Executive summary

Innovative products, services, processes or business models can benefit the environment by reducing pressure on natural resources and/or the emission of pollutants. At the same time, environmentally friendly innovation can foster economic development. The environmental goods and services industry is growing fast in OECD and non-member countries alike. Like information technologies a few decades ago, it can enhance the competitiveness of other industries. This explains why a number of OECD governments see environmentally friendly innovation (hereafter eco-innovation) as a major driver of green growth.

Market mechanisms alone will not provide an appropriate amount of eco-innovation at the right time. This is because innovators may not reap all of the benefits of their innovations and because environmental benefits may not be appropriately valued by markets. Policy intervention is therefore a must. From a policy perspective, the question is: What is the best way to support the development and diffusion of eco-innovation? More specifically, from an environmental policy perspective, the issue is to stimulate innovation that will benefit the environment.

This perspective has consequences. First, it acknowledges that eco-innovations may originate in a variety of contexts and that environmental performance may not be the initial driver. Second, non-technical innovation matters (for instance, the on-demand bicycle service in Paris relies little on technology and heavily on a sophisticated business model and appropriate organisation). Third, the way innovations are used (that is, whether more or less competently) matters.

This report explores how these consequences help to shape eco-innovation policies. It complements previous OECD work on eco-innovation, which generally focused on the impact of market failures on the amount of environmental inventions and on the instruments and policy packages that can remedy such failures. It also complements ongoing studies

of business approaches to eco-innovation and empirical analyses of the changes in industrial structure required to achieve green growth.

National strategies for eco-innovation have strengths and limitations

Most OECD countries have developed national strategies to support eco-innovation. In Europe, the Environmental Technology Action Plan (ETAP) has invited EU members to develop eco-innovation roadmaps and to report initiatives taken at national and/or local level to support eco-innovation. Outside Europe, a number of OECD countries have similar initiatives; in particular, Korea and the United States have designed explicit strategies to stimulate eco-innovation.

National strategies address a variety of objectives: bridging the gap from the demonstration phase to commercialisation (*e.g.* in the field of carbon capture and storage or micro combined heat and power generation), improving consumer awareness (*e.g.* of biopackaging), defining technical standards (*e.g.* for electric cars), and building a critical mass (*e.g.* for combined heat and power generation). They cover a wide range of policies, from environment to science and technology, industry, transport, competition, and energy policies. They mix very diverse tools and initiatives, from support for research and development (R&D) to market creation and export promotion. They involve initiatives by public authorities at both national and local levels and offer lessons regarding an appropriate split of responsibilities between them. Roadmaps provide a framework to assess the coherence of these policies.

More could be learned from these strategies if standardised measurement references could be used to assess the impact of specific eco-innovation policies in national contexts. This would require:

- more systematic information on the contextual features of the country, including industry structure and domestic market size, key environmental challenges, the knowledge base as regards eco-innovation, and the strength of the domestic venture capital industry;
- qualitative information on the design of instruments that underpin eco-innovation policies.

It is not clear how national strategies support the development of eco-innovations when alternative technological trajectories abound (see Box 0.1). There is a risk that a strategy, when too narrowly or strictly focused, will restrict the scope of technological options that will be explored

and impinge on the development of alternative trajectories. Timing is essential.

Box 0.1. Technological trajectory, defined

The concept of technology trajectory refers to a single branch in the evolution of a technological design of a product or service. Movement along the technology trajectory is associated with research and development.

The economic literature argues that only a small fraction of the possible directions a technology could have taken materialises. Owing to the institutionalisation of ideas, markets and professions, development of a technology can get "stuck" in one trajectory, with firms and engineers unable to adapt to ideas and innovation from outside. Alternatively, technological trajectories for a given product or service may proliferate, eventually fragmenting markets into segments that substitute poorly for one another. Independent technological trajectories are characterised by limited demand substitution and R&D scope economies.

The concept is useful for analysing the pattern of linkages across submarkets on both the demand (substitution) and technological (R&D scope economies) sides. To address this issue, Sutton (1998) suggested introducing the notion of distinct technological trajectories, each associated with a distinct submarket. When products in submarkets are close substitutes, a firm advancing along one trajectory with a large R&D effort will manage to win market share from firms operating on other trajectories and submarkets. Alternatively, when products in different submarkets are poor substitutes, the market becomes separable into a number of independent submarkets, and a superior R&D effort in one will have little impact on the others.

The concept usefully allows for a distinction between markets in which innovation progresses along a single trajectory, and those marked by a continuous proliferation of technological trajectories. This distinction has significant implications for the analysis of the respective roles of market forces and public policies. Moreover, it is an invitation to take account of the customer side and to evaluate the potential benefits of an eco-innovation in light of existing substitutes and the nature of market competition. The concept also has methodological consequences. To assess competition between distinct technological trajectories as well as the potential for product substitution and R&D economies of scope, empirical investigations should not be restricted to a particular eco-innovation, but should consider other alternatives and the associated industries.

Source: Adapted from an unpublished methodological note by Gilles Le Blanc for the OECD Global Forum on Environment focused on eco-innovation, November 2009.

Moving from green technologies to the environmental benefit of innovation-in-use

The case studies examined in this report highlight the long history of selected eco-innovations (such as combined heat and power generation and electric cars) and note that they often originated outside the environmental domain. For example, carbon capture and storage combines a set of commercially available component technologies from the oil, chemical and power generation industries. Furthermore, a number of eco-innovations are not regarded as particularly high technology: for example, biopackaging can improve the environmental performance of the food, drink, cosmetics and pharmaceutical industries, using mundane resources and mature techniques.

A number of policy messages derive from these observations:

- making mature technologies more market-friendly is as important as producing new knowledge;
- technical and non-technical innovations matter equally;
- capturing innovations originating in non-environmental domains opens a large spectrum.

It follows that eco-innovation policies interact with policies developed in other domains. This raises issues of consistency, governance and monitoring. In particular, from an environmental policy perspective, monitoring could focus on the environmental benefit of innovation-in-use.

Eco-innovation policies are linked to industrial and competition issues

When considering the trajectories along which eco-innovations are developed and brought to the market, innovative industries reveal two opposing patterns which may require policy makers to consider a number of concepts, instruments and indicators when developing eco-innovation policies.

The first pattern is one of R&D economies of scope and market substitution, which lead to escalation along a single technical trajectory and potentially to a high level of concentration. Typically, only one combined heat and power generation (CHP) technology is used in the market for a given size of applications. In such cases, public R&D expenditure benefits all players in the field; similarly, all firms potentially benefit from market

creation mechanisms (*e.g.* performance standards, labels, green procurement).

The second pattern emerges when there is no economy of scope for R&D and when demand is split among non-substitutable goods and services. For instance, the electric car industry may be characterised by the coexistence of separate trajectories (*e.g.* hybrid, full electric), with little (if any) economies of scope for R&D, and non-substitutable market segments. In such a context, there is a risk that public R&D expenditure and market creation mechanisms will only benefit one cluster of industries, at the expense of others.

This links eco-innovation policies to industrial and competition issues. When facing a proliferation of possible technical trajectories, should a government concentrate R&D efforts and budgets on one technological trajectory or encourage a diversity of solutions by simultaneously supporting alternate routes? The first option focuses public support but may generate lock-in effects. The second option fragments R&D efforts and markets, potentially delaying diffusion. The CHP case study shows that Germany and Canada adopt different strategies in this area and have different policy priorities.

Co-ordination is needed across time, layers of government and the public and private sectors

As the case studies make clear, eco-innovation policies need to be co-ordinated in many ways.

First, policies to support eco-innovation generally develop and evolve over long periods, and coherence can be difficult to maintain over time. In addition, priorities and needs evolve and instruments have to be revised and adapted. For instance, policies to support micro-CHP in Germany have developed over 30 years; the initial emphasis was on R&D and has led to important developments and a fragmented marketplace; since 2005, the major instrument is NOW, a joint initiative of several federal ministries, which mainly aims to develop applied research and field tests. Policy makers would benefit from a better understanding of when and how to introduce an instrument, and when and how to phase others out.

Second, sub-national authorities actively support eco-innovation. They have developed capacities to address environmental concerns at their level, and they consider environmental goods and services as new engines for growth. Co-operation built on a better understanding of the respective roles of the different layers is needed across levels of government.

Third, co-ordination between research and industry is essential. Deployment matters just as much as development of new knowledge. The private sector is the main vehicle for deployment, both domestically and internationally (through trade and foreign direct investment). This means that:

- demonstration is essential, and governments can bridge the gap between research and industry when markets fail;
- knowledge transfer networks, incubators and other forms of partnerships can help to circulate information between research and industry;
- public-private partnerships can contribute to effective governance in support of eco-innovation.

Fourth, when markets are uncertain, (international) co-operative research can pool development risks and share information. The case study on carbon capture and storage identifies opportunities for international co-operation (*e.g.* on common regulation; on policies to transport and store carbon in neighbouring countries; on R&D and demonstration subsidies). More could be learned on the appropriate instruments, timing and risks related to (international) co-operation for eco-innovation, taking account of environmental, science, industry and competition perspectives.

Eco-innovation calls for focused technology transfer models

To reap the full environmental benefit of available products, services, and processes, the transfer of eco-innovations is essential. Transfers to developing countries topped the policy agenda on climate change mitigation at the Conference of the Parties 15 in December 2009 in Copenhagen.

Recent research shared at the 2009 OECD Global Forum on Environment suggests that international co-operation mechanisms are more effective when they strengthen developing countries' own capacities to grow or adapt existing eco-innovations. This requires flows of underlying and tacit knowledge (know-how and know-why). This is not limited to higher education: low-skill jobs may be required.

The report inventories viable models for a more focused, needs-based approach to building eco-innovation capabilities in developing countries.