation and the policy instrument needs. The project looked at innovation and policy instruments in a different way, and asked which policy instruments relate to which innovation driver / barrier / determinant. Since the POPA-CTDA project took two years to complete, only relevant findings (policy instrument results) for the Innovation Dynamics project were presented. The presentation focused on mapping the innovation cycle and drawing insights on which instruments are most effective at which point of the innovation cycle. Figure 1 shows the results from the question 'are particular instruments particularly useful at different points in the innovation cycle'?

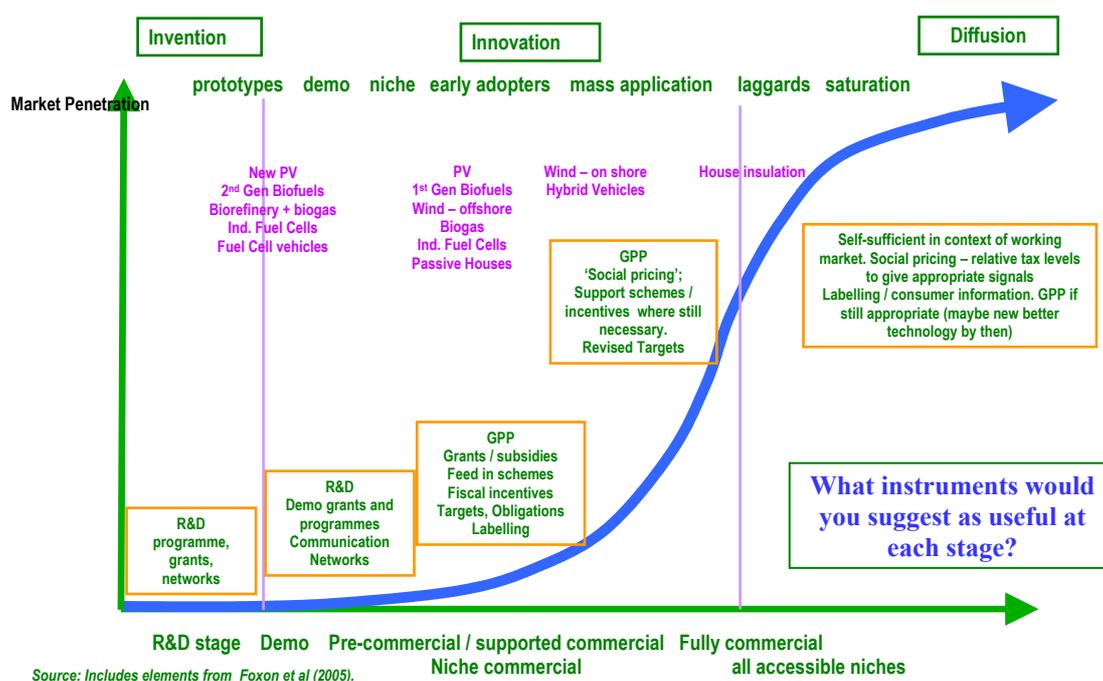


Figure 1: Are particular Instruments particularly useful at different points in the innovation cycle?
Source: ten Brink 2006

Patrick ten Brink explained that Figure 1 demonstrated the classic S shaped diffusion curve. The curve is made up of several sub-curves of individual technologies. The graph shows that there are three distinct ways of looking at the innovation cycle, presented at the top of the Figure: invention, innovation and diffusion. This reinforces the findings of the case study reports which generally found that incremental forms of innovation were just as important as breakthrough forms of innovation. Secondly, below this level on the graph the cycle can be broken down further into

supplementary stages: prototypes, demonstration, niche, early adopters, mass application, laggards and saturation. Thirdly, at the bottom of the figure there are further ways of dissecting the innovation cycle: R&D stage, demonstration, pre-commercialisation, niche commercialisation, supported commercialisation and finally full commercialisation.

The project grouped (in pink on Figure 1) each of the technologies into the relevant stages of the innovation cycle. The green boxes then show how each policy relates to the technology. The resulting suggested methodology is one of linking the most appropriate policy instrument to the technology, taking into account the stage of the innovation cycle.

He concluded that it is important to observe innovation as more than just a single technology; as it includes the production process, the system and its delivery and its implementation. Policies can therefore be targeted at any point along the 'value chain'. Secondly, it is important to design instruments with a lifespan so that they do not outlive their usefulness. Thirdly, giving good information on the instrument (such as when it will start, how long it will be there, eligibility) to the market will facilitate policy deployment. Fourthly it is important for policy to appreciate the inter-linked nature of technologies, as no technology is fully independent. Finally, an instrument mix is needed rather than a single instrument – in order to develop the technology, share knowledge, obtain access to the market, and stimulate the market.

5. OECD Presentation – Determinants of Environmental Research and Development

Nick Johnstone from the OECD Environment Directorate presented complementary findings from work that he has been undertaking at the OECD. It was reasoned that the rate and direction of innovation are two of the most important factors involved when analysing eco-innovation. In the OECD analysis of the factors which lead to successful innovation support, policy stringency (and sometimes inspection frequency as a proxy for policy stringency) was found to be a strong determinant in encouraging firms to invest in environmental R&D.

Similarly, the OECD found strong support for flexible policy instruments (such as performance standards and green taxes) in encouraging environmental R&D. Conversely, technology based standards were found to statistically reduce the likelihood of a firm to invest in eco-innovation. There is also very strong support for government technical assistance programmes – such as informational support mechanisms provided by the public sector. Environmental management (such as accounting and training) had a positive influence on encouraging eco-innovation, however, formal environmental management systems were found to have close to zero effect.

It has also been found that if the personnel responsible for environmental decision making in a firm is located in the institution's finance department, there is an increased likelihood for investment in environmental R&D. Finally, Nick Johnstone asserted that when calculating such trends, it is vital to bear possible endogeneity and simultaneity in mind. For example when analysing the influences of change one must take into account the possibility that the observed change may have occurred due to a) a variable within the firm only (an endogenous change) or b) a combination of a variable within the firm and a variable external to the firm (a simultaneous change)

6. Open Discussion

Comments from open discussion with workshop participants

The discussion centred on the following issues:

- A previous investigation not covered by the pulp and paper case study found that there were no causal links between eco-efficiency improvements and policy measures implemented at the time. One of the conclusions of the report was that due to the large number of policies in place, it was impossible to say which policy measure contributed to the increase in eco-efficiency / reduction of environmental impact.
- There was an interest in the extent to which cultural factors can affect deployment of a successful policy measure, and the extent to which such an analysis could be incorporated into the case studies' framework for analysis.
- It was acknowledged that the case studies must be viewed as being country, and under certain circumstances 'corporate', specific. While the projects must attempt to draw out general lessons for policy makers, it was noted they must also have regard to the specific circumstances from which the lessons were taken.
- Although different proxies can be used to measure policy stringency, it was accepted that such variables can lead to a flawed analysis. However, it was noted that an interesting area of further research is the work being carried out on assessing complementarities and redundancies that can occur between policy instruments.
- There is an important distinction to be made between technological standards and performance standards, when assessing innovation inducing instruments.
- Econometric studies with their ability to identify long term trends and statistical significance, such as the work undertaken by Nick Johnstone at the OECD, can help overcome the problems associated with case study work.

Closing remarks from the Commission

Robin Miège gave the final summary of the workshop including the following points:

- The presentations and subsequent discussions had shown both the benefits and drawbacks of using the case study approach. Although the studies could focus on individual technologies and sectors, due to this focus there was often a myopic problem and a lack of analysis of the 'bigger picture'. It was suggested that perhaps an incorporation of a systems approach could be added to the analysis.
- The research has highlighted the need for an assessment of other policy packages, exploring for example joining up environmental policies with complementary policies such as research, educational or regional policies. A question for future research is how one could introduce a package which includes complementary measures which will optimise the effect of innovation. These questions relate to more long term sustainability objectives.

- Some case studies, especially the hazardous chemicals case study which looked at the substitution of solvents, have successfully broadened the horizon of analysis.
- However, Robin Miège highlighted the need for more analysis in the case studies of the design of policy instruments. Outstanding questions included: How does one design the best instrument? When is the best time to deploy a policy? How can policies be made to fit with the investment and innovation cycles?
- It was noted that the innovation dynamics project is timely, as revisions to the Emissions Trading Scheme, IPPC Directive and waste legislation are all forthcoming.

7. Conclusions

Headline Conclusions

- **Automotive industry**

Innovation levels differed greatly between countries, but innovation seemed driven by the stringency of the standards:

 - Japan most innovation, little information about the development of standards;
 - USA standards unambitiously low, improvements in energy efficiency may have been driven by high oil prices;
 - Europe had induced 'modest' levels of innovation, but other trends (i.e. dieselisation) had more influence
- **Office appliances**
 - Strict public procurement policies induced strong innovation in Japan and the USA; in Japan this was combined with increasingly stringent standards;
 - In Europe no mandatory energy efficient public procurement; uneven use of energy efficiency criteria in member states' public ICT tenders.
- **Photovoltaics**
 - Rapid innovation (and investment) in Japan and Germany, driven by substantial financial incentives and R&D support;
 - Japan provided an interesting example of policy support across all the stages of innovation;
 - Far lower financial commitment (and little investment) in the UK;
 - Jury was still out on investment payback in national economic terms. The deployment of PV in Germany was largely supplied by Japanese manufacturers.
- **Pulp and paper**
 - Strong 'normal' Innovation in Europe with respect to abatement technologies in a mature industry, but the effect of policy is not clear;
 - Characteristics of the instrument (e.g. its stringency) more important the nature of the instrument itself.
- **Hazardous chemicals**
 - General success in encouraging innovation or diffusion of existing technology, using a range of instruments, including regulations and taxes;
 - Different policy approaches in Sweden, Denmark and Germany;
 - Interesting contrast between approaches that seek to reduce the use of hazardous substances (Sweden, Denmark) and those that seek to contain them (Germany);
 - Less hazardous substitute chemicals showed a remarkably consistent rate of learning (about 20-30%) across different chemicals;
 - Sweden and Denmark, the two EU countries applying the substitution principle, also have the highest rate of R&D in their respective chemical industries;
 - German technological development clearest example consistent with Porter hypothesis.

The Chair's analysis of overall themes

On the lessons which can be learnt from the case studies, Paul Ekins argued that public purchasing seems to be a very effective policy measure, especially when it comes to surviving the so called 'valley of death' from pre-commercialisation to deployment. Regarding support through all of the innovation stages, and the evidence of incremental rather than breakthrough innovation, it was argued that one must not underestimate the importance of **incremental innovation** since most progress has been achieved through such developments. Furthermore, inducing innovation requires **strong policy measures** which give clear messages, except perhaps where innovation drivers are already strong. While the German chemicals substitution case study provides the clearest evidence consistent with the Porter Hypothesis (regarding regulation-induced **competitive advantage**), upon close reading support for the Hypothesis could also be found in the Japanese electronic appliances case study and, perhaps, the success of energy-efficient Japanese cars in the US market. The Japanese Top Runner Programme, with its dynamic (i.e. increasingly stringent) standards and mandatory public procurement of 'Top Runners', may have delivered competitive advantage across a number of products.

Annex I – List of workshop attendees

PARTICIPANTS LIST - Workshop on innovation induced by environment policy 21 of June 2006 Brussels

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Annex II – Workshop agenda



EUROPEAN COMMISSION
DIRECTORATE-GENERAL ENVIRONMENT
Directorate G - Sustainable Development and Integration
ENV.G.1 - Sustainable Development & Economic Analysis

Assessing innovation dynamics induced by environment policy

Workshop, 21 June 2006 - Brussels.

Chaired By Professor Paul Ekins, Policy Studies Institute, UK

THE COMMITTEE OF THE REGIONS
RUE BELLIARD 101 –1160 AUDERGHEM (BRUSSELS)
MEETING ROOM : BEL 53

10:00 – 10:30: Registration

10:30 – 10:40: Welcome and introductions by the chair

10:40 – 10:50: Introduction by Robin Miège (DG Environment)

10:50 – 11:00: Project structure and implementation by Frans Berkhout (IVM)

Paper presentation

11:00 – 11:20: Presentation of methodological paper: Paul Ekins (PSI)

11:20 – 11:30: Discussant's response: Mark Hayden (DG Economic and Financial Affairs)

11:30 – 11:45: Open discussion of methodological findings

Case studies

11:45 – 13:00: Case study presentations:

1. Car fuel economy / CO₂ emissions: Onno Kuik (IVM)
2. Energy efficiency of electr(on)ic appliances: Frans Oosterhuis (IVM)
3. Solar PV: Patrick ten BRINK (IEEP)

13:00 – 14:15: LUNCH

Case studies

14:15 – 15:25: Case study presentations, Overall findings and POPA results:

4. Emissions from pulp and paper production: Onno Kuik (IVM)
5. Substitution of chemical substances: Frans Oosterhuis (IVM)
6. Overall themes and findings: Paul Ekins, (PSI)
7. Results from POPA project: Patrick ten Brink (IEEP)

15:25 – 15:45: COFFEE BREAK

15:45 – 16:15: Discussants' response (*2 discussants, 15 minutes each*)

- Gjalt Huppes (Leiden University)
- Carlos Montalvo (TNO)

16:15 – 16:30: Determinants for environmental R&D: Nick Johnstone, (OECD)

16:30 – 16:55: Open discussion

16:55 – 17:00: Closing remarks from Commission

