CLEANING UP?
STIMULATING INNOVATION IN ENVIRONMENTAL TECHNOLOGY

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Innovation is the key to success in many areas of business, not least in improving environmental performance. Opportunities arise to develop domestic and global markets for industrial processes and consumer products based on meeting customer needs at the same time as improving environmental performance.

POST has reviewed industry's responses to environmental pressures and what drives innovation. This note summarises a longer report[1] on innovation in environmental technology.

ENVIRONMENTAL TECHNOLOGY

The environmental technology market is a diffuse grouping of goods and services, loosely held together by the aim of reducing environmental impacts. The market includes 'end-of-pipe' air and water pollution control equipment, monitoring and consulting services. This definition is imprecise, but traditionally excludes so-called 'cleaner' technologies that prevent or minimise the production of pollution at source. The full report provides details of end-of-pipe and cleaner technologies

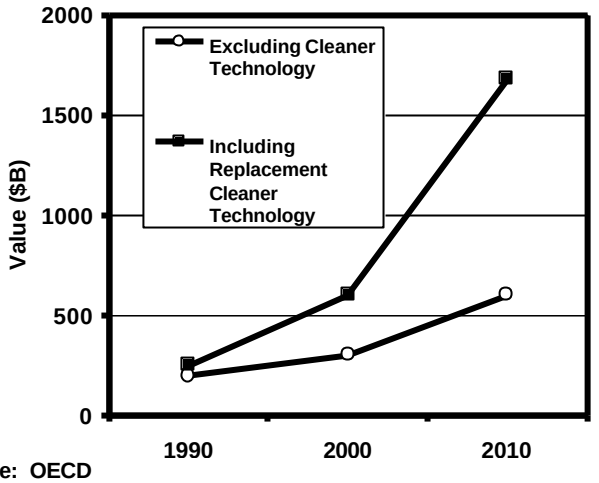
Estimates from the OECD suggest the 'core' environmental technology industry (i.e. mostly 'end-of-pipe' equipment) will be worth $600 billion globally by 2010. Meanwhile, switching to cleaner technology as plants are replaced would push the figure for the total environmental technology industry to over $1500 billion (**Figure 1**). A huge potential for markets in cleaner technologies exists but this is currently not receiving much attention – leading some to suggest that industry is *"missing the green wave[2]."*

WHAT IS INNOVATION?

The key to developing markets in technologies is 'innovation', but this has many meanings. Commonly it is taken to mean *the successful exploitation of ideas.* Essentially, innovation is about creating change for the good, by creating strong links between the generation and dissemination of knowledge, technical progress and long-term growth in productivity and wealth.

Traditionally, innovation has been regarded as a 'pipeline' in which funds are pumped in at one end and commercial products appear at the other.

FIGURE 1 THE VALUE OF THE WORLDWIDE ENVIRONMENTAL TECHNOLOGY MARKET



Source: OECD

However, innovation is now increasingly recognised as a complex process that involves input from governments, academia and industry (and increasingly from other interested parties) at many different stages in the transfer of knowledge. Thus, innovation is increasingly seen as a process of creating **collaborative networks**.

Stemming from this 'network' model of innovation, many now agree that **basic research provides innovators with techniques to solve problems rather than an agenda of ideas ripe for exploitation**.

The commercial opportunities of new technologies (the 'market pull') provide a stronger driver than what is technologically possible (the 'technology push'). This is perhaps particularly the case for innovation based on engineering and physical sciences, such as information technology and process engineering. The reverse is more often the case in the biological sciences, where scientific advances often drive the market (e.g. in genetically modified foods).

Thus, the route by which science can lead to new products is highly complex, and there are no guarantees that increasing expenditure on fundamental research will necessarily lead to commercial success. Therefore, it is now recognised that innovation needs not only investment in research but also that industry needs to play an important role in matching new knowledge with successful development, demonstration, dissemination and marketing. These issues are discussed further in the full report.

1 *Cleaning Up? Stimulating Innovation in Environmental Technology*. POST Report No. 136, April 2000. Report free to Parliamentarians (contact 020 7219 2840). Available to the public, price £15+P&P (contact the Parliamentary Bookshop, 020 7219 3890). See also www.parliament.uk/post/home.htm

2 ESRC Global Environmental Change Programme, 28th March 2000.

TABLE 1 MODELS OF INDUSTRY'S TECHNOLOGICAL RESPONSES TO THE ENVIRONMENT

	'Regulated Industry'	'Greening of Industry[1]'	'Industrial Ecology[2]'
Nature of response	Reactive compliance with technology-based standards	Proactive improvement in environmental performance ('compliance-plus')	Increased resource efficiency to provide competitive advantage
Driver for innovation	Regulation	Market opportunities and policy pressures (achieving 'double dividends')	'Framework' policies to encourage market competition (meeting the 'triple bottom line')
Focus of innovation	Pollution abatement ('end-of-pipe' clean-up) and waste management	Process change ('cleaner production')	Novel products and services involving cleaner design and lifecycle thinking
Source of innovation	Equipment suppliers	Environment integrated into the firm's technology strategy	New market entrants provide radical new service packages
Applicability to sector	Mature sectors	Sectors selling to final consumers	Knowledge-based industries
Current position	Most firms	Few firms	Few firms

Notes:
1. Changes to processes occur within individual firms to increase environmental performance and to reduce costs at the same time.
2. Increased environmental performance is designed into the life cycle of the product: design, manufacture, use and after use.

Source: based on research undertaken at SPRU, University of Sussex

ENVIRONMENTAL INNOVATION

There is a consensus that the most cost-effective way of industry's environmental performance in the medium to long-term is to change the design of products and processes, rather than relying on end-of-pipe technology. This is likely to be achieved with cleaner technologies that minimise the use of raw materials, energy and water, and avoid the production of pollutants[3] (**Figure 2**), for example by using approaches such as 'green chemistry'.

Drivers

Technological change within industry is influenced by environmental policy. The environmental policy 'tool-box' holds a variety of instruments to realise better environmental quality. These range from technology-based environmental standards, through economic incentives such as pollution taxes, to direct financial incentives such as R&D subsidies, ending finally with communication and networking tools.

The effectiveness of these tools in bringing about environmental improvement has been studied for many years. The full report points out that no one instrument on its own can stimulate companies to innovate successfully. Rather, a mixture of instruments (and flexibility in the style in which they are implemented) is needed, depending on the specific factors and circumstances of the firms and sectors involved. Also, the policy climate needs to be stable and credible over a protracted period, to minimise risks faced by industry.

Thus, innovation flourishes where regulation is flexible and policies are stable.

Such a context helps companies reduce their costs of compliance and also aids the regulator and government in reducing opposition to environmental policies. Industrial companies can be classified according to one of three 'models' of how they respond to environmental pressures (**Table 1**). Within each of these models there are four key factors which are widely recognised as important drivers for improving environmental performance:

- Avoiding prosecution for failure to comply with legal requirements
- Realising opportunities for cost-savings related to resource use and waste disposal
- Responding to pressure from customers along the supply chain, including final consumers
- Maintaining company image and competitive advantage.

Barriers

Currently, the 'Regulated Industry' model is most widespread (Table 1), despite the availability of cost-effective solutions in many areas that could help firms move to the other models. A number of barriers can be identified, therefore, that may keep companies locked into the 'Regulated Industry' model:

Financial and Economic Barriers – such as market failures caused by imperfect information; a mismatch between those paying the costs of installing any efficiency measures and those receiving their benefits; and high costs in finding out about the environmental properties of a device or

3 End-of-pipe clean-up techniques will still be necessary though, both within a process, to assist in recycling, recovery and reuse of materials; and for the clean-up of residual waste streams.

system. The conventional operation of the market at any time may also inhibit take-up. Thus, certain technologies may not be cost-effective in a particular instance; there may be hidden costs, where technology investments entail extra costs not included in decision-making models; and where financiers may restrict access to capital for certain individuals or organisations (e.g. because they may be high-risk borrowers).

Institutional Barriers – where decisions are not made on the grounds of rational economic self-interest. Examples include cultural ignorance that systematically neglects cross-sectoral, cross-disciplinary and environmental issues; organisational structures that may create incentives for inefficient designs; and the fact that those responsible for environmental management may lack sufficient power within an organisation.

Behavioural Barriers – such as making decisions on the basis of limited information using rules of thumb and routines in situations where, commonly, the goal is to provide a satisfactory solution, rather than an optimum one. People may be resistant to change because they are committed to standard practice. The form and source of information is often as important as cost in determining whether people will take up measures being proposed (e.g. it must relate to their own concerns, and they must trust the source). Lastly, there may be a lack of, or antipathy towards, environmental awareness.

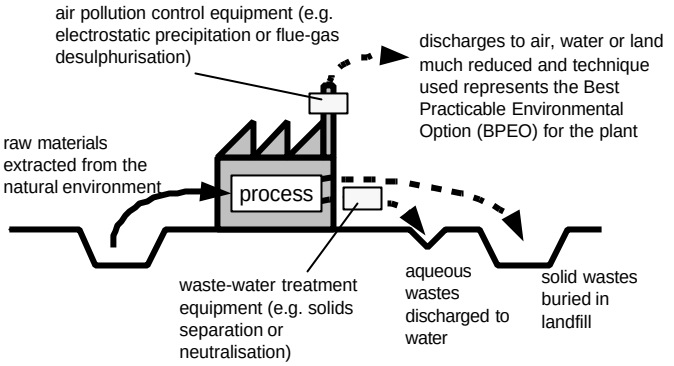
ENCOURAGING INNOVATION

Laying the Foundations

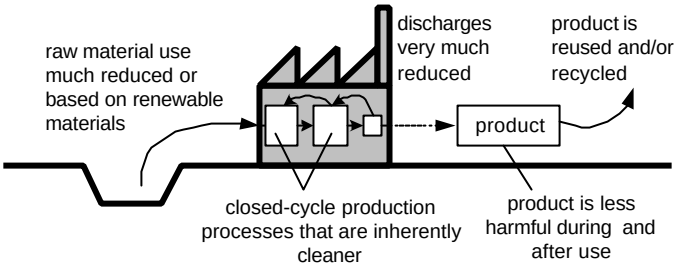
The consensus surrounding cleaner technology includes the UK Government, which has called for a "*green industrial revolution*"[4]. The challenge is how to bring this about, thereby moving the bulk of industry towards the 'Greening of Industry' and 'Industrial Ecology' models in Table 1. The government' response has been though an approach ('**market transformation**') that works with the market and encourages entrepreneurship. Its objectives include promoting best practice, and supporting research and innovation. Underpinning this will be a framework of information and investment programmes and, where appropriate, regulatory and fiscal measures.

FIGURE 2 APPROACHES TO POLLUTION CONTROL

End-of-pipe Clean-up



Cleaner Technology



Source: POST

But how should the UK move forward in developing the support for research and innovation necessary to help industry shift to a more sustainable basis? Three key elements are necessary:

- **Strategy** – to define the objectives and scope of innovation required, recognising the need to both 'get the science right' and to take full account of the business processes necessary to bring technologies to the market place. This also needs to identify the interested parties involved from government, regulators, research councils, academia, industry, consumers, etc.
- **Coordination** – to ensure that all actors are fulfilling their commitments, are working across traditional boundaries of academic disciplines and business sectors, while at the same time avoiding unnecessary overlap between participants and initiatives.
- **Funding** – the level of funding ought to match the commitment. It does not need to come from one source, however, and a partnership approach is most likely to be successful in delivering the research effectively.

However, it has been suggested by many commentators that defining a mechanism to achieve these objectives, would need to take account of several factors:

4 Speech made by Chris Mullin MP, Parliamentary Under-Secretary of State at the Department of the Environment, Transport and the Regions, at the Environmental Industries Commission Conference, 2 December 1999

- Industry is made up of many disparate parts, comprising firms of many different sizes, often involved in highly complex supply chains in domestic and overseas markets, and with differing levels of managerial and technical competence in this area.
- There are many different manufacturing processes with environmental consequences where a wide range of techniques can improve environmental performance.
- There are many sources of funding for innovation, often with different objectives and mechanisms, aimed at different audiences, and targeted at different phases of the innovation process (from 'proof of concept' through to pilot and demonstration projects).

It is important to recognise the inherent complexity in industry. Without a clear understanding of the broad range of factors influencing technology choice in industry, the correct mix of incentives, funding programmes and research mechanisms cannot be determined. Therefore, the opportunity exists for government, industry, academia and others to develop **a coherent strategy for innovation in environmental technology to help develop sustainable industry.**

Towards a New Strategy

There are several possible approaches to defining such a strategy. These include setting up a **Sustainable Technology Task Force** comprising a broad range of members. The Task Force could be established within the Foresight programme. Alternatively, it could form part of the work of the newly created Advisory Committee on Consumer Products and the Environment (ACCPE)[5]. The full report sets out a number of alternative mechanisms, but, whichever mechanism is adopted, the terms of reference for delivering a strategy might include:

Reviewing current and planned activities in this area in the UK and elsewhere (e.g. the UK's major competitors: the USA, Germany and Japan).

Identifying areas of duplication, overlap and omission - including whether separate programmes on sustainable technology should be established, or whether a 'sustainability' element should be integrated within other programmes. On the one hand, a separately funded programme runs the risk that industry and researchers could see sustainable technology as a sideline issue. On the other hand, building the concept into mainstream disciplines and sectors could mean that sustainable technology receives less attention and is not strongly 'championed'. A third alternative is to adopt both approaches and to produce a 'suite' of programmes.

Developing a national framework for innovation in environmental technology, which would:

- Set out the objectives for a framework - e.g. protecting the environment; conserving natural resources; developing and maintaining strong academic and industrial innovation; and enabling industry to compete in global markets for efficient products and process technologies.
- Set out the strategy by identifying the major areas for research, development, demonstration, dissemination and marketing[6] necessary to ensure the objectives are met - including technological aspects, as well as issues related to economics, management and public policy.
- Promote the means to implement the strategy - taking account of the variety of funding sources; the structure and complexity of industry; the opportunities for enhanced environmental performance throughout industry; the desirability of specific or integrated innovation programmes; and the need to work across boundaries of discipline, sector and country.

IN CONCLUSION

Environmental innovation is increasingly seen as a key to improving the efficiency of industry worldwide. This suggests a new model for industry based on innovative production, products and services that combine increased efficiencies and environmental performance. However, the full report suggests that realising this and the commercial opportunities it represents requires:

- **Stable long-term policies for environmental performance and sustainable development.**
- **A mix of policies to maximise the opportunities for innovation across industry.**
- **A coordinated and well-resourced national strategy for innovation in sustainable technologies.**

5 Among its terms of reference, ACCPE will focus on "*tackling the major environmental impacts of products across their life cycle, taking into account developments at the EU level on integrated product policy.*"

6 Including domestic and overseas markets in the developed and developing worlds.