



Sustainable Manufacturing and Eco-innovation: Towards a Green Economy

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Introduction

In recent decades, expanding economic activity has been accompanied by growing concerns about climate change, energy security and scarcity of natural resources. While industries are showing greater interest in sustainable production and are undertaking a number of corporate social responsibility (CSR) initiatives, progress falls far short of meeting these pressing challenges. Moreover, improvements in efficiency in some regions have often been offset by increasing consumption in other regions, while efficiency gains in some areas are outpaced by scale effects. Without new policy action, recent OECD analysis suggests that global greenhouse gas emissions are likely to increase by 70% by 2050.

Provided that governments send a clear policy signal now about their medium and long-term climate change objectives, the cost of climate policy measures could be kept quite low in the next few years. Raising efficiency in resource and energy use and engaging in a broad range of innovations to improve environmental performance will also help to create new industries and jobs in coming years. The current economic crisis and negotiations to tackle climate change should thus be seen as an opportunity to shift to a greener economy.

Incremental improvement is not enough, however. Industry must be restructured, and existing and breakthrough technologies must be more innovatively applied to realise green growth. Short-term relief packages deployed today can stimulate investments in technologies and infrastructures that help innovation and enable changes in the way we produce and consume goods and services in the future.

This *Policy Brief* examines how innovation can result in new technological and systemic solutions to environmental challenges and contributes to a wider range of OECD work aimed at analysing the policies that can efficiently support the development and diffusion of eco-innovation. ■

How can innovation help industries and governments go green?

Innovation has long been seen as central to economic performance and social welfare; it is increasingly recognised as a significant driver of economic growth. More recently, industry leaders and policy makers have also looked at innovation as the key to making radical improvements in corporate environmental practices and performance. For example, the European Union’s Environmental Technology Action Plan (ETAP) aims to accelerate the development of environmental technologies and eco-industries, while the Japanese government promotes the concept of eco-innovation as “a new field of techno-social innovations that focuses on the environment and people”.

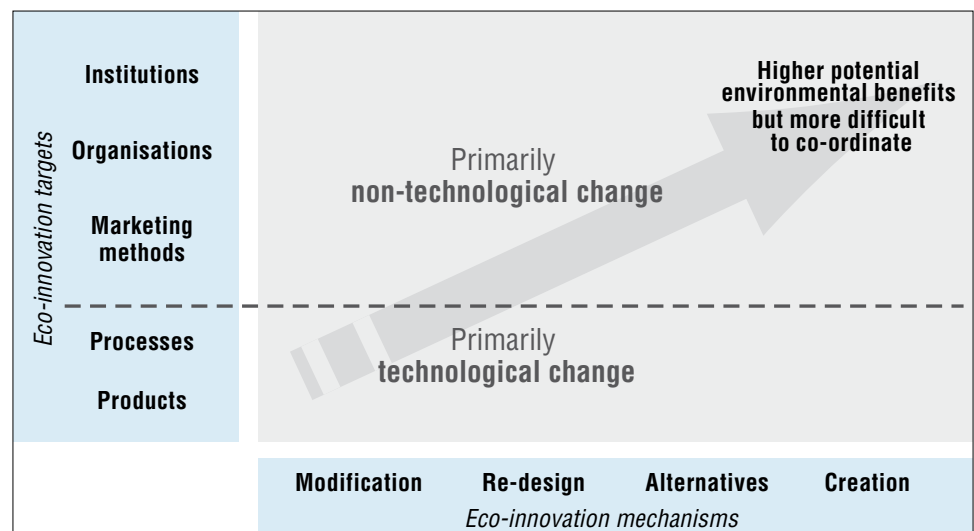
The OECD defines innovation as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations”. Eco-innovation is generally the same as other types of innovation but with two important distinctions:

- Eco-innovation represents innovation that results in a reduction of environmental impact, no matter whether that effect is intended or not.
- The scope of eco-innovation may go beyond the conventional organisational boundaries of the innovating organisation and involve broader social arrangements that trigger changes in existing socio-cultural norms and institutional structures.

Three main facets of eco-innovation can be distinguished (see Figure 1):

1. *Targets*, which are the basic focus areas of eco-innovation. These are products, processes, marketing methods, organisations, and institutions. Eco-innovation in products and processes tends to rely on *technological* development, while eco-innovation in marketing, organisations and institutions relies more on *non-technological* changes.
2. *Mechanisms*, which are how changes in the target areas are made. They can involve modification of practices, re-design of practices, alternatives to existing practices, or the creation of new practices.

Figure 1.
THREE FACETS
OF ECO-INNOVATION



3. *Impacts*, which are how the eco-innovation affects environmental conditions.

Experience shows that more radical changes in methods, such as alternatives and creation, usually result in higher environmental benefits. ■

What is industry doing now?

Industries have traditionally addressed pollution concerns at the point of discharge. Since this end-of-pipe approach is often costly and ineffective, industry has increasingly adopted cleaner production by reducing the amount of energy and materials used in the production process. Many firms are now considering the environmental impact throughout the product's lifecycle and are integrating environmental strategies and practices into their own management systems. Some pioneers have been working to establish a closed-loop production system that eliminates final disposal by recovering wastes and turning them into new resources for production. Eco-innovation helps to make possible this kind of evolution in industry practices. While more integrated practices, such as closed-loop production, could potentially yield substantial environmental improvements, they can only be realised by combining a wide range of innovation targets and mechanisms, and both technological and non-technological changes. This is often referred to as *system innovation*.

A study of eco-innovation from three industry sectors suggests that the primary focus of current eco-innovations tends to rest on technological developments and advancements. Nevertheless, a number of non-technological innovations, such as establishing separate environmental divisions or creating inter-sectoral or multi-stakeholder research networks, have spurred technological developments. Some industry leaders have even begun to explore systemic innovations that are changing the way their businesses fulfil consumer demands (see Box 1).

The automotive and transport industry has taken several steps to reduce CO₂ emissions and other environmental impacts, notably those associated with fossil-fuel combustion. Combined with growing demands for mobility,

Box 1.

ECO-INNOVATION IN ACTION

Vélib': The City of Paris launched this popular self-service bicycle-sharing system in 2007. Bicycles are available at over 1 450 stations located throughout the city. The system runs on an innovative business model: the advertising company, JC Decaux, provided start-up financing to cover 10 years of operation and associated costs in return for full control of a portion of the city's billboards.

Shift from products to services: IBM offers an energy-management service to data-centre clients who want to reduce energy costs. Xerox's Managed Print Services helps the company's clients to optimise energy use and reduce printing costs. Michelin provides tyre-maintenance services, according to kilometres driven, through its Fleet Solutions programme.

Advanced high-strength steel for cars: Thirty-five steel makers from 18 countries jointly formed the Ultra-Light Steel Auto Body (ULSAB) initiative in 1994, in partnership with an automotive engineering company. Since cars built with advanced high-strength steel are lighter, their power train can be downsized, thus substantially improving the vehicles' fuel economy and reducing CO₂ emissions over their lifetime.

particularly in developing economies, many eco-innovation initiatives have focused on increasing the energy efficiency of automobiles and other forms of transportation, while at the same time improving safety. Eco-innovations in the automobile industry have been realised largely through technological advancements, typically in the form of product or process modification and re-design, such as more efficient fuel-injection technologies, better power-management systems, energy-saving tyres and optimisation of painting processes. Yet, there are also indications that the understanding of eco-innovation in the transport sector is broadening. New players are emerging through alternative business models and modes of transportation, such as the bicycle-sharing scheme in Paris, as new ways of dealing with pollutants and congestion caused by automobiles.

Driven by increasing prices and scarcity of raw materials, **the iron and steel industry** has made significant progress in increasing its environmental performance through a number of energy-saving modifications and re-designs of various production processes. New ways of working within the industry have made many of these technological advances in products and processes possible. For example, an international collaboration between vehicle designers and steel makers resulted in the development of advanced high-strength steel to manufacture lighter and more energy-efficient automobiles.

The electronics industry has so far been mostly concerned with its products' energy consumption. With consumer demand for electronic equipment exploding, companies are also seeking more efficient ways to dispose of their products. As in the above two sectors, most eco-innovations in this industry have focused on technological advancements in the form of product or process modification and re-design. These, in turn, build upon a number of innovative organisational and institutional arrangements. A notable example is IBM's use of large-scale Internet discussion groups, dubbed "innovation jams", to harness innovative ideas circulating among thousands of people. Alternative business models, such as providing product-service solutions rather than physical products, have also emerged. ■

What role can government play?

Although government regulations and standards have helped to reduce damaging environmental impacts to a large extent, they typically are not the most efficient way to reduce emissions and do not offer enough incentives to innovate beyond end-of-pipe solutions.

Nor have innovation policies so far focused sufficiently on environmental concerns. Realising the potential of eco-innovations will require actions to ensure that the full cycle of innovation is efficient, with policies ranging from investment in research to support in commercialising breakthrough technologies. OECD analysis also indicates that better pricing will be one of the best triggers for the development and diffusion of green technologies.

Results from a survey of ten OECD governments on existing national strategies and policy initiatives show that an increasing number of countries now perceive environmental challenges not as a barrier to economic growth but as a new opportunity. But not all countries surveyed seem to have a specific strategy for eco-innovation; when they do, there is often little policy co-ordination among the various departments involved.

Government policy initiatives and programmes that promote eco-innovation are diverse and include both supply-side and demand-side measures. As most countries recognise the need for a more collaborative approach to innovation, many initiatives involve creating networks, platforms or partnerships that engage different industry and non-industry stakeholders. Demand-side measures are receiving increasing attention, as governments acknowledge that insufficiently developed markets are often the key constraint for eco-innovation. For example, green public procurement provides an opportunity to foster demand for eco-innovation, although such policies need to be carefully designed as government procurement rules may inadvertently run the risk of harming competition and support technologies which deliver sub-optimal performance. Current demand-side measures are often poorly aligned with existing supply-side measures. A more comprehensive understanding of the interaction between supply and demand for eco-innovation will be a pre-requisite for creating successful eco-innovation policies (see Box 2). ■

Where are future opportunities for advancing eco-innovation?

The OECD's *Innovation Strategy* is looking in-depth at how government policies can best support innovation to address key challenges, including environmental challenges. Eco-innovation has the potential to lead to significant economic opportunities. But investors need a clear and credible price signal and long-term targets now to make the appropriate investment decisions for a greener future. Even with such a price, the costs of some innovations may be very high initially, and government will have to share the risk of new technologies with the private sector in some circumstances. A number of other measures are already being employed by countries to support environment-related research and development (R&D). An analysis of the results of the survey on current government innovation policies reveals several areas for improvement among such measures:

Box 2.

ECO-INNOVATION POLICIES IN ACTION

Funding for technology deployment: The United States Department of Energy (DOE)'s Technology Commercialization Fund (TCF) complements “angel investment”, or early-stage corporate product development. The TCF brings the DOE's national laboratories and industry together to identify technologies that are promising, but face the “commercialisation valley of death”.

Top Runner programme: Japan's Top Runner programme, launched in 1998, adopts a process of setting and revising standards by taking the current highest energy-efficiency rate of products in some 21 product groups as a benchmark, instead of setting fixed targets. This flexible standard-setting creates incentives and competition among manufacturers to improve product performance without providing financial support.

“Carrot and stick” for diffusing eco-products: France introduced the Bonus-Malus (reward-penalty) scheme for personal cars in 2007 to encourage manufacturers to develop low-emission vehicles by guiding consumer choice. This scheme provides a subsidy to those who purchase a new car that emits less than 130 grams of CO₂ per kilometre, while imposing a penalty on those who buy a new car that emits over 160 g CO₂/km.

Supply-side measures

- **Equity support:** Many governments have taken measures to ease access to finance for businesses and entrepreneurs developing innovative technologies through venture capital. Few specific measures or instruments have thus far been introduced for businesses developing environmental technologies or eco-friendly products and services.
- **Research and development:** Most R&D programmes seem to be mainly sector or technology specific, and few countries seem to focus on shifting R&D investments towards environment or eco-innovation. R&D in general-purpose technologies, such as information technology, bio-technology and nano-technology, could be of great relevance to eco-innovation, but may not be identified as such.
- **Pre-commercialisation:** Many available environmental technologies have not been successfully introduced into the market, since the market is not yet well developed or since existing infrastructures and production and consumption patterns may be obstacles to commercialisation. Many government initiatives help businesses to bring their new environmental technologies to the market, though the focus is sometimes limited to promising energy and transport-related technologies.
- **Education and training:** Education and training programmes are critical for developing the human capital needed for eco-innovation and a potential labour force for “green jobs”. A number of countries have taken measures to mainstream environmental education in the school curricula or vocational training, but further focus is needed.
- **Networks and partnerships:** Many policy programmes require co-operation in research projects and support the development of networks. Governments can foster public-private partnerships and networking platforms for eco-innovation.
- **Information services:** Most advisory services for SMEs have not specifically targeted the environment, let alone eco-innovation. Governments could play a key role in disseminating information on energy efficiency and environmental technologies.

Box 3.

BENCHMARKING ECO-INNOVATION – THE NEED FOR MEASUREMENT

Indicators help businesses understand the environmental impacts of existing production systems, benchmark their performance, define specific objectives and monitor progress. No existing single set of indicators can cover all aspects that businesses need to address to improve environmental performance. Instead, a combination of existing indicator sets can help businesses gain a comprehensive picture of environmental impacts across the value chain. To encourage system innovations, a new set of indicators that identifies system-wide impacts of new products and processes will need to be developed.

To improve understanding about eco-innovation for better policy making, the nature, drivers, barriers and impact of eco-innovation also needs to be captured at the macro (sectoral, local and national) level. Since no single method is again sufficient for the task, an “eco-innovation scoreboard” could be developed by combining different statistics and information. That would provide a clearer overview of trends in eco-innovations and greatly improve awareness among policy makers and businesses.

Demand-side measures

- **Regulations and standards:** Industry tends to regard environmental regulations as an unwelcome burden, adding costs and reducing competitiveness. Flexible and well-designed standards and regulations, however, could help to diffuse advanced environmental technologies and eco-products by creating demand.
- **Public procurement and demand support:** Some governments have started to highlight procurement as a way to spur innovation. Governments may also directly support consumers with subsidies, tax incentives or other benefits to encourage the uptake of eco-products and services.
- **Technology transfer:** Technology transfer is a way for technology-importing countries to increase resource efficiency in a relatively short time while providing exporting countries with market and innovation opportunities.

With eco-innovation gaining ground within both industry and government as a way to tackle environmental degradation and to foster green growth, the OECD is intensifying its work in this area. Research on eco-innovation is still in its infancy, particularly concerning systemic eco-innovations, which have greater potential for overall environmental improvements but are also highly complex, involving non-technological changes. In this context, the OECD project on sustainable manufacturing and eco-innovation has identified several forward-looking activities, including:

- develop a “toolkit” to help businesses benchmark their performance and improve their production processes and products (see Box 3);
- gather examples of eco-innovations, particularly those of more integrated, systemic approaches, and conduct in-depth analyses of such innovations to deepen understanding and extract lessons for practitioners and policy makers; and
- identify promising policies that encourage eco-innovation by sharing best practices among OECD governments.

In parallel, further OECD work is also underway to analyse the policies that can efficiently support the development and diffusion of eco-innovation, including how to strengthen the design of policy instruments and lower barriers to the diffusion of eco-innovation. New work is also underway on the policy frameworks that can best encourage green recovery and green growth. ■

For further information

For more information about this *Policy Brief* and the OECD project on sustainable manufacturing and eco-innovation, please contact: Tomoo Machiba, e-mail: tomoo.machiba@oecd.org, tel.: +33 1 45 24 99 84 or visit www.oecd.org/sti/innovation/sustainablemanufacturing.

For related OECD work on eco-innovation, please also visit: www.oecd.org/environment/innovation/globalforum and www.oecd.org/env/cpe/firms/innovation.



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