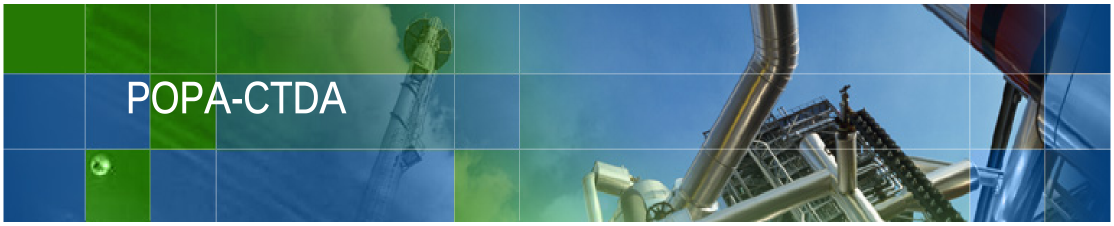

Policy pathways to promote eco-innovation

EU Sixth Framework Programme
Policy Oriented Research

Thematic Priority 8.1, Policy-oriented research (SSP), FP6-2002-SSP-1,
Project no. 502487

Policy Brief 1/12
Summary findings

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Lessons learnt

Policies and associated regulations promoting eco-innovation development and diffusion via the application of a single instrument focusing in a single driver is dome to fail. Eco-innovative behaviours in firms are contingent on a myriad of factors that must be addressed simultaneously and followed up across time.

The policy mix needs to be targeted to a specific group and time. The policy mix must be applied in a coordinated manner by all authorities and stakeholders involved. This requires a common vision on aims and targets. All the empirical work conducted on factors affecting eco-innovations indicates that the application of a single policy instrument for the promotion of development, adoption and exploitation of cleaner technology is very likely to fail.

Although some common principles can guide policy to create framework conditions supported by horizontal measures, there is the need to generate programs of government intervention that are sector and technology specific.

Competitiveness in the environmental sector should be seen contingent on a host of factors that are beyond the sphere of environmental and technology policies. The framing conditions for a region to remain competitive in the long term is closely related to other policy realms. Amongst others we ca include education, trade and competition, finances, regulation, …

Competitiveness of European eco-industries in the longer term is more likely to depend on heavy investment on regulatory, organisational and technological innovation rather than on giving impulse to firms trading on traditional environmental end-of-pipe technologies. The competitive age will be decided in a struggle “for the markets” not “in the markets”, where R&D will play a fundamental role.

The competitiveness of European eco-industries depends as much on regulatory and organisation innovations as it does on technological innovation.

Here it is very relevant to highlight that the current state-of-the-art on environmental technologies and eco-innovation are very far from favourably bending the natural laws of matter and energy. This lesson comes out of the exercise of selecting the eight technology clusters used case studies. Despite that all cases selected belong to some most advanced eco-innovations available, all of them present environmental drawbacks. It is an imperative that our current stock of technological options, even the most advanced, must be seen as a step in a transition to a higher state of technological development. The guiding benchmark in our future technological development, if we are to be sustainable, is how well new eco-innovations bent the first and second laws of thermodynamics. This principle must be acknowledged at the highest levels of science, technology and innovation policy making.

Sustaining international competitiveness will depend in a three folded strategy: maintaining today’s competitive edge in current end-of-pipe markets; promoting current best cleaner technologies available; creating a strategy to achieve sustainable innovations and smart growth strongly supported by new fundamental knowledge on how to bend the first and second laws of thermodynamics (competition for future markets).

Targets of ETAP and objectives of POPA-CTDA

Why do eco-innovations do not arise and diffuse at a faster rate than currently are? What policy can be put in place in order to best foster their development and deployment? These are the questions that this reports attempted to respond.

The increased development, use and integration of cleaner technologies into our society is seen by many as a means of meeting key several objectives at the same time – environmental, economic and social – and also demonstrating that environment and economic development do not have to be opposing choices.

Cleaner technologies are seen as a key mechanism to help decouple economic growth from negative environmental impacts and hence respond to environmental concerns. At the same time, innovation can be a route towards more efficient processes and products, helping the economy becoming more efficient, and hence support economic and social goals through prosperity and job creation, as sought under the Lisbon Agenda.

These issues are well appreciated. What is less well understood is how best to achieve the needed innovation – from invention, to innovation and diffusion of this innovation across the economy and society. A particular area where clarity has been needed is that of which instruments can encourage which type of innovation and how. This report offers insights on this, building on a DG Research co-funded project.

ETAP

In 2004, the European Commission adopted the Environmental Technologies Action Plan for the EU (ETAP)[1] designed as a framework for the support and development of these important innovations. ETAP aims at removing financial, economic and institutional barriers to the development of environmentally friendly technologies. ETAP defines environmental technologies to include all technologies whose use is less environmentally harmful than relevant alternatives. This is therefore quite a broad definition that allows both true clean technologies (e.g., zero emission closed circuit processes), cleaner technologies (e.g., more efficient processes or products) and also end-of-pipe technologies (e.g., filters)[2].

ETAP is composed of actions around three main themes:

- Getting from Research to Markets – which needs an understanding of a clean technologies' development path and the evolution of its relevant industry
- Improving Market Conditions – which can include issues of the existence of markets, access to markets, fixing the market (so that prices reflect true (social) costs), and making the markets work efficiently.

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[1] Communication from the Commission to the Council and the European Parliament *Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union* - COM(2004)38, 20.01.2004

[2] Note that the work focuses on technologies, but much of the thinking also applies to techniques; innovation also happens at the level of the techniques (e.g., environmental management systems). The work is also relevant in the broader BAT – best available techniques – context as set in the IPPD directive.

- Acting globally – which needs understanding of the interrelations with global markets and potential global footprints of EU activities and implications of EU policies and instruments and promoting technologies internationally.

More precisely, the Environmental Technologies Action Plan contains 28 actions of which 11 were chosen as priority actions (PAs) for the Commission, national and regional governments, industry and other stakeholders to improve the development and uptake of environmental technologies. The PAs are to:

Getting from Research to Markets

- Increase and better coordinate research (PA1),
- Launch three technology platforms bringing together researchers, industry, financial institutions, decision-makers and other relevant stakeholders (PA2),
- Establish European networks of testing and standardising (PA3),

Improving Market Conditions

- Develop and agree performance targets for key products, processes and services (PA4),
- Mobilise financial instruments to share investment risks (PA5),
- Review state aid guidelines (PA6),
- Review environmentally-harmful subsidies (PA7),
- Encourage procurent of environnemental technologies (PA8),
- Raise business and consumer awareness (PA9),
- Provide targeted training (PA10), and

Acting Globally

- Promote responsible investments in and use of environmental technologies in developing and economies in transition countries (PA11) – eg through trade agreements; development of cooperation funds

Objectives *and approach*

In agreement with the agenda outlined above, the aim of this research project was to assess the issues driving and barriers slowing the development and uptake of cleaner technologies across the energy, agricultural, transport and industrial sectors of the economy. The project identified what are the barriers impeding progress of cleaner technologies and what policy initiatives, and additional research tasks, are needed to address these barriers. The output of this policy-targeted research is expected to be of particular use to policy makers looking for new tools and insights into how to encourage innovation and use of cleaner technologies and hence help in the practical implementation of sustainable development. This project explored the drivers, barriers and policy context for cleaner technologies in each of the sectors mentioned above via the conduction of eight case studies where in-depth analysis of specific technologies. The analysis combined extensive survey work into the reasons behind innovation and business engagement in technology development and uptake, with stakeholder and expert consultation.

This project has advanced the state of the art on environmental and technology policy research by developing and empirically testing at the EU level a model to assess barriers and drivers to the firm's engagement in the development and use of cleaner technologies (eco-innovation). The approach of this project integrated the newest theoretical and methodological insights from the innovation and environmental policy realms. The project applied a definitional system that enabled empirical testing of the conditions under which innovative behaviour of firms could be fostered. Special effort was be placed on the design of policy measures to define new environmental and technology policy pathways to tackle barriers that hamper the development and diffusion of cleaner technologies. This was done in a interactive fashion with a broad range of stakeholders from . The project produced insights that are at the horizontal policy level but also but also rich knowledge at the sector and technology cluster level.

The empirical work was conducted across nine EU member states. These included The Netherlands, Sweden, Spain, Germany, United Kingdom, Austria, Hungary, Poland and Czech Republic. The field work included interviews with 109 different stakeholders involved in development, uptake and promotion of eco-innovations. This included regulators, researchers, manufacturers, users, and distributors of eco-innovations. A survey with a broader number of stakeholders included the mailing of 2440 questionnaires. The rate of response was 14.5% rendering 356 responses. This level of response enabled the statistical validation of model used with very satisfactory statistical results concerning the validation of the instrument used. In this sense the research activities fulfilled the scientific objectives of the project. The project generated behavioural indicators that explain and clearly show what barriers affect now the development and adoption of eco-innovations and how these barriers may evolve in the medium and long term. Some of the insights are presented below, full access to the deliverables in the eight case studies are available in www.popa-ctda.net.

Outlook of Eco-innovation barriers and drivers

Currently the level of willingness and involvement of the average firm in Europe is low. There are exceptional forerunners that are leading the way forward in the eight technological clusters considered in this study (cleaner vehicles, renewable energy technologies, energy efficiency in buildings, stationary fuel cells, bio fuels, bio refineries, white bio technologies and mobility chains). Figure 1 depicts the trends that were reported by the respondents that participated in the survey. In general the outlook in the long term looks very positive in all the drivers considered. Figure 1 depicts the rational expectancies for the whole sample and for an stratification of the sample on developers and users of eco-innovations and regulators.

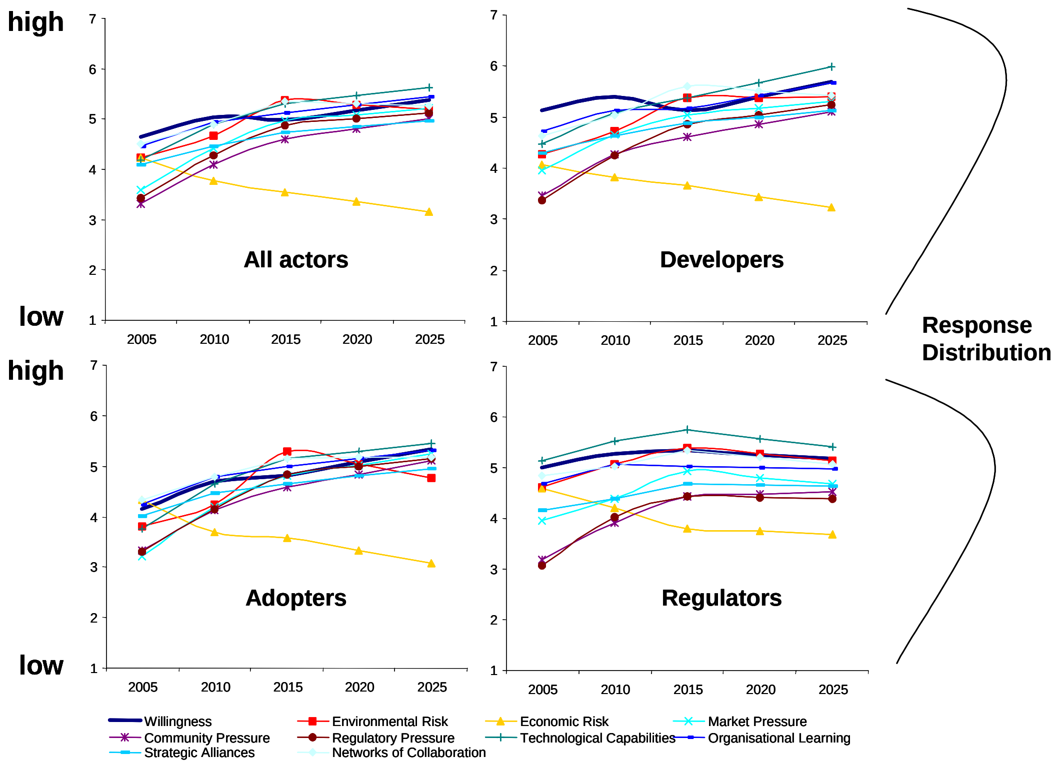


Figure 1. *Drivers of eco-innovations – an outlook 2005-2025*

Figure one is a summary abundant information about a myriad of factors affecting the development and uptake of eco-innovations. The factors were clustered in ten indexes that explain 60% of the variance of engagement of eco-innovation in the sample. In general the empirical work demonstrated the innovative behaviour of firms can be explained in term of their willingness to innovate; the perceived economic and environmental risks; the pressures coming from regulation, markets and the community; and the control exerted over the technology and innovation (i.e., technological capabilities, learning and strategic alliances and networks of collaboration).

As mentioned above and it is clear form Figure 1, in general the outlook for uptake in the future is positive. That is, the average stakeholder that participated in the survey expects that not only eco-innovation will be an imperative but all the conditions pushing, conducing and enabling eco-innovations development and uptake will be present. For example, economic risk, normally considered a major factor affecting development and adoption of innovations, is expected to steadily decrease in the next years. Similarly, environmental risks are meant to be more prominent and avoidable. It is worth to be noticed that the average respondent in the sample expects environmental risks to start decreasing after 2015. Here perhaps there is the positive believe amongst respondents that actions taken now concerning eco-innovations and changes in production and consumptions patterns will have a positive impact on the environment. As it will be shown further below there is a very positive attitude concerning the benefits of eco-innovations in the environment (see Figure 2 below).

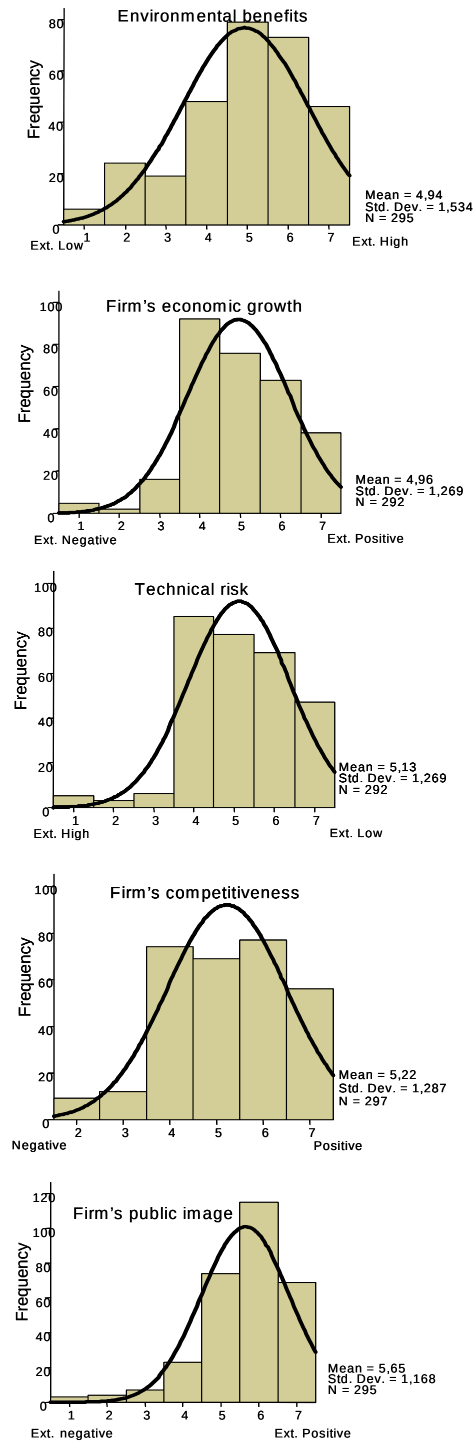


Figure 2. *Attitudes towards eco-innovation*

Concerning the perceived pressure or demand for eco-innovations in by the market (e.g., competitors, consumers, pace of innovation in the sector); regulation (e.g., European directives and national, international treaties, industrial standards); and diverse communities (shareholders, local communities, firm's internal staff) are all expected to steadily increase to a point where they are high. This not currently the case of the average firm but there were some in the sample that were already under considerable pressure to engage on eco-innovation. Last, and most crucial are the real capabilities to eco-innovate. Here there is also a very positive outlook specially in the case of developers and adopters of eco-innovation. We could expect that the diffusion of skills, knowledge and capabilities to improve the efficiency of current and new more advanced technologies will occur across diverse sectors of the European economy.

The expected trends and positive outlook described above is underpinned with very positive attitudes in a large proportion of stakeholders that participated in the survey (see Figure 2). These attitudes refer to the effects the eco-innovations are expected to have on the firm's competitiveness, public image, economic growth, environmental benefits and the limited technical risk involved for the average firm. Figure 2 depicts the normal distribution of responses in the sample in each of the potential effects of engaging on eco-innovation on the firm. In all aspects of the standard scale of attitude a large proportion of the respondents indicated positive outcomes, a small proportion indicated to be uncertain about the effects on their firm and minimum part of the sample expected to negative effects arising from the development and adoption of eco-innovations.

Here it is important to highlight that eco-innovations suffer many of the same problems that other innovations have in the early stages of development and uptake. An great difference indicated by this study and previous studies is that increases of awareness of the environmental risks associated with current practices of production and consumption make a great deal of difference in the willingness of producers and users to engage on eco-innovations.

Here it is very relevant to mention that the current state-of-the-art on environmental technologies and eco-innovation are very far from bending the natural laws of matter and energy. This lesson comes out of the exercise of selecting the eight technology clusters used case studies. Despite that all cases selected belong to some most advanced eco-innovations available, all of them present environmental drawbacks. It is an imperative that our current stock of technological options, even the most advanced, must be seen as a step in a transition to a higher state of technological development. The guiding benchmark in our future technological development, if we are to be sustainable, is how well new eco-innovation bent the first and second laws of thermodynamics. This principle must be acknowledged at the highest level in science, technology and policy making.

Environmental technologies and European competitiveness

This section intend to make a case for the further support of R&D on eco-innovations that decouple environment degradation from economic growth and sustain competitive age in the long term. In addition it intends to serve as justification for the selection of the case studies in this research project. Currently the global environmental technologies market reached approximately $US556 billion in 2003 (Globe Net, 2005). Recent estimates project a total value of $US850 billion by 2010.3 With varying numbers, some estimations indicate that environmental technologies (or eco-industries) in Europe employ over 2 million people. European firms participating in the global market account for about one-third and are growing at 5% per year (COM 2006). Figure 7 shows the size of the main global markets in 2003 and market segmentation per application type in 2005. The US (40%), the European Union (31%) and Japan (17%) are the leading exporters and have the largest internal markets of environmental technologies.

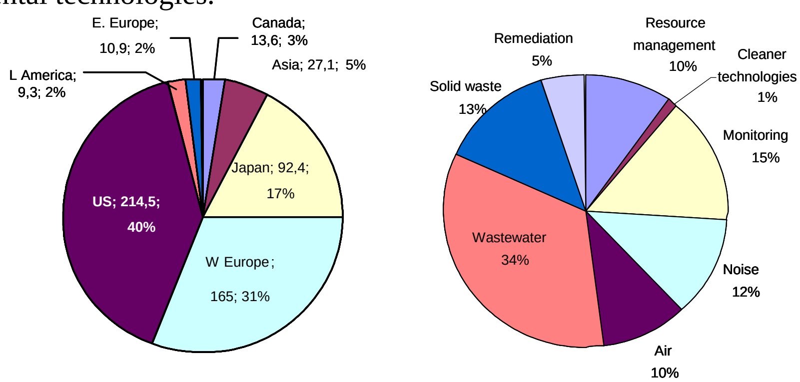


Figure 3. *Environmental technologies: World markets and market segmentation* (US Dollars)
Sources: COM 2003, Globe 2003, OECD 2005

The market in Europe reached $ US165 billion in 2003. The environmental technologies sector is expected to generate large business opportunities in the near and long-term. If we look at traditional segmentations of the market, the largest business areas are wastewater treatment, and environmental instrumentation. Water and wastewater treatment presents the greatest opportunities in the global market. The global water market has been growing rapidly over the last decade and accounts for 34% of the world's total environmental market. This is followed by solid waste management (13%), noise control (12%), and emissions control (10%). Globally, the environmental monitoring and instrumentation (and closely related information systems) market has an estimated value of $US7.1 billion. It is in this area that innovation occurs most frequently in automation of equipment and information technology

[3] Excluding cleaner technologies or eco-innovations.

applications. Given the trends in energy, water, and raw materials consumption and generated waste, and expected growth demand from emerging economies like China, India, Rusia and Brazil, is very likely that the demand for pollution control, sanitation, and environmental services and equipment in general, will increase sharply in the next decade. The area (i.e., cleaner technologies) that promises best results in terms of long term competitiveness and environmental protection is currently surprisingly low (1%). This is most likely a misrepresentation, but it is still extremely low compared to the global market of environmental technologies. This is most likely to occur because national accounting systems have still not been developed to a point to include all types of eco-innovations.

Given the global and market trends in traditional environmental technologies the business opportunities are huge. Does European industrial policy effort should focus mainly on supporting competition in current markets or are we looking at the role of eco-innovation to create new markets? Currently competition in the sector to a large extent occurs "*in the markets*", but also to some degree occurs "*for the markets*". In current markets of traditional equipment of pollution control (that represent the largest proportion of the market) long term financial services and turn key projects characterize the typical medium and large size pollution control, sanitation and renewable energy systems. Thus provision of economic resources to purchase facilities and equipment is a strong component of firms' competitiveness, where, despite existing regulation, the best available technology plays a small role in the decisions about what is finally installed in a factory or municipality. For example, water treatment technologies are mature, and competition is mainly based on price of equipment and the cost of capital needed. Many city governments across the world are contracting for water treatment services (both drink and waste waters) with foreign investors, with the promise that this will be kept in place for up to 30 years.

Following the analysis in the same segment, because water technologies are mature, mastery of the technology requires only basic skills in few engineering fields. Thus, any country can in the course of 5 – 10 years acquire sufficient skill (knowledge via reverse engineering) to compete nationally and internationally provided that their companies have access to cheap venture capital. This scenario is valid for most of current traditional pollution control technologies. Currently, firms working on traditional environmental technologies operate across diverse sectors. In contrast, cleaner technologies (eco-innovations like the ones addressed in this project) are frequently sector specific, and particularly in relation to modification of products and processes where in-depth knowledge of the technology relevant to the sector is necessary. Where should the European eco-industry be in 15 years? What are the lead markets in the sector?

One of the main aims of ETAP is to decouple environmental degradation from economic growth. Here it is important to highlight that the generation of residuals (pollutants or other) is a problem common to all industries, and especially advanced technology industries, such as microelectronics, micro-systems biology, nano-technologies. The reason is that these advanced technologies require large amounts of pure materials, and large production and supporting systems per unit produced. As mentioned above the common thread connecting all industrial activities is neglect of the first and second law of thermodynamics.[4] For more than 150 years of industrialization economic activities underpinned by our current technological stock have been and are producing pollution and causing environmental degradation (both

[4] According to the first law, matter can neither be created nor destroyed, but only transformed. The second law refers to the fact that every anthropogenic work produces a degradation of energy and matter. These laws have many implications for product and process development in particular and for whole economic system in general. For a discussion see Georgescu-Roegen (1971).

localized and global depending on the scale and scope of industrial operations and consumptions patterns). The challenge lies in replacing a large proportion of our current technological stock with new technologies underpinned by new science that does not violate, but accommodates the first and second laws of thermodynamics. It is surprising that the implications of these laws have been largely neglected and are still not readily accepted in the in the technology and industry policy arenas. The implications are huge, but the problem is becoming greater over time as global economic growth increases with the development of Eastern Europe and the emergent economies enter the mass consumption model of development

On the positive side there is huge role for R&D and innovation to underpin the structural transformation of the environmental sector and bring about structural change across the economy. If this challenge is taken seriously – as it should, given the severe anomaly of our current technological stock – there is the possibility of rolling out one of he biggest economic multipliers of modern times. The sector requires industrial and innovation policy throughout the innovation cycle, from basic research to diffusion and global exploitation of eco-innovations.

Policy pathways to promote eco-innovations

The research activities conducted generated a number of lessons and insights about the reality and challenges that the promotion of development and adoption of eco-innovations entails.

- In the course of the project we have learned that in the average the firms' engagement on eco-innovation is not conditioned by a main single factor. Furthermore the number of factors affecting the development and adoptions of innovations is large, quite large. We have identified that there are first, second and third order factors affecting innovations. This meaning than once first order factors (like cost of capital, environmental risk perception or technical risk) are removed by policy intervention or in a *laissez-faire* fashion, second and third order factors came to determine innovation (like capabilities to innovate or to adopt innovations). In this project we have reduced the number of drivers by clustering them in nine meaningful dimensions. A common rule in all case studies conducted is that there are a number of barriers and drives interacting.
- One of the main lessons derived form the empirical testing of the model that underpins the assessment of barriers and drives in this project is that in many instances the current policy effort is misplaced. In this project we have demonstrated that the engagement of firms on innovative behaviour is dependent on the interaction of different drivers (or barriers). The relevance of this finding for policy design is that most policy instruments are directed to one barrier (or driver) leaving unaffected the rest of factors affecting the development and adoption of eco-innovation. For example, it is not sufficient to apply programs of environmental awareness raising (or de benefits of eco-innovation for competitiveness) when there are no supporting programs to create capabilities to innovate (or facilitate financing) for specific firms. It is imperative that policy intervention programs and the EU or national level include an array of targeted instruments – to a specific target group – that have qualities to affect the different dimensions that affect the firms willingness and behaviour to adopt eco-

innovations. Thus there must be a coordinated policy actions (or instruments) to effectively promote innovation.

- Currently there are a large number of policy instruments available that could help to promote innovation. One large inefficiency in their application is the minimal coordination and targeting on specific sectors and technologies. Figure 4 shows a list of available instruments in the EU.

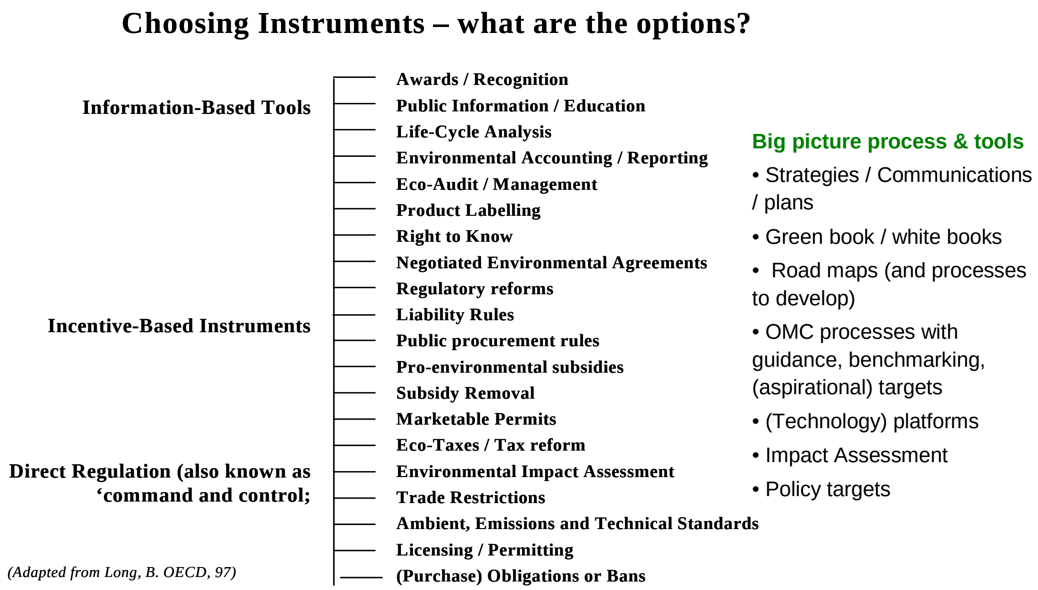


Figure 4: *List of Available Instruments*

A path for action

The main target of the study was to propose a number of measures that would spin a virtual spiral of development and adoption of cleaner technologies. The above insights have shown the diversity of factors affecting eco-innovation, factors that vary across context and time, and are contingent in the stage of the innovation considered. At the first glance it seems unfeasible to focus the policy effort in a specific target factor. The approach to the problem of promoting eco-innovation demands a policy mix that at least in theory is coherent with the empirical insights achieved in the whole study via the technology cases considered. Following the empirical insights is the possible to start setting a path for action that is firmly grounded in behavioural theory and empirical analysis.

We have seen that very many factors (barriers and drivers) can potentially come to influence decisions of diverse stakeholders to engage on innovations, so many that is difficult to target. The exercise of synthesis and clustering of many barriers into few generic underlying concepts comes to simplify the design of policy. In this study we have demonstrated that at the firm level the decision to engage on innovation is driven by fe generic factors - in summary by:

1) the perceived outcomes of engaging on innovation account for most of the variance in the data collected, these are: perceived positive (or negative) outcomes and positive (or negative) attitudes to cleaner technologies. In turn the predisposition to innovate is conditioned by the

perceived current and future environmental risk and the perceived benefits that the new technology would bring. This perception creates synergies (sometimes counterbalanced) with the current and future economic risk that eco-innovation entitles for the firm. We have seen that currently the perceived risks are moderated for most stakeholders and is believed to increase considerably in the next decade, while the economic risk is expected to diminish from high to minimal in the next decade. These factors accounted by the smallest proportion of the explained variance in the sample (10.77%).

2) the social norm dictated by the context where the firms operate, that is markets, stakeholders and regulation. The higher the pressure perceived the more willing were the firms to engage in cleaner technologies. Currently the average pressure is perceived as moderated but is believed to increase considerable in the next five to ten years, in some cases being extremely high. These factors explained up to 22% of the variance in the sample.

3) The decisive factor contrary to much of the literature is the actual capacity to innovate that firms have in-house and through its networks of suppliers of inputs, materials, components and know-how. The factors integrating the capacity to conduct and implement eco-innovations where clustered into four underlying categories that are well known within innovation studies. These were technological capabilities, organisational learning capability and strategic alliances and collaboration to outsource new knowledge and know-how. These factors cluster in a single dimension that accounted for the largest proportion of the variance in the sample (25%). In addition, all these factors were inversely related to the levels of perceived economic risk across all the study cases. This means that generally the higher the actual control over the innovation process that firms hold regarding the eco-innovation the lower the perceived economic risk. This is highly related to technology and capital risk.

Given the three points above any strategy to promote the development and adoption of cleaner technologies must start from creating the framework conditions to increase the support to deploy cleaner technology capability in the sectors considered – at the firm level. This must come first in the policy agenda. As we have seen above there are already many RTD potential instruments in place at the European level.

Second in the policy effort must come structures that reinforce the social pressure. As mentioned in Chapter four the social pressure is very likely to increase in the medium term is all aspects conforming the social pressure component. In general there is a very evidence in this study of a positive relationship of social pressure and the engagement on eco-innovation. Many of the instruments mentioned in figure 4 above could contribute to the reinforcement of a social norm that drives eco-innovation.

Last, in the policy effort could come measures addressing the creation of environmental awareness and reduction of economic risk. Currently there is already, through mass media, a considerable campaign on environmental sustainability mainly stemming from the energy and climate change debate, not only in the EU but in most part of the international community. As the acknowledgement of cleaner technology as an economic multiplier become more pervasive the business case is very likely to become clearer for sceptic stakeholders.

In cybernetics is well known that the mechanism controlling a complex phenomena must be simpler than the phenomena that is intending to control. The heuristics provided above are quite simple to be mastered as there are few factors that guide policy and action. The theoretical and empirical underpinnings supporting such a heuristics are strong. The targeted action plan addresses the micro-motivations and preconditions that drives firm behaviour and innovation strategy. The challenge here is to actually efficiently coordinate and target - via a policy mix - the action of diverse stakeholders and jurisdictions across the European Union. The policy mix needs to be targeted to a specific group and time. The policy mix must be applied in a coordinated manner by all authorities and stakeholders involved. This requires a common vision on aims and targets. All the empirical work conducted on factors affecting eco-innovations indicates that the application of a single policy instrument for the promotion of development, adoption and exploitation of cleaner technology is very likely to fail.

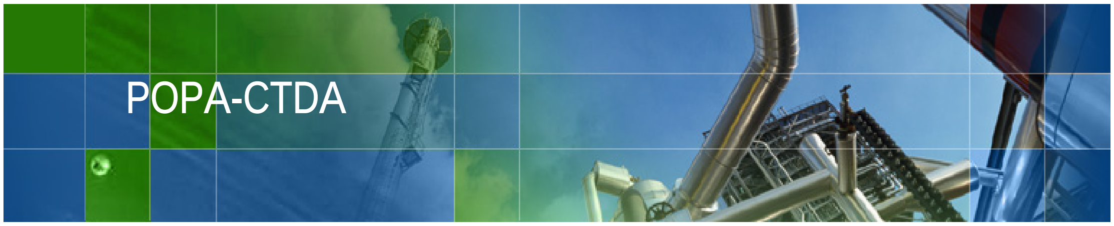
The above heuristics must be moderated by a number of lessons and insights that the research activities and stakeholders meetings raised on innovation and instruments, lessons that are useful for the range of policy makers, commentators, innovators and innovation up-takers, including:

- Innovation is more than just the technology everyone focuses on – but also the production process and also the system and its delivery and implementation. The innovation chain is much longer than some tend to assume when talking of innovation. The search for where to apply which instruments can usefully explore all stages.
- No technology is fully independent – all are linked; networks/systems. Moving from one system (system change / transition management) to another is much harder than moving within a system. It is important to understand the inter-linkages, dependencies, enabling factors, barriers/lock-in issues etc
- There are different levels of system change – eg move to biofuels for cars is a small system change (fuel supply), moving to fuel cells cars a bigger system change; moving beyond personal mobility a much larger one.
- Evolution is vital – there are generations of technologies, and wide families within generations.
- Instruments each have their own natural lifespan - it is important to design them such that they do not outlive their usefulness - and place in the cycle.
- To give a level of information/certainty to the market – give advanced warning of the instrument - when it will start, how long it will be there, eligibility.
- You can start by niche and adopt a strategy of ‘niche-hopping’ or can start by whole market or both; the choice depends on the technology, the market, the players and the amount of political capital and will.
- Accelerating the rate of evolution / innovation can help, as can disseminating the evolution. Sometime disseminating now what works can achieve the objectives better than waiting for the ‘better’ technology.
- Generally an instrument mix is needed rather than a single instrument - for developing technology, sharing knowledge, obtaining access to the market, and stimulating the market.
- There is no single road map for innovation as a whole but a range of road maps unique to a technology – depending on the actors, markets, technologies (types, maturity) and country contexts. A road map can usefully say *who* can usefully do *what*, *when* and for *which part* of the innovation chain.
- For innovation to work it requires all elements in the innovation chain to work, if one element of the chain is not there, then progress slows.
- There is also no one driver or barrier, but a series of steps and hence a series of different (packages of) instruments needed involving a changing series of actors. It is

important that the choice and design of instrument reflect the relevant actors motivations.

The optimal policy mix for a targeted intervention program to a specific group, this demonstrated by the empirical work in this project would be the following: Increase environmental risk awareness in suppliers and users of eco-innovations; let market pressures act and intervene with the creation of niche markets via public procurement; increase technological capabilities and facilitate demonstration projects; facilitate the creations of network of collaboration; minimise economic risk and direct regulation. Direct regulation has shown to work only when there are ready available technical solutions and there is an undisputable powerful state. Both necessary conditions are not meet in the case of eco-innovations.

Ultimately in developing a strategy and plan to encourage innovation and instruments to achieve the goals, generic insights and conclusions may be useful guides or a check list, but ultimately it is the national conditions in the international context that correspond to the specific technology and industry in question which will determine what is likely to work or not.



Other Policy Briefs

The POPA-CTDA project disseminated eleven policy briefs addressing the challenges to develop and diffuse specific eco-innovations in Europe
Policy Briefs:

[1/12] Summary findings,
[9/12] Cleaner vehicles,
[10/12] Mobility chains and
[11/12] Eco-innovation and European International Competitiveness
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Policy Brief [2/12]: White Bio-technologies
Oliver Wolf and Luis Delgado
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Policy Brief [3/12]: Stationary fuel cells
Christian Sartorious, Gerhard Angerer and Annette Roser
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Policy Brief [4/12]: Bio-refineries
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Policy Brief [5/12]: Bio-fuels
Catherine Bowyer, Malcolm Fergusson, Martina Herodes, Patrick ten Brink, and Jason Anderson
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Policy Briefs: [6/12] Energy Efficiency in Buildings,
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