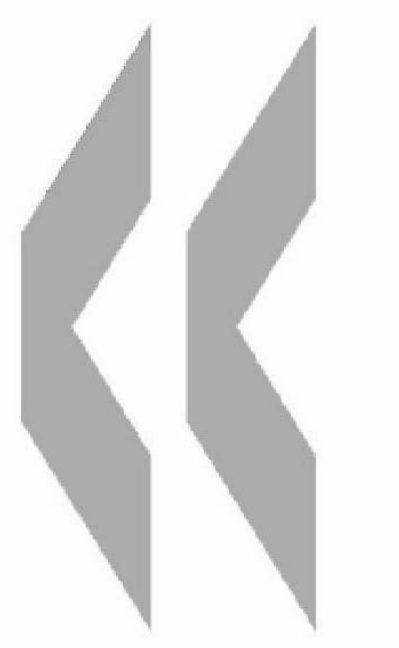

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Identifying Complementary Measures to Ensure the Maximum Realisation of Benefits from the Liberalisation of Trade in Environmental Goods and Services Case Study: Korea

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IDENTIFYING COMPLEMENTARY MEASURES TO ENSURE THE MAXIMUM REALISATION OF BENEFITS FROM THE LIBERALISATION OF TRADE IN ENVIRONMENTAL GOODS AND SERVICES

CASE STUDY: KOREA

OECD Trade and Environment Working Paper No. 2004-03

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ABSTRACT

The extent to which countries benefit from trade liberalization of environmental goods and services largely depends on the country context. This study looks at the situation in the Republic of Korea. Korea began actively promoting its environmental technologies in the early 1990s when the government identified environmental goods and services (EG&S) as one of several strategic national industries. The role of the government was particularly significant in creating demand for environmental services by encouraging private investment including foreign investment in local sewage-treatment projects in areas where local governments cannot secure adequate funding. Two segments of the EG&S industry appeared to provide priorities and opportunities for Korean exporters and importers; wastewater treatment and protection of the ozone layer. In particular, water and wastewater sub-sector has been the most successful exporting industry in the environmental sector in Korea. Experience with Korea also reveals that the effects of environmental imports were positive and they were absorbed without major problems except for some cases where infrastructure based on imported technologies has not been adequately maintained due to lack of domestic expertise.

Key words: environmental goods and services, environmental technologies, trade liberalization, trade and environment, wastewater treatment, ozone layer protection, Korea

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The report is available on the OECD website in English and French at the following URL addresses: http://www.oecd.org/trade and http://www.oecd.org/environment.

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IDENTIFYING COMPLEMENTARY MEASURES TO ENSURE THE MAXIMUM REALISATION OF BENEFITS FROM THE LIBERALISATION OF TRADE IN ENVIRONMENTAL GOODS AND SERVICES

CASE STUDY: KOREA

Executive summary

For the past 30 years, as their country has rapidly industrialised, Koreans have become increasingly conscious of environmental issues directly affecting their quality of life. With a high population density and small land mass, Korea has among the world's highest levels of pollutant emissions per square kilometre. At a time when international pressure for action on global environmental issues is accelerating, Korea's environmental infrastructure in many areas, such as wastewater and solid-waste treatment, remains inadequate by comparison with other developed nations.

The country's first Pollution Prevention Act dates from 1963. In 1979, an Environmental Administration (later to receive full ministry status) was established to co-ordinate activities then carried out by a host of ministries and agencies. The following year the constitution was amended to include the right to live in a healthy, clean environment. Environmental problems grew more serious in the 1980s, and in succeeding years the body of environmental law became larger and increasingly specialised. As of April 2003, the Ministry of Environment (MOE) had direct responsibility for 33 environmental laws, and more than 50 other laws related to environmental issues were overseen by other ministries.

Korea began actively promoting its environmental technologies in the early 1990s when the government identified environmental goods and services (EG&S) as forming one of several strategic national industries. Initiatives include a private-public R&D programme to take Korea's environmental technology to an advanced level. The MOE estimated the total environmental market at USD 8.7 billion in 2000, with services accounting for nearly 40% and annual growth expected to average 13%.

Two segments of the EG&S industry that illustrate the priorities and opportunities facing Korean exporters and importers are those related to wastewater treatment and protection of the ozone layer. The wastewater subsector involves a basic environmental service and probably the greatest financial demands. It is the leading area of privatisation in the environmental sector, is increasingly open to international trade and foreign direct investment, and has been an active, visible exporter of technologies and services. Korea's efforts to replace ozone-depleting substances (ODS) to meet Montreal Protocol targets demonstrate the influence on demand for improved environmental quality of national commitments in multilateral environmental agreements.

The Korean Government has played a significant role in creating demand for environmental services. Since 1997, for instance, it has encouraged private investment, including foreign investment, in local sewage-treatment projects in areas where local governments cannot secure adequate funding. The major foreign-owned players in pollution control are engineering and construction companies affiliated with Korean conglomerates, and companies participating as suppliers or subcontractors to Korean firms. Typically they provide technology or equipment in areas where Korean companies lack technological capability, such as purification and sludge treatment. Assessments of the effects of environmental imports suggest that in general they have been absorbed without major problems, though in some cases infrastructure based on imported technologies has not been adequately maintained due to lack of domestic expertise.

Korea's water and wastewater subsector has been the most successful exporting industry in the environmental sector. A 1996 survey showed that 52% of Korean environmental exports were related to

wastewater treatment. Exports are concentrated in pollution prevention facilities and machinery, followed by whole plants. The bigger firms participating in this trade tended to be construction or engineering companies, which can incorporate environmental facilities into large exports, while most small and medium-sized firms participating specialise in environmental facilities and machinery.

Even before becoming a party to the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, Korea had opted for actively participating in global ozone-protection efforts. Thus, it joined the Montreal Protocol on 27 February 1992, and by the following May had banned imports of the most potent ODS. With a target of halving production and consumption of Annex A substances by the end of 2005 from the 1995-97 baseline, Korea achieved a 69% reduction in Annex A substances between 1992 and the end of 2001.

Since 1992, production of Annex A substances has fallen by 63% and imports by 80%, but for Annex B substances, where Korea pledged to cut production by 85% by 2005, production and imports continued to increase through 2001. Use of Annex C substances (HCFCs) has also been increasing. Research into substitutes for ODS, such as ozone-friendly propellants for fire extinguishers, is being actively pursued.

While it is difficult to generalise, this case study enables several observations to be made about Korea's EG&S market and trade liberalisation: (i) demand-side factors have been more important than supply-side factors in driving environmental quality improvement; (ii) commitments under multilateral environmental agreements have created significant demand for certain EG&S; (iii) for exporters of EG&S, commercial viability, competitiveness on quality and price, and financing availability have been more important than tariff or non-tariff barriers; and (iv) further liberalisation would likely have little effect on services, and varying effects on exports of goods.

Introduction

The combined environmental and economic benefits related to environmental goods and services are perceived as promoting "win-win" outcomes that should encourage governments to liberalise trade in EG&S. Decisions to pursue such liberalisation, however, depend on detailed assessments of individual country needs and the likelihood of benefits accruing to that country. This study looks at the situation in the Republic of Korea.

Financial analyses of the EG&S sector suggest that liberalisation could generate significant economic returns for suppliers and consumers. Factors that foster growth in the EG&S sector include government-initiated regulatory regimes, demands from the general public, and industry initiatives designed to reduce operation and production costs. Another demand-generating factor is education about environmental impacts. For the industry itself, operation and production practices that improve productivity can also affect the demand for EG&S.

This study examines the wastewater sector in detail because it involves an immediate, basic environmental service in Korea and is probably the most demanding in terms of financial resources. It has been the primary focus of privatisation in the environmental industry, is increasingly open to international trade and foreign direct investment, and has been particularly active and visible in exporting technologies and services. The wastewater sector amply illustrates how demand for improved environmental quality has evolved due to the development of national environmental regulatory and institutional mechanisms.

The paper also considers Korea's efforts to replace ozone-depleting substances to meet targets under the Montreal Protocol. This example is used to examine how demand for improved environmental quality has evolved due to national commitments to meet targets through participation in multilateral environmental agreements.

For the purposes of this paper, "environmental industry" is often used to describe the EG&S sector. Many suppliers of environmental services integrate those services with environmental goods, for instance during the manufacture, installation and maintenance of pollution-control equipment. Thus it is not always easy to distinguish between environmental goods and environmental services.

Demand-side factors

Regulatory framework

For the past 30 years, Koreans' awareness of environmental issues directly affecting their quality of life has grown in line with the country's rapid industrialisation. Yet, even as international pressure for global action to preserve the environment has accelerated, Korea does not entirely seem to have met the public's demands for a better environment. Air quality, especially with respect to ground-level ozone, continues to deteriorate in major urban areas, and water quality in major lakes and rivers remains far less than what people desire, while the number of polluting sources continues to increase. Against the standard of other developed nations, Korea still lacks adequate environmental infrastructure in areas such as wastewater and solid-waste treatment. Deficiencies also exist in the nation's land-use policies.

The 1963 Pollution Prevention Act, enacted to address environmental concerns arising from industrialisation, proved ineffective and impractical for managing complex environmental issues, so in 1971 it was drastically revised. Among the measures introduced were emission standards and permits for the construction of polluting facilities. With rapid industrialisation and development continuing through the 1970s, public concern about pollution surged significantly. In response, the 1977 Environmental

Preservation Act introduced several programmes to address environmental problems more proactively and comprehensively and to prevent environmental damage or degradation. In 1980, the Environmental Administration was established to co-ordinate environmental activities for which a host of ministries and agencies had been responsible.

Also in 1980, the Constitution was amended to provide all Korean people with the right to live in a healthy and clean environment. Article 35 states: "All people shall have the right to live a life in a healthy and pleasant environment, and the government and the people shall make efforts to conserve the environment." This provision is at the top of the hierarchy of Korea's system of environmental law. Immediately below it is the backbone of Korean environmental law, the 1990 Basic Environmental Policy Act (BEPA). This Act set out the principles and goals of the national environmental policy, while separate environmental statutes on air, water and waste, along with national and local regulations, provide detailed rules and emission limits. BEPA incorporates the "polluter pays principle," which sets a strict liability standard for environmental harm, and requires environmental impact assessments for certain types of projects.

Spurred by the increasing severity of environmental problems in the 1980s, the framework of Korea's environmental law was transformed in 1990 with the passage not only of BEPA but also of the Air Quality Preservation Act, the Water Quality Preservation Act, the Noise and Vibration Control Act, the Toxic Chemicals Control Act and the Environmental Dispute Settlement Act. At the same time, the Environmental Administration was upgraded to ministerial level as the Ministry of Environment (MOE). Other laws followed, including the Soil Environment Preservation Act, the Drinking Water Act, the Environmental Impact Assessment Act and the Underground Living Space Air Quality Control Act.

As of May 2005 there were 39 environmental laws under the jurisdiction of MOE (Annex A, Table A1), and over 60 other laws relating to environmental issues overseen by other ministries, including the Ministry of Construction and Transportation, the Ministry of Commerce, Industry and Energy, the Ministry of Maritime Affairs and Fisheries, the Ministry of Science and Technology, and the Ministry of Agriculture and Forestry.

The Air Quality Preservation Act sets regulations on air-pollutant emissions from businesses, households and automobiles. The Water Quality Preservation Act regulates industrial wastewater discharges, sets performance requirements for wastewater discharging equipment, and prohibits the dumping of toxic substances and specified other waste into public waters. The Waste Management Act defines waste treatment standards and related licence requirements. The Toxic Chemicals Control Act covers the production, sale, transport and storage of toxic or hazardous substances. The Act on Development and Support of Environmental Technologies promotes the development and diffusion of environmental technologies and the growth of the environment industry.

The government directly regulates industry through pollution standards, licensing, and guidance and inspection. It also employs financial instruments, including the Environmental Improvement Fee, the Emission Fee, the Deposits for Waste Discharge, the Waste Fee and the Water Quality Improvement Fee.

In addition, after conducting a pilot project on corporate environmental reporting, involving 13 businesses with good environmental management records, the government published the Guideline on Environmental Reporting 2002 in May 2002. The objective of the guideline is for each company to publish and disseminate a report disclosing corporate environmental management records, environmental improvement efforts and other environmental information to financial institutions and other interested parties. Meanwhile, academics are developing a more comprehensive corporate sustainability index. All these developments help stimulate the environmental industry.

The following sections provide descriptions of the state of environment, organised by media, of relevance to the environmental industry.

Air

With a high population density and small land mass, Korea has high levels of pollutant emissions per unit of land area, with, for example, NO emissions 2 to 16 times higher than other OECD countries and particulates 4 to 21 times higher. The Seoul metropolitan area accounts for 12% of the country's total land area but 46% of its population and 58% of emissions (by volume), and this density makes urban air quality management particularly difficult (OECD, 1997). The Special Act on Seoul Metropolitan Air Quality Improvement, which was enacted in December 2003, aims to bring the city's air quality into line with that of advanced nations by 2014. Specific steps include strengthening limits on total maximum loads, establishing a management system that takes into account the pervasive nature of air pollution, and drastically reducing automobile pollution.

As Korea's major industries have increased in size and number, the government has more stringently enforced its regulations. Korean companies will therefore need to increase investment in air-pollution control in the process of expanding or upgrading facilities. This is expected to create business opportunities for suppliers of products such as flue-gas desulphurisation and denitrification equipment, high-efficiency dust collectors, motor vehicle emission reduction devices and air-quality measurement equipment.

Water

On 14 March 1991, 30 tonnes of phenol, a toxic chemical, were released into an upper tributary of the Nakdong River near Kumi City. Doosan Electro-Materials Co. was held responsible for polluting this drinking-water source by discharging wastewater contaminated with phenol. This incident dramatically changed Koreans' general perception of environmental accidents and their consequences, and made the Korean Government realise that tighter environmental policies and strict monitoring were required to reduce the possibility of such incidents. Stricter regulatory measures followed during the 1990s, along with the passage of the Water Quality Conservation Act. In 1996, MOE set up a comprehensive water-quality management programme. Since then, government efforts to improve water quality have primarily involved construction of water and wastewater infrastructure and more stringent management of pollution sources. Generally, the public sector has assumed a greater role in stimulating investment in water and wastewater management.

Solid and hazardous waste

Korea's waste-management policy prioritises management approaches in the following order: reduction, reuse, recycling, energy recovery, incineration and landfill. Since the enactment of the Promotion of Saving and Recycling of Resources Act in December 1992, the government has expanded investment in incinerators, landfills and food-waste treatment facilities. Its waste-management policy focuses on increasing incineration rather than landfill capacity. As the available landfill space can only decline, Korea will likely increase research into the application of biotechnology to the management of food waste and other solid waste. The need to revise and strengthen anti-pollution measures rose sharply after the financial crisis of 1997 as an increasing number of corporations engaged in illegal waste disposal in an effort to reduce costs.

Korea introduced a volume-based waste fee system in January 1995, imposing a differentiated charge proportional to the amount of waste generated. Waste is collected in special plastic bags, for which

households pay a price reflecting the average cost of treating the waste. To further encourage recycling, on 1 January 2003 the government launched an extended producer responsibility system, requiring producers and importers of products and packaging material that generate large amounts of waste to ensure that it is recycled.

Soil

Soil contamination, being less obvious than water and air pollution, has accordingly received less attention from the public and the government. Korea approved the Soil Environment Preservation Act in January 1995 and amended it in March 2001. The revised Act is modelled after the United States' Comprehensive Environmental Response, Compensation and Liability Act. It introduced an important system: when land with a soil-contaminating facility is offered for sale or lease, potential buyers or lessees can conduct an environmental site assessment. A key rationale for this system was that potential environmental liabilities associated with poor environmental risk assessment and management had impeded merger and acquisition negotiations with foreign companies after the 1997 financial crisis. Companies have since begun to realise the importance of environmental due diligence.

Industry promotion

Korea began actively promoting its environmental technologies in 1994, following passage of the Act on Development and Support of Environmental Technologies. The government identified the environmental industry as a strategic national industry (others included information technology, biotechnology, nanotechnology and aerospace). The MOE had already begun in 1992 to implement a three-stage, private-public research and development (R&D) programme, called the G-7 Project, to upgrade environmental technology to an advanced level. By 2001, over USD 300 million had been spent in this programme and 331 R&D projects had been concluded. Since 1998, 140 projects have been conducted with an emphasis on commercialising environmental technologies developed through the G-7 Project. As a result, 810 applications and registrations for industrial property rights were filed over 1998-2000, compared with 348 (and 36 applications for product commercialisation) over 1992-97.

Capitalising on the know-how gained in the G-7 Project, a project to develop key next-generation environmental technologies was launched in 2001. Called Eco-technopia 21, it involves 23 programmes in four technology-development areas: integrated environmental management, ecosystem preservation and restoration, pollution prevention, and global environment and climate change. The project is undertaken jointly by private research institutes and businesses with the help of a projected USD 1 billion in government funding over 2001-10, including USD 66 million in 2001 (Annex A, Table A2). Since 2002, foreign research institutes have been allowed to participate through a contractual relationship with the lead Korean institutes.

The government offers two types of environmental investment incentives to industry: tax incentives and low-interest loans. The first involves reductions or exemptions for customs duty on imports of pollution-control equipment. In 2000, for instance, the government granted 70 such reductions and exemptions, covering USD 157 million worth of imports. Tax exemptions are also made for local companies installing imported cleaner production technology. In 2002, the government granted USD 138 million in long-term, low-interest loans to investors in environmental infrastructure and developers of new technologies.

Investment companies, financial institutions and Korea's Small and Medium Business Administration formed an environmental venture fund totalling USD 194 million over 2001-02 to help promising environmental venture companies put their businesses on track and enter the Chinese and

Southeast Asian markets. The Environmental Technology Business Incubator, part of the National Institute of Environmental Research, provides management support in this effort.

Environmental organisations and public awareness

The Korean Government operates 13 environmental commissions under the current environmental laws and regulations. The Environmental Preservation Commission (EPC), headed by the Prime Minister, is the highest-level policy-making institution. The government also operates councils to discuss policy issues with industry, environment-oriented non-governmental organisations (NGOs) and the military. A Presidential Commission on Sustainable Development (PCSD) was established in September 2000 as an advisory body to aid in preparation of the 2002 World Summit on Sustainable Development (WSSD) and to promote the concept of sustainable development more generally.

Hundreds of NGOs influence environmental issues in Korea. The nearly 300 non-profit environmental organisations registered with the MOE as of 2005 include major research institutes, industry associations, academic societies and environmental activist groups. Environmental NGOs have been instrumental in raising public awareness and increasing public participation in environmental decision making. Their involvement in major environmental disputes has led to the creation of faster, more effective environmental dispute settlement mechanisms.

On the industry side, the Korea Environmental Industry Association (KEIA) represents pollution-control contractors and other environmental businesses. KEIA frequently organises events and programmes related to international co-operation and promotion, such as trade missions, technical seminars and conventions. In March 2000, the Korea Environmental Venture Association (KEVA) was established, with a charter membership of 73 environmental start-up companies. With the Federation of Korean Industries playing a key role, the Korea Business Council for Sustainable Development (KBCSD) was established in March 2002 to facilitate industry participation in policy-making in this area.

International environmental co-operation

Korea began seriously to take up global environmental issues in the 1990s. Korea supports sustainable development as a general policy objective. To encourage the participation of the nine major groups emphasised in Agenda 21, 231 local governments (out of 248 nationwide) have initiated Local Agenda 21 programmes.

Korea is a party to 45 international environmental agreements, including the Montreal Protocol, the Basel Convention, the Convention on Biological Diversity and the Kyoto Protocol. It ratified the Montreal Protocol in 1992 as an Article 5 (developing) country, having adopted a law in 1990 to limit the production and use of chlorofluorocarbons (CFCs). Korea has introduced strict quotas on all producers and importers of ozone-depleting substances and offers incentives to promote recycling of CFCs and halons. An active participant in the worldwide effort to save the ozone layer, Korea promotes the retrieval and recycling of CFCs and encourages the use of substitutes. It has announced its intention to ban the production and use of CFCs before 2005.

Korea ratified the United Nations Framework Convention on Climate Change in 1993 and the Kyoto Protocol in 2002. Under its general obligations as a non-Annex I country, it submitted its first national communication in March 1998. A month later, the government established an Interministerial Committee on the Climate Change Convention, headed by the Prime Minister. A variety of measures in accordance with the convention have been developed and implemented.

Korea ratified the Convention on Biological Diversity in 1994 and has finalised a national strategy on biodiversity. It has not yet ratified the Catagena Protocol on Biosafety. As a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Korea has banned trade in bear bladders and tiger parts used in traditional medicine. Korea ratified the Basel Convention in 1994, and is adapting its legislation to implement the OECD Decisions on hazardous waste. In addition to these multilateral environmental agreements, Korea actively participates on issues related to trade and the environment at the World Trade Organization.

Overview of Korea's environmental industry

Volume

As of the end of 2002, Korea's environmental industry consisted of 17 business categories and more than 17 000 companies engaged in some aspect of environment-related business. Environmental expenditure data from the Bank of Korea, the nation's central bank, indicate that the pollution-control market expanded 15-17% a year on average after 1990, reaching USD 7.7 billion in 1997. The market declined to USD 6.6 billion in 1998 but bounced back almost to its previous level at USD 7.1 billion in 1999. Of this amount, government expenditure, mainly on infrastructure construction and management, accounted for 55%, or USD 3.9 billion. Expenditure by the private sector was dominated by industry (USD 2.9 billion), with USD 0.3 billion (4.3% of the total) spent by households. By environmental medium, spending on pollution prevention is estimated at 46% on water and soil, 35% on waste management and prevention, 16% on air pollution and 3% on noise, vibration and other problems.

More recently, the MOE estimated Korea's total environmental market at USD 8.7 billion in 2000, with services accounting for 39%, equipment and parts for 37% and construction and installation for 24%. A 2001 study forecast the market's growth at an average of 13% a year between 1999 and 2005 (Table 1).

Table 1. Market growth projection of Korea's environmental industry

Market sector		1999 (USD million)	2005 (USD million)	Average growth rate %
Environmental services	Solid and hazardous wast	1 800	3 500	11.5
	Water treatment	917	2 000	13.5
	Remediation	360	790	14.0
	Consulting and engineering	62	147	15.5
	Experiment and analysis	67	132	12.0
	Subtotal	**3 300**	**6 600**	**12.5**
Resource utilisation	Recycling	2 200	4 800	13.5
	Water resource use	138	302	14.0
	Energy resources	17	167	46.8
	Subtotal	**2 300**	**5 300**	**14.1**
Technology and equipment	Water treatment	826	1 750	12.5
	Air-pollution control	729	1 500	11.3
	Waste management	226	523	15.0
	Preventative technology	17	108	36.6
	Monitoring equipment	24	53	13.8
	Subtotal	**1 900**	**3 800**	**12.7**
Total		**7 500**	**15 700**	**13.1**

Source: Samsung Global Environment Institute Projection, in Park and Kim (2001).

Korea's efforts to develop environmental technology are focused on engineering and construction, mainly for infrastructure such as municipal wastewater treatment plants and incinerators, though sewage

sludge treatment is also a particular focus of the government and Korean companies. Environmental services, along with ecosystem remediation and pollution-prevention technologies, can be expected to grow as Korea shifts from end-of-pipe technology to more proactive and preventive strategies.

A 2001 MOE survey showed that almost 95 000 people were employed in the EG&S industry, including 1 711 research personnel. There were about 13 500 holders of environmental licences, most of them employed in the water and wastewater industry (36%), air pollution control (22%) and waste management (7%).

Imports

In general, Korea lags far behind the advanced industrial nations in terms of technological capability in the environmental sector. The gap is largely attributable to its short history of environmental management and the difficulties it has encountered in trying to develop basic environmental technologies. Thus, to date, Korea has largely depended on foreign suppliers of environmental technology, mainly from Japan, the United States, Germany and other European countries (Annex A, Table A3).

During the Uruguay Round, Korea made commitments under the General Agreement on Trade in Services (GATS) on five categories of services related to environmental technology: wastewater treatment, industrial waste treatment, exhaust gas purification, noise control and environmental impact assessment. Except for limiting the number of wastewater-treatment suppliers and imposing an economic needs test for the establishment of a commercial presence in industrial waste treatment, no restrictions on market access or national treatment were imposed. Korea indicated in its initial offer for the GATS negotiations, in April 2003, that the limitations would be removed. Korea appears to have no regulations or policies restricting foreign suppliers of services linked to environmental technologies from entering its market.

Foreign environmental engineering firms and equipment manufacturers usually participate in the Korean market for major environmental projects as subcontractors to large Korean companies or as providers of specialised technology. The Korea Investment Service Center estimates that imports account for 46% of the environmental technologies Korea uses in waste treatment, 26% in engineering, 17% in water and wastewater treatment and 11% in pollution measurement and evaluation technology.

Regarding technical capabilities of Korean firms, some leading Korean environmental companies have started commercialising technologies such as dust filtration and desulphurisation equipment. Other first-generation post-treatment technologies (e.g. dust collection, advanced wastewater treatment, small-scale incineration) are in the demonstration stage, achieving pollution-abatement levels 60-80% of those achieved in the most-advanced nations. The MOE's general assessment is that the nation's environmental technology performs in the range of 40-70% of the levels found in the most advanced countries.

Exports

Korea started exporting environmental equipment to Asian countries in 1990. A study by the Korea Investment Promotion Agency (KOTRA) showed total exports amounting to USD 3.8 billion in 1998, up from USD 50 million in 1994. Some 83% of exports went to South-east Asia (e.g. Malaysia, Thailand) and South Asia (mainly India). In 2001, China became the leading destination, accounting for almost half of the traded value. Goods and services within the water and wastewater group comprised 52% of the total, followed by air-pollution control (26%) and waste management and recycling (16%). Most of the trade was in components for air-pollution control, such as bag filters and electrostatic precipitators, and water-pollution control, such as sedimentation and reverse-osmosis equipment. Overseas projects related to

construction of environmental facilities increased from USD 0.6 million in 1990 to USD 63 million in 1995.

An MOE survey in 2001 indicated that Korea exported USD 380 million in 2000, up from USD 307 million in 1999, with environmental goods accounting for 68% and environmental equipment and parts for 32%. MOE surveys in 2002 and 2003 show consistent increase in environmental exports; USD 4 018 and 5 819 respectively.

Case 1: Wastewater management

Background

Korea's legal framework and government policy regarding water and wastewater experienced considerable change and progress in the 1990s. First came the 1990 Water Quality Preservation Act, followed by the 1991 Act on Treatment of Sewage, Excreta and Livestock Wastewater. In 1993, the MOE introduced Comprehensive Measures for Clean Water Supply for 1993-97, and the government streamlined its complex interagency process for dealing with environmental issues by giving MOE greater power. Meanwhile, a series of water-pollution incidents in major rivers, notably the 1991 phenol pollution of the Nakdong River, had raised national concern over drinking water safety, and pollution-prevention measures for major river basins were significantly stepped up (Annex A, Table A4).

In 1996, the MOE launched the ten-year Comprehensive Measures for Water Management and has since taken various measures to protect aquatic environments and improve the management of water resources. The 2002 Acts Relating to Water Resource Management and Community Support for the Three Major Rivers and the 1999 Act Relating to Water Resource Management and Community Support for the Han River give legal backing to the Comprehensive Measures for Water Quality Improvement of the Four Major Rivers. Water-quality standards were set for pH, biological oxygen demand, chemical oxygen demand, suspended solids, dissolved oxygen, E. coli, lead, hexavalent chromium, polychlorinated biphenyls and alkylbenzene sulphonate.

Korea's system of charges for pollution discharges was initially not structured so as to deter polluters significantly. Introduced in 1983 to punish violations of regulatory standards, the charges were based on excess emissions beyond an acceptable level of toxicity rather than on the total volume of pollutant discharged. Some polluters diluted their wastewater and thus paid no charges because the discharges fell below the limit. In 1997, the system was changed so that total emission charges now combine a basic charge with a surcharge on excess emissions.

Over 1993-2001, government expenditure on wastewater treatment, sewerage and other projects to improve water quality totalled some USD 14 billion. The current long-term plan calls for the MOE to invest about USD 25 billion over 1996-2005 on infrastructure projects to improve water quality. Table 2 presents the goals of the long-term plan while Tables 3 and 4 show Korea's environmental infrastructure and investments in infrastructure projects as of 2001.

Table 2. Major goals of the Comprehensive Measures for Water Management 1996-2005

Indicator	1996	2005	Remark
Percentage of municipal wastewater treated	50	80	Based on population served by public treatment
Percentage of livestock wastewater treated	42	74	Based on public treatment
Percentage of industrial wastewater treated	73	90	Based on public treatment in industrial estates

Source: MOE, 2002a.

Table 3. Investment in environmental infrastructure projects, 2001

Type	Value (billions of won)	Units.	Capacity ('000 tonnes)
Municipal wastewater treatment	946	13 projects	829.3
Sewerage maintenance	708	2 200 km*	n.a.
Night soil treatment	62	7 projects	2.2
Industrial wastewater treatment	60	11 projects	108.7
Livestock wastewater treatment	52	3 projects	0.9
River clean-up	71	42 rivers**	n.a.
Total	1 899	31	941.1

* total length in kilometres
** number of rivers
n.a. = not applicable
Note: Average exchange rate in 2002: 1 USD = 1 200 Korean won
Source: MOE, 2002a.

Local governments are responsible for building and operating public sewer systems, while the MOE has the authority to approve municipal wastewater treatment projects in consultation with the Ministry of Construction and Transportation. Some local governments use their own companies to operate municipal sewer systems. Regional governments are responsible for issuing approvals for construction of sewage pipelines.

As the volume of municipal wastewater discharged has grown, the government has increased investment in municipal wastewater treatment facilities. In 2001, 184public sewage treatment plants were operating nationwide, treating 73% of total municipal wastewater, up from 42% in 1994 (Table 4). As the government aims to raise the percentage of sewage treated to the level achieved in other OECD countries (e.g. Germany with 89% and the Netherlands with 96%), the market for EG&S in this area can be expected to show strong, continuous growth.

Table 4. Trends in public sewage treatment in Korea, 1994-2001

	1994	1996	1998	2000	2001
Population ('000)	45 512	46 426	47 174	47 977	48 289
Population connected to treatment ('000)	19 081	24 420	31 099	33 843	35 369
Percentage connected	42	53	66	71	73
Number of plants	57	79	114	2172	184
Total capacity ('000 tonnes/day)	9 391	11 452	16 616	18 400	19 230

Source: Ministry of Environment, Korea (2002a).

The government has amended the 1990 Water Quality Preservation Act seven times to meet changing environmental conditions and needs. The number of discharging businesses rose from 37 621 in 1998 to 48 876 in 2001 (Annex A, Table A5). Between 1983 and 1991, the government built six industrial wastewater treatment plants in major industrial estates. Since 1997, it has provided subsidies covering half the cost of installing new wastewater treatment plants in selected industrial estates.

In 2001 alone, 35 industrial wastewater treatment plants were built nationwide with total daily capacity of 694 000 tonnes, equivalent to 61% of the volume of industrial wastewater discharged that year. Establishments discharging small volumes are allowed to contract treatment to specialised firms instead of installing their own dedicated treatment plants. In 2001, 51 such firms were registered with local environmental agencies.

Table 5. Status of Korea's wastewater treatment infrastructure (2001)

Type		Total
Wastewater treatment	Number of plants	184
	Capacity ('000 tonnes/day)	19 230
Night soil treatment	Number of plants	187
	Capacity ('000 tonnes/day)	32
Industrial wastewater treatment	Number of plants	117
	Capacity ('000 tonnes/day)	754
Livestock wastewater treatment	Number of plants	39
	Capacity ('000 tonnes/day)	10
Total	Number of plants	**527**
	Capacity ('000 tonnes/day)	**20 026**

Source: Ministry of Environment, Korea (2002a).

Market influences

The Bank of Korea estimated the turnover in Korea's market for water and wastewater services at USD 3.3 billion in 1999, representing 46% of the whole environmental market. The government spent USD 2.2 billion that year on managing water quality and wastewater,[1] and industry spent USD 0.9 billion on the control and treatment of water and wastewater.

Over 2000-05, MOE planned to invest USD 230 million in developing environmental infrastructure for wastewater treatment: USD 214 million for sewage treatment plants and USD 16 million for facilities to treat livestock wastewater (Annex A, Table A6). The MOE's budget for the improvement of water quality and wastewater management for 2003 was USD 268 million, a 5% decrease from 2002.

Total investment in wastewater treatment projects by industry peaked at USD 498 million in 1996. Investment declined to USD 216 million in 1999, but operational spending increased, reaching USD 607 million in 1999 as business activities expanded.

In 2001, Korea's pollution-control industry conducted 1 443 public and private water-pollution projects valued at USD 617 million (MOE, 2002b). Of the 988 contractors licensed to build pollution-control facilities, 501 were qualified in water and wastewater treatment. Major contractors typically hold licences for all types of pollution control: air, water, and noise and vibration abatement. There are 47 such general environmental contractors, many of them divisions of large engineering and construction companies. The major players are engineering and construction companies affiliated with Korean conglomerates such as Samsung, Hyundai, LG, Lotte, Ssangyong, Keumho, Doosan and Dongbu, along with independent construction firms such as Dong-Ah, Namkwang and Limkwang.

Foreign firms usually participate in sewage-treatment infrastructure projects as suppliers or subcontractors to Korean firms. Typically they provide technology or equipment in areas where Korean companies lack technological capability, such as purification and sludge treatment. Companies include the U.S. firms Black & Veatch, CH2M Hill and CDM, the French firms Degremont and Veolia Environnement, and Stantec of Canada. Korea's environmental technology has advanced largely through licensing agreements with foreign firms.

EG&S imports have been facilitated by unilateral trade liberalisation rather than any regional instruments. Multilateral instruments such as GATS have also affected the Korean market. Korea has eliminated almost all import barriers to trade in environmental services. For instance, in sewage services, the only restriction Korea imposed under its GATS commitments was related to commercial presence, where the number of foreign suppliers are limited to 25. The government expects to re-examine such limitations in connection with further GATS negotiations.

Korea has strengthened its protection and enforcement of intellectual property rights for foreign exporters and investors since the 1990s. By 1996, 76 licensing agreements had been filed for water-pollution control. Similar statistics are unavailable from 1997 on, as licensing arrangements were deregulated in 1996. It is likely, however, that the number of technology transfers increased because of this regulatory reform. In the past, Japanese firms dominated the market for imported pollution-control technologies, including water-pollution control, with an estimated share of 50-60%, followed by U.S. companies with 20-25% and European firms with around 20%. The market for water-filtration equipment

[1] Government investment in water and wastewater infrastructure increased from around USD 1.2 billion in 1995 to USD 2 billion in 1997, then declined to USD 1.6 billion in 1998 as a result of the economic crisis before rising 7% to USD 1.7 billion in 1999.

shows a similar pattern (Annex A, Table A7). The competitiveness of foreign firms depends on superior technological capabilities and attractive financing terms.

Several foreign firms have entered the Korean environmental-infrastructure market via partnerships with major Korean contractors. In January 2000, Samsung's Construction Division announced a joint venture agreement with Operations Management International, Inc. (OMI), a subsidiary of CH2M Hill, to pursue sewage-treatment projects undergoing privatisation. Samsung stated that OMI would provide financing and transfer advanced technologies for sewage treatment. LG Engineering & Construction has introduced technologies from several Japanese and U.S. companies in sewage treatment and waste incineration (U.S. Dept. of Commerce and USAEP, 2002). Samsung Engineering has a strategic alliance with Veolia in a bid to become a major supplier in wastewater management in Korea, and the companies may establish a joint venture (Water Resources Environmental News, 2002).

The government has played a significant role in creating demand for environmental services, including through its encouragement of participation by private companies, especially foreign companies. The 1999 Act on Private Capital Inducement on Social Overhead Facilities allows private investment in sewage-treatment projects in areas where local governments cannot secure enough funding locally. Privatisation of sewage treatment plants began in 1997; 72 of 150 plants are operated by the private sector, and 16 out of 228 private sector participation (PSP) projects are now in operation. The privatisation of a sewage-treatment project requires an agreement between the MOE and the local government. The state-run Korea Environmental Management Corporation (KEMC) provides technical and operational support to local governments in managing environmental infrastructure. As the OMI-Samsung partnership shows, privatisation offers opportunities for foreign companies to enter or grow in Korea's environmental infrastructure market. The 1998 Foreign Investment Inducement Act paved the way in this direction.

For areas that badly need sewage treatment but lack local funds, the MOE, local government agencies and KEMC have signed an agreement to attract private capital to build sewage treatment plants. Pilot projects underway through this agreement involve 15 businesses in 12 cities and counties. The local government agencies involved receive preferential loan terms from the government. Tables 6 and 7 show the status of sewage treatment plants consigned to private companies.

Table 6. Pilot projects to attract private capital

Number of cities and counties	Number of projects	Facility capacity (tonnes/day)	Project cost (hundred million won)		Amount of attracted private capital
			Total	Central Government	
12	15	167 000	3 057	1 520	1 537

Source: Ministry of Environment, Korea (2002a).

Table 7. Sewage treatment plants consigned to private companies (2001)

Category	Number of treatment plants	Capacity ('000 tonnes/day)
Sewage treatment plants under construction or in operation	184	19 230
Sewage treatment plants consigned to private companies	91 (49%)	9 836 (51%)

Source: Ministry of Environment, Korea (2002a).

Assessments of the effects of allowing EG&S imports into Korea vary. According to Park and Kim (2001), Korea has generally absorbed imported environmental technologies without many problems. Some technologies, however, may have been introduced without due consideration of domestic circumstances or without sufficient prior testing. In some cases, infrastructure based on imported technologies has not been adequately maintained because of a lack of domestic technical experts. Moreover, because 58% of the Korean-foreign partnerships in this area have been technological alliances based on licensing agreements, rather than joint projects (22%) or joint ventures (4%), the transfer of technology to the domestic industry has been less than it might have been.

Imported technologies have nevertheless helped improve quality in Korea's environmental industry. A 1996 KOTRA survey indicated that most Korean environmental firms acquired their technological expertise either by importing technologies (21%) or by imitating existing foreign or domestic technologies (31%). Nevertheless, many companies (42%) developed their own technological expertise (KOTRA, 1996). The imported content of the environmental products and facilities that Korea's environmental industry produces is reported to be considerably less than 50%, and for more than half the companies the proportion is less than 10%. In some subsectors, such as water and wastewater, Korean technologies are gradually replacing imported ones.

Exports

Korea's water and wastewater industry has been the most successful part of the environmental sector in technology exports. For example, Vikowa, a Korea-Vietnam joint venture,[2] successfully bid on a build-operate-transfer (BOT) contract to build and supply equipment for the fourth phase of a water supply project in Hanoi with a total estimated cost of USD 48 million (of which USD 32 million was covered by World Bank loans). Another example involves a sewage treatment technology developed by Hana Co. of Korea with the China Environment Science Society, which set up a joint venture company in Beijing to exploit it. Called advanced molecule-decomposition technology, the innovation can be used in treating wastewater from coal carbonisation and from the dye, pharmaceutical and oil refining industries, as well as municipal sewage.

The 1996 survey by KOTRA showed that 52% of Korean environmental exports were in the wastewater subsector. By type of goods exported, a majority were pollution-prevention facilities and machinery (60%), followed by whole plants (17%). The bigger firms participating in this trade tended to be construction or engineering companies, which can incorporate environmental facilities into larger plants. Most of the small and medium-sized enterprises (SMEs) involved were specialised in environmental

2 Vikowa is a joint venture between the Kolon Company of Korea and the Vietnam Import-Export Construction Corporation, Vinaconex.

facilities and machinery. Environment-friendly goods accounted for 11% and environmental technologies for 8% of total Korean exports in 1996.

Some 36% of Korean environmental exporters saw themselves in 1996 as competitive in terms of both technology and quality, while 21% reported that they considered their prices competitive. Some pull factors on the part of trade partners seem to be important as well: 13% of Korean firms reported that existing networks in recipient countries were a key factor in their decision to export, followed by recognition (7-8%) and incentives (2%) in importing countries.

The major obstacles to exports reported were insufficient market information (35%), shortages in financing (29%), lack of recognition of product or service in the receiving country (16%) and difficulties in import or export procedures (12%). The 1996 KOTRA survey showed that external barriers such as tariffs and regulations were relatively insignificant. First indicated that they relied considerably on services provided by the Korean Government, such as market information, training programmes and advice on foreign standards and regulations.

KEIA (2002) identified several potential barriers to exports of EG&S to China. It indicated that: (i) government procurement favoured local firms for many environmental services; (ii) small and medium-sized projects initiated by local governments were often limited to local bidders; and (iii) China was increasingly encouraging foreign investment based on BOT contracts, including for sewage-treatment projects initiated by local governments. Although these barriers are regulatory in nature, they can be overcome with adequate financing.

Korean SMEs have had a relatively difficult time laying the groundwork necessary to do business overseas, with financing being a particular problem. The Export-Import Bank of Korea, through the Economic Development Co-operation Fund (EDCF), has provided loans for projects in developing countries since 1987. The loans have helped finance investments of around USD 200 million a year. In 2001, wastewater and sewage-treatment projects accounted for 8% of EDCF turnover and other environmental projects for a further 6%. KEIA has recommended increasing EDCF funding for environmental projects, making the terms more favourable and streamlining the application process.

Case 2: Montreal Protocol and Korea

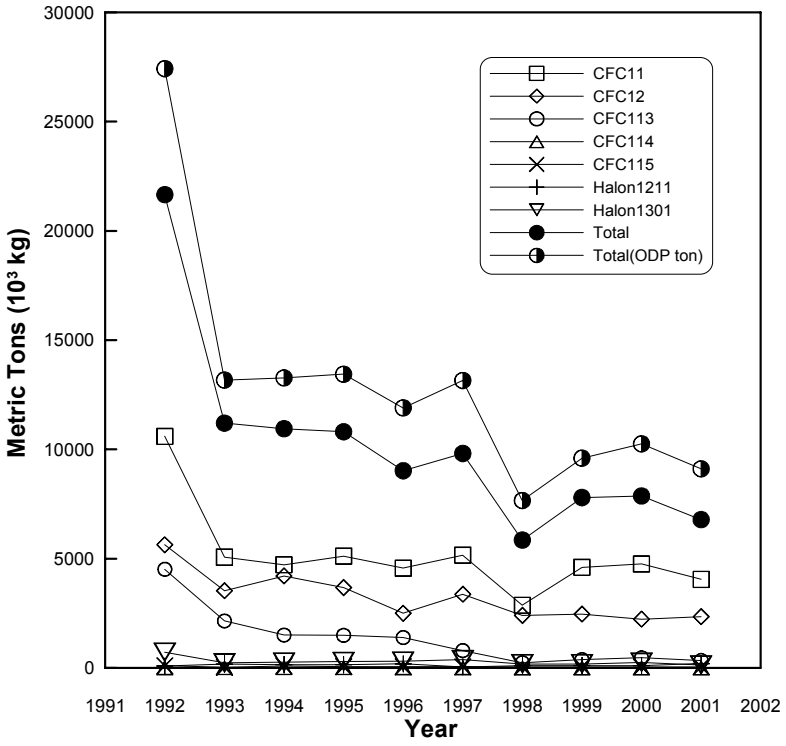
On 27 February 1992, Korea became a party to the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. As an Article 5 country, it could delay implementation of provisions to control ODS. Given the urgency of the situation, however, with the phase-out of CFCs and halons accelerated after studies indicated that the ozone layer was being depleted faster than expected, the Korean Government had opted for more active participation: in January 1992 it enacted laws to regulate ODSs, and as of May 1992 it banned imports of CFC-11, CFC-12 and halons.

The government's basic plan called for halving production and consumption of Annex A substances by the end of 2005 from the 1995-97 baseline. To allow a smooth transition, the plan was for reductions of just under 10% a year over 1998-2004. Korea in fact cut its output and use of Annex A substances by 69% between 1992 and 2001 (Figure 1). Under the Ministry of Commerce, Industry and Energy (MOCIE), a committee established to carry out the ODS phase-out plan sets limits on overall production and consumption, and ODS imports and sales are in turn regulated within these limits. The committee also sponsors technical seminars and workshops.

An important part of Korea's phase-out strategy is its licensing system, which since 1992 has controlled the production, export and import of substances regulated under Annexes A, B and E of the Montreal Protocol, with Annex C substances included since January 2005. All producers, exporters and

importers of regulated ODS must be licensed by the minister of commerce, industry and energy. MOCIE administers the system. By 15 November of every year, applications for licences to import specific substances for the coming year must be filed with the minister. Annual quotas for such imports are allocated in proportion to the total allowable amounts specified in the phase-out schedule. In addition, firms exporting or importing substances regulated under Annex B (CTCs) or Annex E (methyl bromide) must obtain a separate licence for each shipment.

Figure 1. Annual consumption of Annex A substances in Korea



To stimulate efforts to reduce ODS use and develop alternatives, MOCIE set up a revolving fund financed by a tax on output and imports of Annex A substances, at rates ranging from USD 00.015 to USD 00.30 per kilogramme. By the end of 2000 the fund had grown to USD 30 million. The Korea Specialty Chemical Industry Association (KSCIA) was assigned to manage the fund and co-ordinate other ODS-related activities. Loans for R&D have been provided to national institutes such as the Korea Institute of Science and Technology (KIST) to help them develop alternatives to ODS and technologies for destroying CFCs. Despite such efforts, some businesses have complained of problems in adapting to the restrictions.

Impact on production, exports and imports

Domestic production of Annex A substances fell by 63% between 1992 and 2001. Imports of Annex A substances fell by nearly 80% between 1995 and 2001, from 1 645 tonnes to 353 tonnes. Exports have stayed at around 1 000 tonnes a year.

The situation with regard to Annex B substances stands in sharp contrast. Korea pledged to cut production by 85% by 2005. As of the end of 2001, however, production and imports were still increasing.

The quantity seems to be determined by market demand for products such as refrigerators that contain HCFCs, since Annex B substances are used as raw materials in the production of HCFCs.

HCFCs, which were the first CFC substitutes, are regulated under Annex C. The goal for highly advanced countries is to phase out HCFCs by the end of 2030 (developing countries have until 2040), reflecting an inevitable short-term increase in consumption. Korea's use of Annex C substances has been gradually increasing, from 11 418 tonnes in 1995 to 17 045 tonnes in 2001.

Substitutes for ODS

The situation for substances not regulated by the Montreal Protocol is more complex. HFCs are now the main substitute for ODS. Korea's consumption of HFC-134a, all of it imported, rose from 2 936 tonnes in 1997 to 3 997 tonnes in 2001 (Table 8). HFCs, used particularly in refrigeration, are also used heavily by the electronics industry. Although electronic products are not classified as environmental goods per se, they must often meet environment-related requirements. As CFCs render a product unsalable in most export markets today, manufacturers have turned to HFCs.

Table 8. Korea's imports of main ODS substitutes, 1997-2001

(tonnes)

Substance	1997	1998	1999	2000	2001
CFC-116 (C_2F_6) or PFC	147	149	163	189	189
HFC-152a	13	-	32	218	107
HFC-134a	2 936	2 213	3 331	3 899	3 997

Source: Korea Specialty Chemical Industry Association (KSCIA).

Consumption of PFCs, used in making semiconductors (Korea is a leading producer of dynamic random-access memory), has been growing as well. Their use rose from 147 tonnes in 1997 to 189 tonnes in 2001 and is expected to continue increasing in proportion to production of semiconductors, refrigerators and air conditioners. HFCs and PFCs are among the six greenhouse gases covered by the Kyoto Protocol. Their global warming potential is up to 3 000 times that of CO_2. Thus, cutting their consumption is a global imperative if the Kyoto targets are to be met. The semiconductor industry and the Korean Government, unable so far to find a technical and financial solution to this problem, hope it will be resolved through international co-operation on technology development.

Markets for substitutes

The foam-blowing agents CFC-11 and CFC-12 are most frequently used in newly industrialising countries, including Korea. Their use has been decreasing as manufacturers making the transition to other foam-blowing agents, such as HCFC-141b and cyclopentane. Among the countries to which Korea targets exports of CFC-11 and CFC-12 are the Philippines, Venezuela and China. Exports to China have been rising.

Table 9. ODS substitution trends in Korea

ODS	Use	Markets, trends	Substitutes
CFC-11	Foam blowing agents	Increasing demand, early banning of HCFC-141b	- HCFC-141b/142b - CO_2, H2O - HFC-134 - HC (cyclopentene)
	Refrigerants (refrigerators, cars)	Decreasing use of ODS	- HFC-134a - CO_2, HC-600a
	Home air conditioners	HCFC-22	- R-407c, R-410a
CFC-113 1,1,1-TCE	Aerosols Cleaners (electronics, semiconductors)	Increasing demand for substitutes	- HFC, MDI, OPI - H_2O, HC - No-cleaning systems - NAF, HFC-227
Halons	Fire extinguishers		- CO_2, powder - PFC, Inergen

Source: KSCIA.

Research into a mix of substitutes is being actively pursued. As ozone-friendly substances are increasingly used as refrigerants in refrigerators and car air-conditioners, a shift towards HFCs or CO_2 combined with HC is taking place. Efforts to develop ODS substitutes for semiconductor manufacture have been promising. A process for producing semiconductors without washing would be a technological breakthrough, furthering the aims of not only the Montreal Protocol but also the UNFCCC. While Korean firms have not yet achieved this goal, the market for EG&S related to ozone-friendly semiconductor production is expected to grow.

Another area of active research in Korea is the search for substitutes for propellants used in fire extinguishers. The market for fire extinguishers using substitutes such as CO_2, powder or PFC is also expected to grow.

The Link between the Montreal Protocol and EG&S

Eliminating ODS in the production of refrigerators and air conditioners has been a major challenge for the companies making these products, particularly given that procedures for verifying and certifying products' environment-friendliness can create technical barriers to trade. Korean manufacturers are concentrating their technical know-how and strategies on meeting importers' environmental requirements. To develop ozone-friendly products, Korea's electronics industry has been struggling with trade-offs involving economics and safety. For example, substituting foam blowing agents and refrigerants that are not regulated under the Montreal Protocol reduces products' thermal efficiency and thus increases electricity demand, making the products less economical to use. Safety weaknesses associated with ODS substitutes include the risk of fire or explosion, and there are many obstacles to overcoming these. Further research is needed to address such problems.

Conclusion

It is difficult to generalise about Korea's EG&S market in relation to trade liberalisation, but this national case study allows several observations to be made. First, demand-side factors have been more important than supply-side factors in driving environmental quality improvements in Korea. As the public

has increasingly become environmentally conscious, and the government responded with a stronger environmental regulatory regime, demand for EG&S has naturally grown. Second, commitments to comply with multilateral environmental agreements have created significant demand for certain EG&S. Korea's export-oriented industries, in particular, have adapted to meet product standards of importers as well as domestic environmental targets. Korean manufacturers of electronic goods, for example, have made significant technical improvements and innovations in developing natural refrigerants. Third, commercial viability, competitiveness on quality and price, and availability of financing have been more important for exporters in Korea's environmental industry than tariff or non-tariff barriers. Further liberalisation in EG&S can be expected to affect various segments of Korea's environmental industry in different ways. Little impact is expected in environmental services because most trade barriers have already been eliminated, or soon will be, under the country's GATS commitments. For suppliers of environmental goods, it is difficult to say conclusively at this point what the effect would be of further tariff reductions (the current average on environmental goods is 8%, but some tariffs are already as low as 4%). A group of experts interviewed for this study speculated that further reductions in tariffs could have negative consequences for producers that have not yet developed competitive skills and technologies, but that, for Korean companies that have acquired technical expertise, as in some areas of air-pollution prevention and water and wastewater treatment, the impact would be minimal.

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ANNEX A. TABLES

Table A.1. Environmental standards and relevant laws by sector

Sector	Environmental Standards	Relevant Laws
Water Quality (rivers, lakes, underground water, marine areas)	Drinking water Effluent water quality Wastewater discharge	Basic Environmental Policy Act Water Quality Water Quality Preservation Act Act on Treatment of Sewage, Excreta, and Livestock Wastewater
Air Quality	Air emission Emission by manufactured motor vehicles Emission by motor vehicles in operation	Air Quality Preservation Act
Noise and vibration	Manufacturing plant noise and vibration Automobile noise	Noise and Vibration Control Act
Soil Preservation and Toxic Chemicals Management	Soil contamination Restrictions on growing agricultural and fish products Designating toxic substances and other hazardous substances	Soil Environment Preservation Act Toxic Chemicals Control Act

Source: "2002 Environment White Paper," MOE (2002a).

Table A.2. Investment in environmental technology development project

(Hundred Million Won)

	R&D Funding Updates										
	Total	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total	4,364	66	189	301	382	553	397	441	453	468	1,114
G-7 Project of Environmental Technology Area	3,573	66	189	301	382	553	397	441	45	468	323
Ministry R&D	1,809	39	87	129	166	246	246	248	229	257	183
Matching Fund	1,764	27	102	172	216	307	172	193	224	211	140
Eco-technopia 21 project	791	-	-	-	-	-	-	-	-	-	791
Ministry R&D	500	-	-	-	-	-	-	-	-	-	500
Matching Fund	291	-	-	-	-	-	-	-	-	-	291

Source: Ministry of Environment, Environmental Policy Bureau

Table A.3. Imported environmental and process-control equipment: value (USD million) and market shares (%) by country of origin, 1997 and 1998

Country	Total Exports 1997	Market Share 1997	Total Exports 1998	Market Share 1998
USA	221.4	38%	156.0	38%
Japan	177.8	30%	104.6	26%
Germany	101.9	17%	64.7	16%
France	10.8	2%	20.8	5%
Switzerland	8.9	2%	19.9	5%
United Kingdom	23.8	4%	10.1	2%
Belgium	14.3	2%	7.1	2%
Netherlands	6.2	1%	5.6	1%
China	4.1	1%	4.0	1%
Norway	1.6	0%	3.9	1%
Denmark	1.3	0%	3.4	1%
Italy	6.9	1%	3.2	1%
Singapore	1.7	0%	3.1	1%
Canada	2.1	0%	2.3	1%
Sweden	4.9	1%	1.2	0%
Australia	0.02	0%	0.08	0%
Philippines	0	0%	0.03	0%
Austria	0.01	0%	0.02	0%
Total	**587.6**	**100%**	**409.8**	**100%**

Sources: Korea External Trade Center of Seoul, January 1999, and Thomas Associates, San Diego, California.

Table A.4. Environmental status of the four major watershed regions, 2002

Region	Han River	Nakdong River	Keum River	Youngsan River
Main watersheds	BukHan River NamHan River Ansung-cheon	Nakdong River Taehwa River Hyongsan River	Keum River Mankyong River Dongin River Samkyo-cheon	Youngsan River Seomjin River Tamjin River
Total length of watersheds (km)	482	522	396	136
Area (sq. km)	32 200	32 280	17 767	16 886
Annual average precipitation (mm)	1 286	1 137	1 268	1 400
Population (millions)	24.2	13.2	5.6	4.3
Livestock head (thousands)	3 460	2 960	3 150	1 890
Number of effluent facilities	21 968	16 019	8 225	4 938
Percentage of total wastewater treated	81%	58%	51%	52%
Main water resources	Paldang Lake Chamsil Water Resource	Mulgeum Maeri Water Resource	Daechong Lake	Juam Lake

Source: Ministry of Environment (2002a).

Table A.5. Industrial wastewater discharges by watershed region, 2001

	Han River	Nak-dong River	Keum River	Young-san River	Coastal Areas	Other	Total
Number of businesses	15 747	7 736	4 096	1 806	11 206	5 649	48 876
Volume of discharge (m^3 per day)	332 000	591 000	188 000	22 000	1 140 342	349 305	2 555 000
BOD Load before Treatment	313 986	372 255	279 231	11 656	971 145	398 264	2 373 713
BOD Load after Treatment	4 276	8 937	6 438	276	36 167	15 166	43 281

Source: Ministry of Environment (2002a).

Table A.6. Upcoming public sewage-treatment projects, 2000-2005

	2000	2001	2002	2003	2004	2005
Capacity	1 834	861	1 564	886	1 827	5 833
(in thousands of tons per day)	36	30	33	18	18	65
Number of plants (projects)	1 497	1 464	1 540	1 625	1 722	1 975
Planned investment (billions of won)	1 361	1 331	1 400	1 447	1 565	1 795
Planned investment* (billions of U.S. dollars)	1.24	1.21	1.27	1.31	1.42	1.63

Average exchange rate projection for 2000 through 2005: US$1 = 1,100 won.
Source: Environmental Management Research Center, 2000 *Environmental Industry Yearbook* (Seoul, 1999)

Table A.7. Imported water filtration equipment markets 1997-1998

Country	Total Imports 1997	Market Share 1997	Total Imports 1998	Market Share 1998
USA	$10 777	31%	$5 143	36%
Japan	$10 290	29%	$4 193	30%
Germany	$7 262	21%	$1 518	11%
Denmark	$805	2%	$1 126	8%
Norway	$3	0%	$766	5%
France	$693	2%	$493	3%
England	$1 034	3%	$455	3%
Switzerland	$1 234	4%	$262	2%
Sweden	$2 882	8%	$236	2%
Total	$34 980		$14 191	
Segment Growth			-5.9%	

Source: Korea External Trade Center of Seoul, January 1999 and Thomas Associates, San Diego, CA

Table A.8. Phase-out schedule of ODS by the year 2010

(unit: CFC ton; ODI equivalent)

		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CFC	Protocol		9154						4577		1373			0
	Country Plan	8733	8000	7328	6712	6148	5631	5158	4577	2975	1373	915	458	0
Halons	protocol					3676			1838					0
	Country Plan	3805	3428	3088	2782	2506	2258	2034	1838	1471	1104	737	370	0
CTC	Protocol								96					0
	Country Plan				638 (56)	397	247	154	96	77	57	38	19	0
1,1,1-TCE	Protocol						513		359					154
	Country Plan				631 (980)	569	513	429	359	303	256	216	182	154

Source: KSCIA

Table A.9. Export & import, domestic production and consumption for ODS

(unit: ton)

Substances			98	96	97	98	99	00	01
A		Production	9 746	8 621	9 239	5 726	7 238	7 388	7 527
		Imports	1 654	1 460	896	299	439	523	353
	CFCs	Exports	1 038	1 558	752	462	179	404	999
		Sub total	10 362	8 523	9 383	5 563	7 498	7 507	6 881
A									
	Halons	production	445	499	430	289	298	361	333
	Annex A substance		10 807	9 022	9 813	5 852	7 796	7 868	7 214
B		production	3 429	4 668	4 874	5 621	5 831	5 336	5 428
		Imports	10 930	8 758	8 727	5 901	6 148	4 862	4 160
	CTC	Exports	-	16	1 976	6 134	2 306	517	787
		Raw	14 305	13 362	11 342	5 215	9 557	8 231	9 307
		Sub total	54	48	283	173	116	1450	506
B		Imports	8 491	9 409	9 757	7 882	13 155	11 164	11 336
		Exports	-	455	619	509	589	537	553
	1 1 1-TEC	Raw	-	-	2 967	3 730	6 566	4 873	4 853
		Sub total	8 491	8 954	6 171	3 643	6 000	5 754	5 930
	Annex B substance		8 545	9 002	6 454	3 816	6 119	7 204	5 424
C		Production	5 576	7 793	9 202	7 360	13 056	10 979	4 543
		Imports	5 920	7 668	8 611	4 168	7 027	9 725	14 477
	HCFCs	Exports	78	31	228	582	1 024	1 024	1 669
		Raw	-	-	203	231	91	91	306
		Sub total	11 418	15 430	17 382	10 715	17 783	19 407	17 045
E	MeBr	Imports	1 200	1 211	950	390	884	350	516

Source: KSCIA.

Table A.10. ODS reduction schedule in Korea

	ODSs	Reduction Schedule	Uses	Ozone Depleting Potential
A□	- Freon(CFC-11,12,113,114,115)	- Average production and consumption for '95~'97 - 2005.1 : 50%reduction - 2007.1.: 85% reduction - 2010.1. : completely phase-out	-refrigerants for refrigerator, airconditioner -cleaner	0.6~1.0
A□	- Halon (Halon – 1301,1211,2402)	-Average production and consumption for '95~'97 - 2005.1.: 50% reduction - 2010.1.1. : completely phase-out	- Fire distinguisher	3~10
B□	- other freon (CFC-13 etcs)	- Average production and consumption for '98~2000 - 2003.1.: 20% reduction - 2007.1.: 85% reduction - 2010.1: completely phase-out	- chiller, mixed refrigerant	1.0
B□	CTC	- Average production and consumption for '98-2000 - 2005.1.: 85% reduction - 2010.1.: completely phase-out	- row material for CFC -solvents	1.1
B□	- 1,1,1-TCE	- Average production and consumption for '98-2000 - 2005.1.: 30% reduction - 2010.1: 70% reduction - 2015.1.: completely phase-out	- metal cleaner - row material for HCFC	0.1
C□	- 40 HCFCs	<consumption> -Base: annual consumption of 2015 - 2016.1. : no increase - 2040.1.: completely phase-out	CFC substitutes	0.001 ~ 0.52
C□	- 34 HBFCs	<production> Base: annual production of 2015 - 2016.1 : no indrease -'96.1.: completely phase-out		0.02~7.5
C□	- BCM	- 2000.1.: completely phase-out	- Cleaner	0.12
E□	- MeBr	- Average production and consumption for '95~'98 - 2005.1.: 20% reduction - 2015.1.: completely phase-out	-Treating Agricultural products	0.6