



Green industry

Key points

- ***A green industry is the core driver of economic competitiveness and sustainable growth.***
- ***A system change approach is needed to green industries.***
- ***Greening an industry is not an ad hoc, straightforward process but is dynamic and enduring.***

Green industry explained

The United Nations Industrial Development Organization (UNIDO) defines the green industry vision as: "The potential for industries to decouple economic growth and revenues from excessive and increasing resource use and pollution. It foresees a world where industrial sectors minimize waste in every form, utilize renewable resources as input materials and fuels, and take every possible precaution to avoid harming workers, communities, climate, or the environment. Green industries will be creative and innovative, constantly developing new ways of improving their economic, environmental and social performance."¹

A green industry is the concept of promoting sustainable consumption and production patterns in the manufacturing of products.² This involves both the greening of existing products and the creation of green industries that deliver environmental goods and services. A green industry requires manufacturers to accept responsibility for the environmental impacts of their product or service throughout its whole life cycle.

A green industry aims to:

- Improve the efficiency of conventional industries and supply chains
- Create new types of products, such as renewable energy, recycling technologies and organic food production
- Create environmental analysing and advisory services, such as an energy service company, which includes analysis and calculation of ecological footprints
- Create new types of services that are more ecologically friendly, such as ecotourism.

How it works

Greening of industries

All industries, regardless of the sector, size or location, continuously need to improve their environmental performance. This includes commitment to and actions aimed at reducing the environmental impacts of processes and products by using resources more efficiently, phasing out toxic substances, substituting fossil fuels with renewable energy sources, improving occupational health and safety at the worksite, taking increased producer responsibility and reducing the overall risks for the environment.

¹ United Nations Industrial Development Organization, *Green Industry: Policies for Supporting Green Industry* (Vienna, 2011).

² In the Report of the World Commission on Environment and Development: *Our Common Future* from the 1987 United Nations General Assembly, sustainable business has been addressed as a business that "meets the needs of the present world without compromising the ability of the future generations to meet their own needs".

Energy and resource efficiencies drive the greening of industries, which is a worthwhile pursuit for businesses because it reduces the cost of production as well as the cost of compliance with future environmental standards.³

Industrial ecology

The realization that industrial systems can mimic biological ecosystems – in that one organism's or business's waste is the source of food for another organism or business – has led to the concept of “industrial ecology”. One of the strengths of industrial ecology is its “systematic view” of patterns of production, consumption and resource recovery. A basic principle is that a plan for greater resource efficiency and reduced pollution must be integrated across all resource flows, economic sectors, public and private activities and both the short- and long-term time horizons.⁴

How to green an industry

There are many practical approaches to greening an industry, such as:

- Circular economy
- Cleaner production
- Industrial symbiosis
- 3Rs – reduce, reuse and recycle

Country experience: Circular economy policy in China

China is implementing far-reaching policy measures to increase its resource efficiency. This includes the Resource Saving Initiative (2006–2010), which was introduced in the Eleventh Five-Year Plan for Strengthening the Vision of a Green China.

The circular economy policy was established in 2008 through the Circular Economy Promotion Law, which was intended to guide China's economic development in ways that conserve energy, water and materials and protect the environment. The Chinese Government believes development, based on the circular economy, will be essential for the country to sustain its fast-paced growth while mitigating negative ecological impacts and creating more job opportunities.

The circular economy approach integrates cleaner production and industrial ecology into a broader system that encompasses industrial companies, networks or chains of companies, eco-industrial parks and regional infrastructure to support resource efficiencies. The Chinese circular economy sets action targets on three levels:

1. **Company level:** The manager must seek much higher efficiency through the “reduce, reuse and recycle” approach to cleaner production.
2. **Industry level:** Reuse and recycle resources in industrial parks and in clustered or chained industries so that the resources circulate fully within the local production system.
3. **Regional level:** Integrate different production and consumption systems in a region so that resources circulate among industries and urban systems.

The circular economy law states that national, regional and local authorities and government institutions should be responsible for organizing, coordinating and regulating the circular economy initiatives.

The eleventh plan strongly advocated economic development that is in harmony with environmental and resource sustainability and social welfare across the country, including in the less developed western region of China. This economic and social development dimension of the circular economy policy was reaffirmed in the

³ Pierre Desrochers, “Cities and industrial symbiosis: some historical perspectives and policy implications”, *Journal of Industrial Ecology* (2001), vol. 5, No. 4.

⁴ Asian Development Bank and Institute of Global Environmental Strategies, *Towards Resource-Efficient Economies in Asia and the Pacific: Reduce, Reuse and Recycle* (Manila, 2008). Available from www.adb.org/Documents/Papers/Resource-Efficient-Economies/Resource-Efficient-Economies.pdf (accessed 20 January 2011).

Twelfth Five-Year Plan (2011–2016). The National Development and Reform Commission selected more than 1,300 enterprises to join a pilot programme to promote circular economy strategies. At the end of 2011, the agency published a list of 60 companies that had successfully adopted circular economy practices and were promoted as models for other enterprises in China.⁵

Companies applying circular economy strategies

With the Government's strong backing, several companies have been testing the concept:

- Yanjing Beer Group, the world's eighth-largest and Beijing-based brewery, invested in several technologies to cut water and energy consumption in its facilities. This included installation of devices to trap heat and gases generated during the fermenting and brewing processes for use in other procedures and wastewater recycling for use in the cooling system.⁶
- Tangshan Iron & Steel, based in Tangshan City in Hebei Province, installed desulfurizing and dust-removal devices to reduce the air pollution its facilities generated. It also uses secondary energy and constructed a 300 million yuan wastewater treatment plant.⁷ The facility is the largest in northern China. It treats urban wastewater for use in the steel manufacturing process and thus avoids the consumption of freshwater.

Source: Zengwei Yuan, Jun Bi and Yuichi Moriguchi, "The circular economy: A new development strategy in China", *Journal of Industrial Ecology* (2006), vol. 10, No. 1-2, pp. 4-7.

Box 1: Cleaner production

Cleaner production is a strategy for improving natural resource efficiency, reducing and eliminating wastes and pollution, and minimizing risks to human health. Cleaner production is achieved by applying know-how, improving technology and changing attitudes. It goes beyond pollution control and waste management by directly managing production processes and introducing environmental management systems. Recently, the concept of cleaner production expanded to include product life-cycle aspects, such as eco-design and consumption patterns.

The United Nations Environment Programme defines cleaner production as "the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment. For production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes before they leave a process. For products, the strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product."⁸ The goal of cleaner production is to avoid generating waste and to minimize the use of raw materials and energy.

Source: United Nations Environment Programme website "UN Clean Production Programmes". Available from www.cleanproduction.org/Steps.Process.UN.php (accessed 24 January 2012).

⁵ The Central People's Government of the People's Republic of China, *Case Study for the Companies Who Initiate the Circular Economy in China* (Beijing, 2011).

⁶ Kultida Samabuddhi, "A Circular Sustainability," *Bangkok Post*, August 15, 2011, sec. B9.

⁷ *ibid.*

⁸ United Nations Environment Programme website "UN Clean Production Programmes". Available from www.cleanproduction.org/Steps.Process.UN.php (accessed 24 January 2012).

Country experience: Eco-efficiency reaps huge profits in the Republic of Korea

In an eco-industrial park, the waste generated by one company is used as a resource for another (industrial symbiosis), leading to a clear business case for a green industry practice. The eco-industrial park in Gyeonggi Province in the Republic of Korea demonstrates how linking various actors can promote eco-efficiency and generate win-win situations. Following an initial government investment of 440 million won, the recovery of copper from wastewater as well as the reuse of the treated wastewater now generates an annual profit of 4.72 billion won.⁹ In this arrangement, Hwabaek Engineering Co. Ltd recovers copper from wastewater produced by PCB company (Daeduk GDS Co. Ltd) and returns the treated water back to PCB before selling the recovered and refined copper.

Key to the success of the initiative was the strong role of the Government in setting up the enabling conditions. The legal framework Act to Promote an Environment-Friendly Industrial Structure implemented in 1995 was followed by a series of actions to transform industrial complexes into eco-industrial parks. Five pilot projects were launched with the purpose of developing an eco-industrial park model in the first phase (2005–2009). The second phase (2010–2014) is in line with the Government's low carbon, green growth five-year plan, in which the main focus is encouraging replication of good practices through a communication network. Eight eco-industrial parks now operate with support and coordination from the Ministry of Knowledge Economy. According to the Government, the annual resource savings is equivalent to 41.2 billion won. Additionally, the eco-efficiency in the parks avoids the annual generation of 37,000 tonnes of wastewater and 280,000 tonnes of CO₂.¹⁰

Source: Ministry of Knowledge Economy, Republic of Korea, "Outcomes and Future of Korea's Eco-Industrial Parks Optimizing Resource Efficiency", News Release, December 1, 2010.

Country experience: Reducing, reusing and recycling policy in Japan

The Government of Japan adopted a policy of reduce, reuse and recycle (3Rs) to create a sustainable society – one that achieves a balance between the economy and the environment. To reach that balance, the Government is moving from a sole focus on hazardous substance management towards a greening of the entire economy. The 3Rs policy promotes technological development in the areas of resource efficiency and waste recovery and recycling. Additionally, it fosters the development of new green products for both economic and employment growth. As a result, there have been substantial investments in developing energy-efficient home appliances, office equipment and recycling infrastructure.

What are the 3Rs?

The 3R philosophy centres on reducing waste and reusing and recycling resources and products. The amount of waste that is produced should be decreased, products or their parts should be used repeatedly and waste should enter the production cycle as a substitute for raw natural resources. By promoting the 3Rs, waste can be minimized in an efficient way, leading to the reduction of overall resource consumption.

A new approach to reduce waste is the "extended producer responsibility" in which manufacturers are held responsible, to a certain extent, for the adequate reuse, recycling and disposal of their discarded products. Japanese manufacturers are required to adopt the life-cycle assessment approach to minimize the negative impacts of their products on the environment throughout the lifespan of those products. This requirement has succeeded in encouraging manufacturers to develop products that are less likely to turn into waste, easy to reuse or recycle or have little impact on the environment when discarded.

Legal system for a material-cycle society

The Fundamental Law for Establishing a Sound Material-Cycle Society (2000) is the legal framework for promoting

⁹ Ministry of Knowledge Economy of Republic of Korea, "Outcomes and Future of Korea's Eco-Industrial Parks Optimizing Resource Efficiency", News Release, December 1, 2010.

¹⁰ *ibid.*

the 3Rs policy.¹¹ Additionally, the Law for Promotion of Effective Utilization of Resources (2001) was enacted to cover the production stage along with various laws regulating the collection and recycling of waste. The Waste Management and Public Cleansing Law (1970) covers waste management. The Law on Promoting Green Purchasing (more formally the Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities, 2000) encourages the purchase of eco-friendly products by the State, institutions and local governments and promotes consumer demand for such products.

Source: *Japan's Experience in Promotion of the 3Rs* (Tokyo, Ministry of Environment, 2005).

Box 2: Clean coal technologies

The term clean coal technology refers to a suite of coal combustion, conversion and emission-reduction technologies. Clean coal technology increases coal use efficiency and reduces the environmental impacts that using coal causes. The different technologies involved are at various maturity and commercialization stages. Technologies such as low nitrogen oxide burners and flue gas desulfurization are important for reducing the emission of harmful gases associated with acid rain and are highly commercialized. Emerging technologies such as ultra-supercritical steam cycles and integrated gasification combined cycle are still in the demonstration phase.

Although emissions-control technologies continue to improve and new conversion technologies can achieve higher efficiencies, the technical risks, lack of operational experience and uncertainties over carbon pricing keep them from becoming cost competitive with traditional coal-fired electricity plants. While there is a clear theoretical limit for thermal conversion efficiency, excluding carbon capture and storage, it is not yet clear when and where the limits of emission control will be reached.

The selection of clean coal technology will depend on many factors, such as environmental standards, capital cost, operation and maintenance considerations and future carbon charges. The characteristics and quality of coal used can affect the conversion efficiency, capital cost and emission performance of a power plant, and thus plant developers must also take the long-term supply of coal into consideration. The need for flexibility to meet future environmental requirements (such as the ability to retrofit carbon capture and storage facilities to existing plants) may create a preference for technology that features the lowest cost in this respect. However, coal power plants will be expensive to retrofit regardless of the clean coal technology selection, and there are currently no commercially viable technologies that offer the necessary flexibility for a plant to be "capture-ready".

Source: Massachusetts Institute of Technology, *The Future of Coal Options for a Carbon-Constrained World* (Boston, MA, 2007).

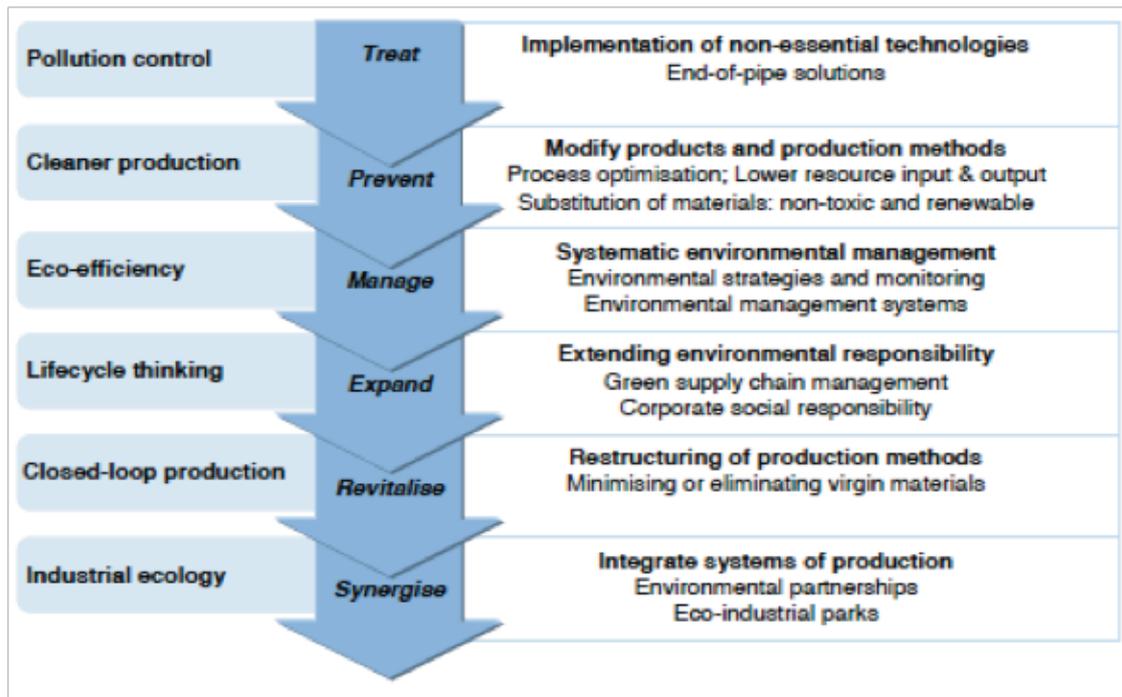
Creating green industries

Businesses that provide green goods and services encompass many sectors and products, including waste management, ecotourism, renewable energy and air pollution control. The segment also encompasses environmental and energy consultants in addition to the providers of integrated solutions, such as energy service companies.

Each country will need to create its own version of green industries. A ready-made solution, universally applicable, is not feasible due to each country's unique natural resources and economic, social and industrial circumstances. The energy supply infrastructure, demand patterns and government capacity also differ from country to country.

¹¹ Japan, *Japan's Experience in Promotion of the 3Rs* (Tokyo, Ministry of Environment, 2005). Available from www.env.go.jp/recycle/3r/en/approach/02.pdf (accessed 29 January 2012).

Figure 1: The evolution of greening industry concepts and practices



Source: Organisation for Economic Co-operation and Development, *Sustainable Manufacturing and Eco-Innovation: Framework, Practices and Measurement* (Paris, 2009). Available from www.oecd.org/dataoecd/15/58/43423689.pdf (accessed 5 March 2012).

Strengths with green industries¹²

Environmental

- Reduces energy consumption and increases energy-efficiency.
- Reduces water consumption and increases water-use efficiency.
- Minimizes waste due to the recycling of materials in which residues from one process or industry are re-sold as inputs to other industries.
- Reduces the total environmental costs from virgin mineral extraction.
- Encourages brownfield redevelopment, whereby eco-industrial developments are located in existing industrial areas and help facilitate a co-location and linking of businesses.

Economic

- Avoids the costs for waste disposal.
- Reduces the costs for raw material purchases.
- Reduces the costs for energy and water.
- Reduces costs through the sharing or centralizing of material managing services.

¹² R. J. Klee, *Eco-Industrial Development Primer* (Connecticut, 1999). Available from http://environment.research.yale.edu/documents/downloads/0-9/106eip-cels_exercise1.pdf (accessed 29 January 2012).

Challenges for green industries

- Relatively low profitability compared with many conventional industries.
- Conflicts of interests between brown and green industries, such as in their attitudes towards cap and trade or carbon tax, prevents them from working together.
- Existing production and consumption patterns dominate throughout the whole manufacturing chain.
- Unclear policy signals and lack of commitment from the government, resulting in short-term policies only.
- Lack of data on green industry development, which makes it hard to assess respective trends, opportunities and barriers and then form effective policies.
- Short-sightedness of conventional business strategies, which ignore benefits in the far future.
- Greening of industries on a national level can induce disadvantages in international markets, which are still dominated by conventional products and production chains and not conditioned to strict environmental standards.

Implementing strategy

Long-term policy: Driving economic growth with green industries means to either increase competitiveness in international markets for green goods and services, such as ecotourism or organic products, increase productivity or create new industries through innovations. Green industry efforts need a long-term government policy that clearly signals to all businesses that a shift towards a low-carbon emitting, resource-efficient economy is obligatory. A long-term and stable government policy will draw private investment into the green industries. Further research that unravels the mechanics behind the fairly new green industries will help policymakers to promote the right strategies.

From a public policy perspective, the greening of industries cross-cuts a range of policy streams. These include industrial policy (such as technology development), environmental policy (such as resource conservation measures) and regional development policy (such as the provision of local infrastructures). Within this policy context, UNIDO has suggested a “policy matrix for the greening of the industries” (figure 2). In the matrix, “green industry policies” refer to the broad range of government interventions that directly or indirectly support the greening of industries.

Figure 2: Policy matrix for the greening of industries



Source: United Nations Industrial Development Organization, *Green Industry: Policies for Supporting Green Industry* (Vienna, 2011). Available from www.unido.org/fileadmin/user_media/Services/Green_Industry/web_policies_green_industry.pdf (accessed 5 March 2012).

Further reading

A Greener Footprint for Industry (Vienna, United Nations Industrial Development Organization, 2009). Available from www.unep.or.jp/ietc/spc/news-nov09/UNIDO_GreenIndustryConceptEbook.pdf

Are You a Green Leader? Business and Biodiversity: Making the Case for a Lasting Solution (Nairobi, United Nations Environment Programme, 2010). Available from www.unep.fr/scp/business/publications/pdf/Are_you_a_green_leader_final_publication.pdf