

## Executive Summary

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*The evolution of sustainable manufacturing has been facilitated by multi-level eco-innovation*

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Manufacturing industries have the potential to become a driving force for realising a sustainable society by introducing efficient production practices and developing products and services that help reduce negative impacts. This will require them to adopt a more holistic business approach that places environmental and social aspects on an equal footing with economic concerns.

Their efforts to improve environmental performance have been shifting from “end-of-pipe” pollution control to a focus on product life cycles and integrated environmental strategies and management systems. Furthermore, efforts are increasingly made to create closed-loop, circular production systems in which discarded products are used as new resources for production.

Many companies and a few governments have started to use the term *eco-innovation* to describe the contributions of business to sustainable development while improving competitiveness. Eco-innovation can be generally defined as innovation that results in a reduction of environmental impact, no matter whether or not that effect is intended. Various eco-innovation activities can be analysed along three dimensions:

- *targets* (the focus areas of eco-innovation: products, processes, marketing methods, organisations and institutions);
- *mechanisms* (the ways in which changes are made in the targets: modification, redesign, alternatives and creation); and
- *impacts* (effects of eco-innovation on the environment).

Innovation plays a key role in moving manufacturing industries towards sustainable production, and the evolution of sustainable manufacturing initiatives has been facilitated by eco-innovation. As those initiatives advance, the process of their implementation becomes increasingly complex and industries need to adopt an approach that can integrate the various elements of eco-innovation to leverage the maximum environmental benefits. Such advanced, multi-level eco-innovation processes are often referred to as *system innovation* – innovation characterised by shifts in how society functions and how its needs are met.

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*Technological eco-innovations are often complemented by non-technological changes*

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To better represent the contexts and processes that lead to eco-innovation, some illustrative examples of eco-innovative solutions have been collected from three sectors: automotive and transport, iron and steel, and electronics. The examples were examined in light of the three dimensions of eco-innovation mentioned above.

Many eco-innovation initiatives in the automotive and transport industry have focused on improving the energy efficiency of vehicles while heightening their safety. The iron and steel industry has in recent years introduced a number of energy-saving modifications and has redesigned various production processes. While the electronics industry has mostly been concerned with the energy consumption of products, growing consumption of the products themselves has also led the industry's effort to increasing recycling possibilities. Overall, technological advances tend to be the primary focus of current eco-innovation efforts. These are typically associated with products or processes as eco-innovation targets, and with modification or redesign as the principal mechanisms.

Nevertheless, a number of complementary non-technological changes have functioned as key drivers. Such changes have been either organisational or institutional in nature. They include the establishment of separate environmental divisions to monitor and improve overall environmental performance and help direct R&D efforts, and the establishment of inter-sectoral or multi-stakeholder collaborative research networks. Some industry players have even started exploring more systemic eco-innovation through the introduction of new business models and alternative modes of provision, such as bicycle-sharing schemes and product-service solutions in photocopying and data centre energy management.

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The essence of eco-innovation cannot necessarily be adequately represented by a single set of target and mechanism characteristics. Instead, it seems best examined in terms of an array of characteristics ranging from modifications to creations across products, processes, organisations and institutions.

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*Existing indicators can be applied  
in combination to accelerate  
corporate sustainability efforts*

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Indicators help manufacturing companies define objectives and monitor progress towards sustainable production. Existing indicators for sustainable manufacturing are diverse in nature and have been developed on a voluntary basis or set as an industry standard or by legislation. To analyse their effectiveness for guiding companies' sustainable manufacturing efforts, nine representative sets of indicators were reviewed (individual indicators, key performance indicators, composite indices, material flow analysis, environmental accounting, eco-efficiency indicators, life cycle assessment indicators, sustainability reporting indicators, and socially responsible investment indices) based on six benchmarking criteria (comparability, applicability for small and medium-sized enterprises, usefulness for management, effective improvement in operations, possibility of aggregation, and effectiveness for finding innovative solutions).

The benchmarking results show that there is no ideal single set of indicators which covers all of the aspects companies need to address to improve their production processes and products. Except for eco-efficiency indicators, each of the nine categories is mainly designed to help management decision making or to facilitate improvements in products or processes at the operational level. In reality, many companies are applying more than one set of indicators at different levels, often without relating them.

An appropriate combination of existing indicator sets could help give companies a more comprehensive picture of economic, environmental and social effects across the value chain and the product life cycle. The further development and standardisation of environmental valuation techniques could also help companies make more rational decisions on investments in sustainable manufacturing activities. New system-level indicators may also be needed to identify the wider impacts of introducing new products and production processes beyond a single product life cycle. Small and medium-sized enterprises (SMEs) and suppliers need to start by collecting data for a minimum set of individual indicators and then adopt more advanced indicators step by step.

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*Different data sources would help identify overall patterns of eco-innovation activities*

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Quantitative measurement of eco-innovation activities would help policy makers and industries grasp trends. It would also raise awareness of eco-innovation among stakeholders and make improvements achieved through eco-innovation more evident. To explore future opportunities for measurement, the strengths and weaknesses of existing methods of measuring eco-innovation at the macro level (*i.e.* sectoral, local and national) are analysed.

It is important to investigate the nature (how companies innovate), drivers, barriers and impacts of eco-innovation in order to capture the overall picture. These aspects can be captured by four categories of data: input measures (*e.g.* R&D expenditure); intermediate output measures (*e.g.* number of patents); direct output measures (*e.g.* number of new products); and indirect impact measures (*e.g.* changes in resource productivity). Relevant data can be obtained either by using generic data sources or by conducting specially designed surveys.

Each measurement approach has its strengths and weaknesses, and no single method or indicator can fully capture eco-innovation activities. Generic data sources can provide readily available information on certain aspects of the nature of eco-innovation, but it may narrow the scope and aspects of eco-innovation to be analysed. While surveys can enable researchers to obtain more detailed and focused information, they are costly to conduct and the number of respondents is likely to be limited. To identify overall patterns of eco-innovation, it is therefore important to apply different analytical methods, possibly combined, and examine information from various sources with an appropriate understanding of the context of the data considered.

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*Supply- and demand-side policies should be better aligned to facilitate eco-innovation*

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Governments in OECD countries have mainly used their environmental policies to promote sustainable manufacturing and eco-innovation, without necessarily building coherence or synergy with other policies. More recently, environmental concerns have started to be integrated in innovation policies. This trend needs to be supported to help achieve ambitious environmental and socio-economic goals simultaneously, as environmental and innovation policies can reinforce each other.

To gain insight into current government policies, existing national strategies and overarching initiatives were analysed based on responses to a questionnaire survey from ten OECD countries (Canada, Denmark, France, Germany, Greece, Japan, Sweden, Turkey, the United Kingdom and the United States). The survey found that an increasing number of countries now perceive environmental challenges not as a barrier to economic growth but as a new opportunity for increasing competitiveness. However, 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.

Initiatives and programmes that promote eco-innovation are diverse and include both supply-side and demand-side measures. Many supply-side initiatives involve the creation of networks, platforms or partnerships that engage different industry and non-industry stakeholders, in addition to conventional measures for funding research, education and technology demonstration. Demand-side measures such as green public procurement are receiving increasing attention, as governments acknowledge that insufficiently developed markets are often the key constraint for eco-innovation.

Current demand-side measures are often poorly aligned with existing supply-side measures and need a more focused approach to leveraging eco-innovation activities. A more comprehensive understanding of the interaction between supply and demand for eco-innovation will be a prerequisite for creating successful eco-innovation policy mixes.

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*More OECD work on indicators  
and case analysis would help  
advance global efforts*

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The above outcomes of research and analysis are drawn together into nine key findings (see Chapter 6). Identified together with the project's advisory expert group, promising areas for the work of the OECD project on sustainable manufacturing and eco-innovation in the next phase (2009-10), and possibly beyond, include:

- **Provide guidance on indicators for sustainable manufacturing:** The OECD could bring clarity and consistency to existing indicator sets by developing a common terminology and understanding of the indicators and their use. It could also play a role in providing supportive measures for increasing the use of indicators by supply chain companies and SMEs.

- **Identify promising policies for eco-innovation:** Better evaluation of the implementation of various policy measures would be helpful to identify promising eco-innovation policies. The OECD can also facilitate the sharing of best policy practices among governments.
- **Build a common vision for eco-innovation:** The OECD could help fill the gap in understanding eco-innovations, especially those that are more integrated and systemic and have non-technological characteristics, by co-ordinating in-depth case studies. This could form the basis for developing a common vision of environmentally friendly social systems and roadmaps to achieve this goal.
- **Develop a common definition and a scoreboard:** With the substantial insights obtained, the OECD could consider the development of a common definition of eco-innovation and an “eco-innovation scoreboard” for benchmarking eco-innovation activities and public policies by combining different statistics and data.