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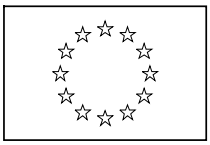

COMMISSION OF THE EUROPEAN COMMUNITIES

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REPORT FROM THE COMMISSION

Environmental technology for sustainable development

EXECUTIVE SUMMARY

At the European Council in Lisbon in March 2000, the European Union set itself the objective of becoming "*the most competitive and dynamic knowledge-based economy in the world*". At the Göteborg European Council in June 2001, a strategy for sustainable development was agreed, by adding an environmental dimension to the Lisbon Strategy. Environmental technologies are an important bridge between the Lisbon strategy and sustainable development, having the potential to contribute to growth while at the same time improving the environment and protecting natural resources.

New and innovative environmental technologies can add to economic growth in a number of ways. Provided they reduce the costs of environmental protection, they allow us to get more environmental protection for less money, or to meet current standards at a lower cost. This frees up resources for use elsewhere in the economy. They also help to decouple environmental pollution and resource use from economic growth, allowing our economies more scope to grow in the long run while still remaining within our environment's limits. This is central to sustainable development.

Finally, an innovative environmental technology sector can help underpin growth if it is capable of tapping into rapidly growing export markets. Trade in advanced technologies can be good both for the EU, as well as other countries that need such technology to help them tackle their own environmental problems. By developing better and more cost-effective technologies we open up a wider range of options to countries that face the same environmental constraints that we do

It is clear that when we talk about environmental technologies we mean far more than 'end-of-pipe' devices to clean up pollution. Environmental technologies include 'integrated' technologies that prevent pollutants being generated during the production process, as well as new materials, energy and resource-efficient production processes, environmental know-how, and new ways of working. In short, we should take a broad view of environmental technologies, as from a policy perspective our concern should be the use and potential of environmental technologies throughout the economic system

The recognition in the Lisbon Strategy that we need to renew our capital stock to improve our economic performance therefore gives us an opportunity to invest in an economy that is both more competitive and capable of supporting sustainable development. In particular, the enlargement of the EU and the investments needed to comply with the environmental *acquis* provide a great opportunity for the EU15 and the Candidate Countries to increase their uptake of environmental technologies and contribute to sustainable development.

Environmental technologies are already a growing industry. Rising demand for a better environment has led to an expanding supply of environmentally friendly techniques, products and services in both the industrialised and the developing countries. However, we do not have data that captures the whole range of innovative technologies in use. The data we have only captures a narrow range of environmental technologies, and includes only those that are driven purely by environmental protection requirements. Nevertheless, the data we do have show this is a diverse and dynamic sector that is well placed to perform in this growing market

Community policies already promote new environmental technologies in a variety of ways. But much of the potential of environmental technologies is unrealised because of market and institutional barriers that hinder their use. In particular, market prices often do not reflect the

full value of environmental resources, which means that markets do not provide the right signals to investors. This leads to systematic under-investment in innovative technologies by both firms and households.

Removing market obstacles and “getting prices right” by internalising environmental costs in market prices is therefore crucial if we are to exploit the potential of environmental technologies to the full, and to provide incentives for further research and development in this field. Other institutional obstacles such as information gaps and capital market constraints also matter. Innovative activity also depends greatly on how regulatory and other policy instruments are designed, putting a premium on improving the quality of regulation and governance

By developing and bringing to the market new environmental technologies, the EU can contribute to sustainable growth both domestically and worldwide. The Commission therefore intends to develop an Action Plan to address the barriers that hinder the wider diffusion of environmental technologies and to promote their development and use.

REPORT FROM THE COMMISSION

Environmental technology for sustainable development

1. INTRODUCTION

When meeting in Stockholm in March 2001, the European Council announced that it would review **the contribution that the environment technology sector can make to promoting growth and employment,** in the spring of 2002. The European Council in Göteborg[1] in June 2001 noted that the Commission would prepare a report on this issue. This Communication is a response to this commitment, setting the scene for the development of a future Action Plan.

This paper has to be seen in the context of the strategic goals set for the EU at the recent Lisbon and Göteborg European Councils. At the European Council meeting in Lisbon in March 2000, the Union set itself the goal of becoming *"the most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion"*. At the Göteborg European Council in June 2001, a strategy for sustainable development was agreed that adds an environmental dimension to the Lisbon Strategy.

The EU sustainable development strategy is based on the principle that economic growth, environmental protection and social inclusion should go hand in hand. In this respect, environmental technologies that lower the costs of environmental protection can play a dual role. On the one hand they help meet us increased demands for a cleaner environment by reducing the environmental impact of economic growth, while on the other they reduce any impact of higher environmental standards on GDP growth itself. In other words, they play an important role in **de-coupling environmental impacts from economic growth**.

There are strong and natural links between the Lisbon Strategy for a competitive, dynamic and inclusive Europe and the Göteborg strategy for a sustainable Europe. **Fostering technological progress and renewing the EU's capital stock are major aims of the Lisbon Strategy.** In order to increase employment and secure financial sustainability, while providing the leeway for more inclusive economic and social policies, the Lisbon strategy sees the need for policies that could raise the growth rate of the EU economy to around 3%. To do this, the rate of investment growth in research, development and technology should substantially accelerate.

Ensuring that future investment is environmentally friendly will be critical. European firms will need to invest more in research and development, and move towards the concept of a knowledge-based industry. In particular, a **substantial increase in both public and private research and development**[2] will be an important signal of the underlying desire for a sustainable future. Only such a change in attitude can shift European industry to a knowledge-

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1 The Gothenburg European Council Conclusions state that "the Commission will present a report assessing how environment technology can promote growth and employment"

2 « The European Council should endorse action to strengthen the European area of research and innovation by setting a target of 3% of GDP for the overall level of public and private spending on research and development by the end of the decade. Within that total, the amount funded by business should rise to around two thirds, against 55% today » Communication from the Commission to the Spring European Council in Barcelona "The Lisbon strategy – making change happen".

based approach, where production systems and consumption models are compatible with sustainable development.

The Lisbon Strategy is also about removing market barriers and **establishing the right incentives for a new wave of technological progress.** Therefore, its overall thrust - including items such as the completion of the internal market in the financial sector, and the simplification of regulatory frameworks - will also help the emergence of innovative solutions and forward-looking firms in the field of environmental technologies. However, the problems of under-investment and slow dissemination are more acute for environment technologies. In addition to traditional factors such as a lack of venture capital, risk aversion or red tape, investment in environmental technologies is limited because market prices do not adequately reward good environmental performance.

This Communication starts with a short presentation, in Section 2, of the concept of environmental technology used in the paper. Indications of the general market for environmental technology are provided on the basis of observed trends in a narrow part of this sector, the European eco-industry (Section 3). Section 4 provides a preliminary description of the global environmental technology market and the position of the European industry in this market. An overview of possible developments in the field of environmental technologies is provided in Section 5, while Section 6 describes the market barriers to their development and use, as well as some of the current actions and instruments being used to overcome these barriers. Section 7 concludes the report by listing some directions for future work.

2. ENVIRONMENTAL TECHNOLOGIES: CONCEPTS AND DEFINITIONS

Environmental technologies include both integrated technologies that prevent pollutants being generated during the production process, and end-of-pipe technologies that reduce the release into the environment of any pollutants that are produced. They can also include new materials, energy and resource-efficient production processes as well as environmental know-how and new ways of working. **This report takes a broad view of environmental technology, to include all technologies whose use is less environmentally harmful than relevant alternatives**.

This concept clearly need not be limited to a small number of core activities. It could include intermediate products, machinery, equipment and vehicles used for environmental protection, and the environmental activity of all businesses. It also recognises that in a knowledge-based economy, **technology is increasingly about our skills and know-how** rather than the simple presence of industrial processes or high capital spending per employee. Hence, environmental technology includes both **low and high-tech applications**. Boosting the degree of technology inherent in low-tech applications is just as important as boosting it in applications that are already high-tech.

Indeed, environmental technologies are so common and diverse in our economy that defining them precisely is extremely difficult. Because any technology that improves on existing environmental performance is an environmental technology in the sense used here, the definition shifts over time. However, this statistical issue is of secondary importance. **From a policy perspective our focus should be on the use and potential of environmental technologies throughout the whole economic system.** Every investment includes a choice between more or less environmental technologies. This is true even for technologies whose

main driver *is not* the environment. Today, total investment in all technology represents about 20% of GDP[3]. This is the "market" for environmental technology this report is looking at.

Of course, some environmental technologies are driven by environmental considerations, including legislation, rather than by profitability. For such technologies we have data based on the OECD/Eurostat definition of the 'eco-industries'. However, it should be stressed that the activity of the eco-industry defined in this way is mainly a response to the environmental impact of economic activity, and increasing the sector's size should not be seen as a policy objective. In the same way, while an efficient health system is a necessary tool to protect health, it is a means, not an end in itself. Indeed, in the long term a small 'eco-industry', defined in this narrow way, would be a sign that society was organising production and consumption in a sustainable way, and producing less pollution that needed cleaning up.

Other environmental technologies are 'win-win solutions' that allow for both an increase in environmental performance while improving economic performance at the same time. For example, some uses of information technology can allow firms to increase their profitability by improving their use of resources - this may lead to environmental benefits, but was not the main reason for their actions. Technologies such as these can decouple environmental pollution from economic growth, allowing our economies to grow faster while remaining within our environment's limits. By definition, win-win technologies are good for firms' profitability and therefore for growth. However, we cannot easily predict the scope for the future development of such technologies.

For these reasons, **it is extremely difficult to assess the potential contribution to growth of environmental technologies as a whole.**

Unfortunately we do not have data that provides a picture of the use of environmental technology in the broadest sense. We do have data on the narrower 'eco-industries'. While this data cannot be used to derive quantitative estimates of the potential for environmental technologies to add to economic growth, it is still worth examining this narrow segment in some detail, as it paints a picture of an industry that is diverse and dynamic. These data also provide a **rough indication of market trends and potential** in the broader field of environmental technologies**.** But it is important to repeat that the scope of this report is not confined to environmental technologies that are captured in the statistical definition of the eco-industry.

3. THE EUROPEAN ECO-INDUSTRY

A measure of environmental technology, narrowly defined, is possible using the standard OECD/Eurostat definition[4] of the eco-industries as "all activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems".

This definition includes three categories of activities: 1) **pollution management** of both a preventive or remediative nature (such as reducing emissions, reducing environmental risk or clearing up environmental damage); 2) **cleaner (integrated) technologies and products**

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3 European Commission**,** 2001

4 OECD & Eurostat, 1999

which are any activities that continuously improve, reduce or eliminate the environmental impact of general technologies; 3) **resource management** (such as renewable energy and water supply).

Estimates of the size of the eco-industry given here are based on official statistics on environmental expenditure, narrowly defined, across the economy as a whole. There are two main caveats in reading and interpreting these statistics.

- Firstly, all technology affects the environment somehow, so OECD and Eurostat only include expenditure clearly **driven by environmental protection considerations**. This means, in practice, that if a firm develops an engine that is cheaper to run, but that just happens to be cleaner as well, then this is not seen as an 'environmental technology' in terms of this statistical definition.

- Secondly, the data probably **underestimate expenditure on cleaner products and cleaner (integrated) technologies** because of measurement difficulties, such as identifying cleaner products, which means that they are only partially included in the estimates.

It is a particular problem that the data do not capture many win-win solutions, which represent both a business opportunity and improve the environment. As a result, estimates of the size of the eco-industry can only be used as a rough indication of current market developments in some areas more directly related to environmental protection and natural resource management, and they do not capture the full range of environmental technologies in use.

In 1999**,** the overall turnover of the EU15 eco-industry sector was **€ 183 billion** (a figure corresponding to 2.3% of EU GDP) and some **1.6 million people** were directly employed in this sector (1% of total employment)[5].[6]

The turnover of the EU15 eco-industries relating to pollution management, cleaner technologies and products was **€ 127 billion** (equivalent to 1.6% of GDP), employing around 1 million people[7]. Figure 1[8] shows that the biggest area of expenditure is wastewater treatment closely followed by solid waste management. The 'Others' category illustrates the **diversity of the sector**. It includes expenditure on noise and vibration; monitoring analysis and assessment; clean up of contaminated soil; environmental R&D and administration and management. In other words, production of environmental technology is spread across the economy and includes both low and high-tech applications.

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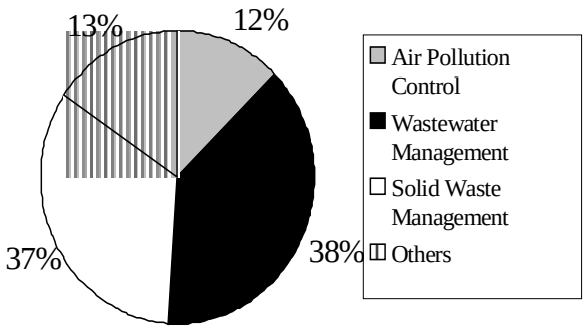
5 Ecotec, 2002

6 The comparison to Gross Domestic Product (GDP) is provided only to indicate the orders of magnitude involved. Turnover and GDP are not directly comparable. In the EU, the best estimate of the share of GDP allocated to environmental protection and resource management is of an order of 3%.

7 Ecotec, 2002

8 Ecotec, 2002

Figure 1: EU15 Pollution Management expenditure by environmental media



Resource management activities accounted for another 650,000 jobs and an additional **€ 56 billion** of turnover (equivalent to 0.7% of GDP) in the EU15[9]. More specifically, this consists of water supply (€ 33 billion), recycling of materials (€ 14 billion), and nature protection (€ 7 billion). These estimates do not include the renewable energy sector. Water supply is a rather mature area of activity for the EU 15, but is **one of the fastest growing market segments in a global context**.

The most reliable data available for identifying EU15 trends relates to 1994 and 1999, for the pollution management and cleaner technologies and products sector[10]. This data show that over those five years the **turnover for this part of the eco-industry grew by an average of 5% real per annum** (compared with an average growth of around 2.5% in GDP). Employment in this sector grew faster than turnover, at a **rate of between 6 and 7% per annum.** This high rate of job creation reflects particularly fast growth in solid waste management, an area of high labour intensity.

BOX 1 - From end-of-pipe solutions to integrated technologies

As Community and national policies were tackling the immediate environmental problems such as managing waste or reducing air and water pollution, their implementation relied strongly on end-of-pipe solutions. It is estimated that on average one-third of investment in environmental technologies is in integrated technologies rather than end-of-pipe solutions, though this share varies between Member States. In the future, we are likely to lean more on integrated technologies that prevent pollution from arising in the first place as we address complex problems such as climate change and resource efficiency.

Integrated technologies are often economically more advantageous as they avoid the extra cost of add-on equipment and lead to more efficient production processes. One objective of policy is to make integrated environmental technologies profitable so that the market will freely support them. The move from end-of-pipe applications to integrated technology solutions should enhance the potential contribution of environmental technologies to Europe's economic development.

9 Ecotec, 2002

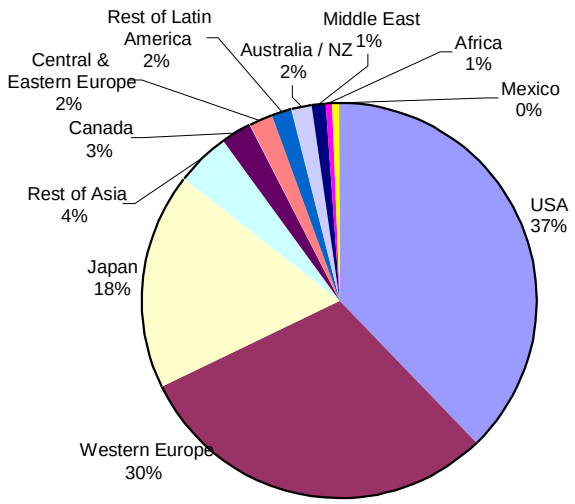
10 Analysis reported in Ecotec, 2002

The turnover of the **Candidate Countries eco-industries** relating to pollution management, cleaner technologies and products is around **€ 10.3 billion** (equivalent to 1.9% of GDP), and with around 770,000 people employed[11]. Real growth in turnover has averaged roughly 10% per annum since 1995 with the need to implement the EU environmental *acquis* being a key driving force. Much of this investment has so far been in pollution management technologies, reflecting the need to invest in an infrastructure that can support sustainable development. However, further growth in investment will still be needed to meet the *acquis,* and growth in investment is not expected simply to stop with accession.

4. THE GLOBAL ENVIRONMENTAL TECHNOLOGY MARKET

According to some estimates the **global market for environmental technologies is worth around € 550 Billion**[12], with the EU making up approximately one third of this market (Figure 2 shows the demand in different regions). The USA, EU and Japan, dominate the global environmental market accounting for 85% of it. The largest export markets for the EU15 eco-industry are the US and the Candidate Countries, followed by South East Asia, South America and the Middle East. Again, these figures should be treated with caution, due to difficulties in statistical definitions.

Figure 2: The Global Environmental Market in 1999



In general, the evidence is that the EU has a **competitive and diverse EU eco-industrial exports sector**, and is a major global player. Official trade statistics are only available for around a fifth of the eco-industry's output but, for this visible portion, the EU had a trade surplus with the rest of the world of over a billion Euros in 1999[13]. Over the last two years though, the trade surplus has declined slightly as other countries develop their own eco-industries - illustrating the pressure on EU firms to stay competitive.

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11 Ecotec, 2002

12 Based on estimates contained in Environmental Business Journal (EBJ) Volume XIII, Number 3/4, 2001, "*The Environmental Goods and Services Industry in the EU to 2010*", IPTS Seville (European Commission), 1999.

13 Ecotec, 2002

BOX 2 - Examples of export success stories

- **Denmark** invested in wind power in the 1980s and is now a world leader exporting a billion Euros worth of wind turbine technology each year.
- **Finland's** eco-industry products (mostly pulp and papermaking technologies) represent around 20% of all Finnish exports.
- **France** is the world's leading exporter of water and waste management services, mainly as a result of the success of two companies, Suez-Lyonnaise-des-Eaux and Vivendi.
- **Germany** has a 17% share of world trade - second only to the USA.
- The **Netherlands** is very export-focussed, with 45% of products and 10% of services exported.
- **Spain** has strong export markets in Latin America (particularly Mexico and Brazil) for products and services in the fields of water purification and wastewater treatment.
- **Sweden has a strong** export performance in the fields of wastewater treatment, indoor air pollution control and cleaner technologies.

It is estimated that between 1998-99 real expenditure on the products of this sector grew by rates of 7-9% in developed markets, whereas growth in developing markets over the same period was higher, at 10-17%, with Africa and Latin America showing the strongest growth[14]. More generally, **many foresight studies predict this will be one of the fastest growing industries in the 21st century[15].**

Given its current competitiveness, and especially if not hindered by market barriers, the European eco-industry seems well placed to benefit from continuing growth in these markets. The EU seems to be particularly competitive in areas such as development of water and wastewater treatment infrastructures, waste management infrastructures and operations, air pollution control technologies and renewable energy goods and services.

For the Candidate Countries, investment will need to grow to between 2 and 3 % of GDP on average to meet the total costs of implementing the environment *acquis*, estimated recently as being at least € 80 – 110 billion[16]. The resulting environmental benefits are estimated to have a total value of between € 130 and € 680 billion over the next 10 years[17]. Both the EU15 and the Candidate Countries should allow these benefits to accrue as efficiently as possible, by ensuring all environmental technology solutions are cheaply available through a competitive market.

The development of this competitive market will be to the **mutual benefit of the EU15 and the Candidate Countries**. Already many EU15 and Candidate Country firms are entering into joint ventures and there is evidence that as a result eco-industries are growing and

14 Analysis reported in Ecotec, 2002
15 OECD, 1999
16 COM(2001)304final
17 Ecotec, 2001

becoming more competitive within the Candidate Countries. Indeed, exports from the Candidate Countries to the EU15 roughly doubled between 1995 and 1999 to € 123 million[18].

BOX 3 – The benefits of technology transfers

Not all of the benefits of trade accrue to the EU. The development of new environmental technology in Europe contributes towards sustainable development **across the world** if these new technologies are shared. In particular, the **EU15's eco-industry can help the Candidate Countries to 'leap-frog'** technology levels, learning from the EU15's past experiences. By developing new technologies that lower the costs of environmental protection, we can benefit both ourselves and others that can make effective use of this technology to tackle their own environmental problems.

However, care needs to be taken that obsolete technologies (such as reconditioned cars and factories) are not dumped in developing countries where environmental regulations are not as strict, or that developing countries are not disadvantaged in other ways. Solutions for climate change and transport problems, in particular, need to be spread and, for example, both the Joint Implementation and Clean Development Mechanism as constituted by the Kyoto Protocol have an implicit technology transfer dimension. There is also scope to promote centres for "appropriate" and "environmental" technology which can help disseminate environmental technologies suited to local needs.

5. THE ENVIRONMENTAL TECHNOLOGIES OF TOMORROW: AN OVERVIEW

Technology in general is a double-edged sword. It is both a cause of a number environmental problems and a key to solving them. Polluting technologies are undermining our basic life support systems – clean water, fresh air and fertile soil. However, **in all economic sectors (transport, energy, industry, agriculture) there are new environmental technologies available or emerging.**

Over the last decade, new technical solutions have permitted the phase-out of harmful, hazardous or scarce materials, replacing them with less scarce and safer materials *(material substitution*). The phasing-out of CFCs in white goods and of chlorine in the pulp and paper industry are only two examples. In many sectors, the development of new high-performance materials has led to significant resource savings and increased recycling (*dematerialization*).

It is not easy to provide a comprehensive map of new inventions, innovations and applications in the field of environment technologies, and this would be out of the scope of this report. However, it is useful to give here a broad picture of the areas where major developments may be expected and where the scope for the use of innovative solutions may be the greatest. The experience of recent years provides robust evidence for this potential, while giving indications about future trends. However, the technologies mentioned below are given only as **illustrations**, and will not necessarily be the best or most cost effective solutions in the long run.

[18] Ecotec, 2002

Energy conversion, conservation and use

Global energy use has risen nearly 70% since 1971[19] and is poised to continue its steady increase over the coming decades. **Worst case scenario estimates are that by 2010 global energy consumption - and CO_2 emissions - will have risen by more than 40 percent from their 1990 levels[20].** Despite a continued fall in energy intensity in most advanced countries, the link between economic growth and increased energy use is far from being broken. The main problem is not the use of energy in itself but the fact that the main source of energy is fossil fuels, which supply roughly 80 per cent of the world's commercial energy[21], with serious effects on the air, the atmosphere and the climate.

The Commission's Green Paper on Security of energy supply[22] outlines options for a future strategy in the framework of the general objectives of Community energy policy, i.e. competitiveness, security of energy supply and environmental protection. A number of the proposals in the green paper are already in an advanced stage of implementation, while others will be launched as part of the Commission's work programme for 2002. The EU's commitment to the Kyoto Protocol is in general a strong driving force behind this policy development.

Certain EU initiatives have been in operation since the early nineties such as SAVE (energy savings, energy efficiency) and ALTENER (renewable energies), whereas others are only in their early stage of implementation such as the agreements on car fuel efficiency with the European car manufacturers and importers. However, renewable energies have been slow to increase in overall terms. Hydropower has little additional potential and **biomass** – the other significant source of renewable energy – has stayed stable in spite of good potential for expansion. **Wind energy** is still at a modest overall level (apart from a few regions), but has shown impressive growth during the nineties (doubling every 2-3 years) and is seen as a major contributor to an overall doubling of renewables to 12% in 2010.

There are also EU initiatives in the pipeline relating to energy conservation in buildings, and the energy efficiency of appliances. Energy conservation techniques have **significant potential for reducing energy demand from the residential and tertiary sectors** (representing 41% of total energy demand[23]). Some estimates suggest that a combination of appropriate building techniques (including thermal insulation, glazing technology, etc.) and new energy management systems could achieve savings in emissions of greenhouse gases from building of up to 20-25% over the next 10 years[24]. In the field of appliances, the challenge is to overcome consumers' preference for lower price at acquisition rather than for lower cost of actual use.

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19 IEA, 2001

20 See, for example: IEA, 2000; US EIA, 2000; IIASA & WEC 1998

21 IEA, 2001

22 European Commission's green paper "Towards a European strategy for the security of energy supply" COM(2000)769

23 ECCP, 2001

24 ECCP, 2001

Transport

Transportation of all types accounts for more than one quarter of the world's commercial energy use (32% in the EU and still rising[25]), with greenhouse gas emissions rising as a result**.** The transport sector is practically 100 per cent dependent on oil and consumes about half of the world's oil production[26]. Energy use per passenger has shown little or no improvement over the last decades. The increasing use of more powerful vehicles and lower occupancy rate has outweighed increases in vehicle energy efficiency. As a result, growing transport volumes have led to a 21% increase in energy consumption between 1990 and 1999[27]. In addition, **the 'external' social and environmental costs of transport are estimated as being around 8% of GDP, and more efficient environmental technology would reduce these costs[28].**

The recent Commission White Paper on the future Common Transport Policy[29] proposes to break the traditional link between economic growth and environmental impact from the transport sector. Important initiatives in this context are improved efficiency in the broadest sense, modal shift towards environmentally friendly modes (rail, inland waterways, short sea shipping), internalising environmental costs in transport prices, promoting alternative fuels and public transport. A number of these measures depend fundamentally on development of environmental technologies, such as **hydrogen/fuel cell vehicles**.

On a broader scale, the use of information technology for the management of transport, or **Intelligent Transport System (ITS),** can significantly contribute to reduced traffic congestion and related environmental impacts. ITS for road traffic management are already operational in various places in Europe, but there is scope for their wider use. The Galileo project will be crucial in realising the full potential of ITS.

Resource use in industrial production

Although the environmental pressures caused by industry are generally decreasing[30], industrial production is a non-negligible source of pollution and industrial emissions have traditionally been subject to regulatory controls. In 1999, **manufacturing industry still accounted for some 28% of total energy consumption and 20% of carbon dioxide and sulphur dioxide emissions in the EU[3132].** According to these European Environment Agency estimates, industrial eco-efficiency in the EU has improved during the last decade, but this result masks diverging trends between individual Member States. Industrial pollutants are particularly characteristic of heavy industries, such as iron and steel, petroleum refining, pulp and paper, and organic chemicals.

There is a big potential to reduce the environmental impacts caused in the production of bulk materials by developing and using technologies that are new, emerging or already commercial. **Examples of significant potential technologies** at an early stage of development include alternative cement-like materials, non-consumable anodes and wetted

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25 EEA, 2001a
26 IEA, 2001
27 Eurostat, 2001
28 INFRAS, 2000. There is a considerable degree of uncertainty in estimates of this type.
29 European Commission's White Paper, "European transport policy for 2010: time to decide", COM (2001) 370
30 EEA, 2001c (notably Figure 1.4 on page 11)
31 EEA, 2001c
32 EEA, 2001b

cathode technology in aluminium production, and smelting reduction in iron making. The use of raw renewable (i.e. plant-derived) materials (RRM) as industrial feedstock is already rather well established in some specific sectors of the chemical industry. A wider distribution of RRM-based products as well as the possibility to produce RRM-based bulk chemicals would substantially help to reduce industrial pollution.

A range of new **biotechnological techniques** is also becoming available and offers the prospect of reductions in raw material and energy consumption, as well as less pollution and recyclable and biodegradable waste, for the same level of production. Biotechnology is considered to be a powerful enabling technology for developing cleaner industrial products and processes, such as biocatalysis. Benefits have been shown for traditional industries like textiles, leather and paper. Bioremediation also has the potential to clean-up polluted air, soil and water: bacteria have been used for a number of years to clean up oil spills and purify wastewater.

Waste management

The European Environment Agency estimates that **over 250 million tons of municipal waste and more than 850 million tons of industrial waste are produced by the EU15 each year**. The annual rate of growth, estimated at around 3%[33], has outpaced GDP growth over the last decade. On the other hand, increased perception of unsustainable trends, reflected in higher charges on waste production and stricter rules on waste collection and disposal, has made waste management a very dynamic field.

Technologies in this field cover **a broad spectrum of treatment methods**, e.g. better collecting devices and vehicles for a more effective recycling of materials like paper, metals and glass; better mechanical separating devices, new large scale technologies for treating organic waste. All together, these new technologies provide a good basis to substantially reduce landfilling and to utilise the generated waste in an optimal way.

Another interesting perspective is that new potential for energy recovery is emerging from various waste fractions (like different kinds of sludge, waste tyres, etc.). This could lead to considerable energy production, though it must be in combination with effective flue gas cleaning systems, to avoid generating noxious air pollutants. The best available technology allows the majority of the energy content in waste to be utilised.

Fisheries

One of the main threats to marine biodiversity is fishing, in particular due to its impact on non-target species and the physical damage to the sea bottom by certain equipment. Considerable progress has been made in the development of sorting grids, deterrents and low-impact bottom trawling. However, **there is considerable scope for further progress in developing equipment** that limits these side effects, and given the worldwide nature of the problems, the eventual technical solutions may have a considerable market. Similarly, the expanding aquaculture would benefit from the development of environmental technology in fields such as foodstuffs, containment, reduction of waste and plague control.

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[33] EEA, 2001b

Information and Communication Technology

The effective orientation and acceleration of **information and communication technology could be a key development**. It could allow greater efficiencies in resource use to be realised by process improvement, product improvement, product to service conversion or structural change.

Process re-engineering for e-business can reduce material use and transport; unused stocks and warehousing can be reduced; better transport and logistics can cut the number of journeys, and empty trucks; more effective use can be made of office and factory space etc[34]. The "information content" of products in terms of their market value has risen faster than their material content has fallen. The further addition of value, through better design, additional features and usability, and the use of more appropriate materials can de-couple growth from resource use.

With advanced communications, other **products could become services**. A newspaper becomes an on-line news service; an instruction manual becomes an interactive technical advice service; access to health care advice and information on-line can improve the quality of care and avoid unnecessary travel. On-line banking provides a more convenient service for many people, without the materials and resources of the retail branches, and the need to travel there.

Overall, the emergence of information infrastructures will change the ground rules of an industrialised society allowing us to make structural changes in the organisation of our transport infrastructures and the way we work and live. Over 10 million people already "telework" in Europe, and about 25% of the workforce used a computer for work-purposes at home in 2001[35]. New workplace designs make better use of space, in more energy efficient buildings, in locations nearer to where people live. Over 50% of European businesses now make use of eWork services provided over communication networks. These changes can help to decouple economic growth from transport growth, and bring new work opportunities into local communities.

6. REALISING THE FULL POTENTIAL OF ENVIRONMENTAL TECHNOLOGIES

The context for targeted policy action

Whilst the potential of environmental technologies is significant, **much of this potential remains unrealised** because of various obstacles which hinder their development and market penetration. Many of the barriers to the introduction and diffusion of new environmental technologies are common to other new technologies. In the development phase, lack of finance for development, risk aversion and uncertainty, insufficient information about the efficiency of the technology, and lack of the necessary expertise are among the factors that limit the development of new technology (see Figure 3).

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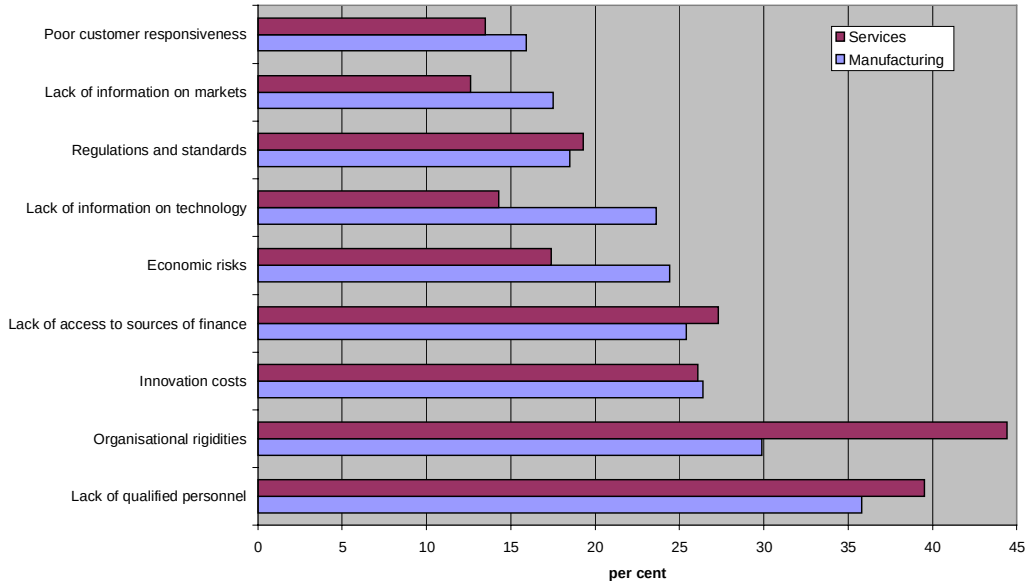
[34] Case Studies of the information society and sustainable development: May 2000 DG-Information Society – C1.

[35] EuroBarometer, Nov 2001: "Quality for Change" A report of the European Commission services – DG-Employment March 2002

These problems are made worse if the regulatory environment is unpredictable. Obviously, economic risks and innovation costs also play a role in this context, particularly for small and medium size enterprises, and once developed, market segmentation and lack of competition can delay the process of diffusion of new technologies. In this respect, **the lessons from general technology policy are entirely applicable to the area of environmental technologies**. [36]**.**

Figure 3: Factors seriously delaying innovating projects[37]



However, **the case for policies to foster innovation in the field of environmental technologies goes beyond the general case for technology policy**. The environment in the form of clean air and water, a stable climate and abundant natural resources and bio-diversity is a common good. Missing, incomplete, or inefficient markets for these common environmental goods mean that the expected rate of return from investments in environmental technologies is lower than it would be if prices reflected the full value of environmental goods or services. This leads to systematic under-investment in innovative environmental technology by both firms and households. This means both that cost effective solutions for environmental problems are not taken up, and that there is less incentive to research and develop such technologies.

In response, Community policies are already promoting environmental technologies in a variety of ways. This includes attempts to "get prices right" by promoting the use of economic instruments. The proposed EU greenhouse gas emissions trading system is a good example. This will create a permanent stimulus to find new ways of cutting emissions in the installations covered, as operators will be able to sell the resulting emission allowances.

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36 The European Commission's Communication *Innovation in a knowledge-driven economy*, COM (2000) 567 of 20 September 2000, reviews recent progress in the Union to stimulate innovation by enterprises, explores what the current priorities should be in order to promote innovation, and defines broad policy lines for pursuing these priorities.

37 European Commission, 2000 'Statistics on Innovation in Europe, 2000

However, despite current policies, it is clear that more needs to be done to address the specific barriers that new environmental technologies are facing to their development and take up.

Policies need to be sensitive to the problems that specific environmental technologies face, as **these problems also vary across the learning curve**. Even when new solutions have been developed, there may be other issues around market penetration which slow adoption and use. In particular, firms and households will not voluntarily adopt environmental technologies that are relatively expensive. This is why a focus of policy has to be on reducing the cost of environmental technologies, so that they can be voluntarily adopted by business as a replacement for older, more polluting technologies.

Indeed, cost factors show one aspect of the **interrelationship between environmental and innovation policies**. In addition, innovation policy needs to pay attention to time-related considerations, notably natural investment cycles. Incorporating environmental advances is least costly when equipment needs to be replaced in the course of the normal investment cycle. For example, the life cycle of a heavy process industry's investment is 20 to 30 years with the moment of investment being an important determining factor for the technology's environmental performance. Choosing the right time to introduce a technology ensures that any impact on growth is made as favourable as possible.

Environmental policy

EU environmental policy can have considerable influence on innovation, and it is important that it makes the most of this influence. For example, by setting policy priorities the Community is providing **clear directions on where new technologies are most urgently needed**.

Increasing predictability and coherence of the legislative framework facilitates long-term and consistent planning and avoids incremental change that drives up costs for researchers and investors alike. In this context, the **6th Environmental Action Programme** "*Environment 2010: Our Future, Our Choice*"[38] identifies four environmental priority areas for the next 10 years: tackling climate change, protecting nature and bio-diversity, improving environmental health and our quality of life and managing natural resources and waste. Specific goals and targets have already been set most notably for action on climate change, including the Kyoto objectives. Specific targets also exist in a variety of environmental legislation.

The 6th Environment Action Programme also recognises the need for environmental policy to **better use the ability of business** to develop innovative solutions that will be adopted in the market and to create proper incentives in the market itself. It acknowledges the **important role of consumers** in influencing the market for environmental technologies. One of the major tools for harnessing business's expertise will be an Integrated Product Policy, which is concerned with cost-effectively reducing products' impacts throughout their life cycle through a range of instruments. This will involve creating the conditions needed for the efficient development and use of environmental technology.

The Directive on **integrated pollution prevention and control (IPPC)** is an important driver for the development and dissemination of environmental technology. Operators of certain industrial installations must apply for a permit based on best available techniques (BAT). The Commission organises a comprehensive information exchange resulting in "BAT reference

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[38] Information about the European Commission's environmental policies can be found at http://www.europa.eu.int

documents" (BREFs) that define the best available techniques at the time. Permit conditions will be updated to reflect changes in BAT. IPPC therefore reflects a dynamic concept allowing for continuous uptake of new environmental technologies.

Voluntary measures can encourage business and households to identify opportunities. One such tool is the Community's Eco-Management and Audit Scheme (EMAS) which encourages companies to continuously assess and improve their environmental management and processes. The EU eco-label provides information to consumers so that they can identify, and reward, environmentally friendly products.

New **environmentally friendly ways of working are of little use if they are not then widely adopted**. The EU Employment guidelines encourage Member States to exploit the employment potential of this sector to the full[39]. The LIFE Programme provides support for innovative and demonstration actions by industry and local authorities. This helps firms to demonstrate the business sense of new environmental technologies.

Energy and transport policies

The energy and transport sectors are characterised by high volume, highly developed and comparatively cheap technology (cars, thermal power plants etc.). New technologies often face an uphill struggle because they will have to go through a technical development process and will initially be produced in much smaller quantities. Wind energy is a relevant case. 10 years ago wind energy was uncompetitive but thanks to financial and other incentives the technology has improved and production volumes increased to the point where costs have come down to levels comparable to fossil fuel based electricity (with optimal wind conditions).

Existing technology also has an advantage by simply being established. Natural gas driven cars can be produced at roughly the same price as gasoline driven. And natural gas costs roughly the same as gasoline. Nevertheless very few would buy a natural gas car because of lack of refuelling points and refuelling points are not being established as long as there is no demand.

Our policies are creating more favourable conditions for the development and market penetration of innovative energy and energy-efficiency technologies in which the EU already enjoys a strong market position. At the same time this contributes to the security of the EU's energy supply and to the attainment of our climate change and other environmental objectives. Similarly, the White Paper on the future Transport Policy[40] proposes a number of measures to improve the environmental performance of transport, partly to shift to less environmentally harmful modes of transport.

Fiscal incentives may enhance energy saving. Wider use of economic instruments and price incentives in both the energy and transport fields, with proper internalisation of external costs, would be an important spur to the take up of cost effective environmental technologies. This idea is already included in the EU employment guidelines, as taxing pollution would allow other taxes, such as those on labour, to be reduced. Employment guideline no. 12 states that each Member State will examine the practicability of and options for using alternative sources of tax revenue, such as taxing energy and pollutant emissions, taking into account the experience with environmental tax reforms in several Member States.

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[39] Employment guideline no. 10

[40] European Commission, COM(2001) 370

Research policy

Objectives and present actions

Industrial production is a key area of human activity, and has been taken into consideration within the 4th and 5th **Research Framework Programmes** (FP4: BRITE EURAM and FP5: GROWTH). The budget of the GROWTH programme is € 2.7 billion. Approximately two thirds of the programme's projects have a clear objective related to sustainable development. In turn, approximately one third of these are mainly aiming at improving the environment by reducing industrial impacts (clean production, eco-efficient processes and design, production with zero waste, life cycle optimisation and material recycling, new light materials).

Research on new industrial technologies or methodologies, and risk prevention aim not only at improving the environment but also at improving cost effectiveness and therefore competitiveness. Through European research programmes, industry and associated research organisations can share the cost of research actions, while using a system-oriented approach, in which chemistry, physics, engineering, life sciences and social sciences are essential and interdependent.

The "Energy and Environment" research programme is also a key research area for the development of advanced environmental technologies for the energy and transport sectors; it also contributes to the development of technologies for the monitoring of environmental policies and sustainable management of natural resources like water and marine ecosystems.

Future EU research actions (2002-2006)

The European Research Area allows **research capacities dispersed across the Member States to be complementary and mutually supporting**. Its principal instrument is the 6th Framework Programme for research, which supports research into new products and services as well as looking for other ways of better applying know-how (for example, how better to manage or monitor environmental activities).

One of the **thematic priorities** of the programme will be "**Sustainable development, global change and ecosystems",** under which funding of more than € 2 billion should be provided over the next 5 years. Amongst other things, this theme will fund research on environmental technologies and, in particular, on sustainable energy, sustainable surface transport and natural resources management.

Another programme priority will target **sustainability of industrial systems**. This priority "Nanotechnologies and nanosciences, knowledge-based multi-functional materials and new production processes and devices") has a budget of € 1.3 billion. It will include a focus on new industrial approaches that reduce the consumption of primary resources (e.g. development of new devices and systems for clean, safe and less carbon-intensive production, sustainable waste management and hazard reduction, and bioprocesses).

In the area of **information society technologies**, research under the heading "work and business challenges" will include a focus on "increasing resource-use efficiency" across the whole range of business activities. The work on "social challenges in a knowledge economy" will continue to explore and develop more resource efficient methods of health-care, e-mobility and environmental management. Additional funding will support **environmental research in such fields as SMEs, biotechnology, agriculture, chemicals and health**.

The key to getting the most out of research spending is the proper exploitation of the results of research and using the public research programmes to **help make new products and services commercially viable**. The Commission will therefore regularly review environmental research needs and priorities to enhance the delivery of robust and applied research.

Trade policy

In November 2001, a new round for trade liberalisation was launched at the 4th WTO ministerial session in Doha. The EU, like many WTO Members, strongly believes that the **multilateral trading system has a key role to play in the achievement of global sustainable development**. The Doha Development Agenda (DDA)[41] will provide an opportunity to maximise the contribution that trade liberalisation can make in achieving sustainable development and globalisation with a human face.

In particular, the DDA provides that, '*in order to enhance the mutual supportiveness of trade and environment, negotiations will start on the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services'*. The definition/classification of environmental goods will need to be refined in upcoming negotiations, while that for environmental services is well positioned for negotiations in the context of the General Agreement on Trade in Services (GATS).

The DDA also provides for the examination of the relationship between trade and transfer of technology, to increase flows of technology to developing countries. An essential component needed to increase these flows will be the enhanced enforcement of intellectual property rights in recipient countries.

In short, trade policy has an important role to play in a sector that has the potential to support sustainable development worldwide, and in which the EU has an important market presence.

7. CONCLUSIONS

As this report shows, **environmental technologies offer a natural bridge between our economic, social and environmental goals**. New and innovative environmental technologies have the potential to raise environmental standards while lowering costs, which would boost economic growth and allow the economy to grow faster without going beyond our environmental carrying capacity. This is central to sustainable development.

Whilst the Lisbon Strategy and existing Community measures will help promote environmental technologies, they are not enough in themselves. To realise the full potential, we need to analyse the market barriers to the use of environmental technologies and tackle them through a mix of targeted policy measures. This is why **the Commission intends to develop an action plan for promoting environmental technologies** along these lines, as announced in the Synthesis Report to the European Council in Barcelona[42].

The Action Plan will build on a **rigorous analysis** of the issues as well as a **broad consultation of stakeholders** from industry, the research community, NGOs and governments, both within the EU15 and the Candidate Countries. The objective will be to

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41 Found at http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_e.pdf

42 European Commission, COM (2002) 14

support the innovation, development and use of environmental technologies that can contribute to growth within the current and future enlarged EU, as well as in developing countries. The Action Plan will involve:

– a survey of promising technologies that could address the main environmental problems

– the identification, with stakeholders, of the market and institutional barriers that are holding back development and use of specific technologies

– the identification of a targeted package of measures to address these barriers, and building on existing instruments

Whilst the work will be ongoing, the first milestones will be the holding of a Stakeholder Forum and then a report on the Action Plan to the 2003 Spring European Council.

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