The Global Environmental Market: Trends and Characteristics[1]

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The global market for environmental goods and services (EGS) is large and growing. The Organisation for Economic Co-operation and Development (OECD) estimates that the global market for environmental services, combined with pollution control and waste management equipment and goods, stood at $200 billion in 1990 and will reach $300 billion by the year 2000.[2] Another calculation of the global market claims the 1992 market was $295 billion and projects a global demand of $426 billion by 1997.[3] These projections do not fully capture business opportunities for preventing pollution through cleaner production. While calculations of environmental market sizes should be viewed with caution due to varying quality of data and definitions of the market, it is clear that the environmental sector is sizable. For comparison, in 1990 the aerospace products industry commanded a global market of $180 billion and the chemical products industry stood at $500 billion.[4]

In order for environmental markets to exist, there must be both the will and resources available to address environmental problems. Regulations and enforcement, including assignment of liability, are the main drivers of environmental markets. Prosperity is an important determinant of environmental market size; contrary to previous expectations, the environmental

[1] This chapter discusses size, trends, and drivers of environmental markets; ch. 5 discusses competitiveness in environmental industries.

[2] Organisation for Economic Co-operation and Development (OECD), *The OECD Environment Industry: Situation, Prospects and Government Policies,* OCDE/GD(92)1 (Paris: OECD, 1992).

[3] Grant Ferrier, president of Environmental Business International, presentation at the Environmental Business Council of the United States meeting, Washington DC, June 8-9, 1993.

[4] OECD, op. cit., footnote 2.

industry is not immune to economic slow-downs. Fiscal incentives now in an early stage of application, such as pollution fees and tradable allowances, may also promote demand. Corporate interest in appealing to the environmental concerns of customers and investors is increasing, particularly where reporting requirements place corporate environmental performance in public view. And opportunities for cost-effective environmental improvement through pollution prevention and improved energy efficiency are becoming better understood; such cleaner production approaches may some day obviate the need for certain end-of-pipe pollution controls.

Environmental priorities differ by country and region. In most low and many middle-income countries, key needs include provision of water, sewer, and refuse services, as well as basic pollution control equipment. In more affluent countries, there is growing demand for more sophisticated equipment and services for pollution prevention, control, and remediation. The largest environmental markets are in the industrialized nations of the OECD, which account for perhaps 80 percent of the international market.[5] The largest single market, about 40 percent of the total, is the United States. However, markets in some non-OECD nations, including a number of rapidly industrializing countries in Asia and Latin America, are poised for rapid expansion.

National markets can be thought of as falling within several broad categories:

- The United States, Japan, Germany, and several other Northern European countries have the most strict environmental regulations. No single country is most stringent for all pollutants or media. Much progress has been made against traditional soot and sewage problems. New problems and those that have resisted previous solution—including smog, acid rain, toxic substances, nonpoint pollution, and climate change—are now being addressed. These countries are at the forefront of environmental management and are sources of demand for new or improved environmental technologies. The United Kingdom, France, Italy, and several other OECD countries form a second tier of countries that have relatively strong environmental standards and enforcement but have not led in environmental management.
- Portions of the European Community (EC), including Spain, Portugal, and Greece, often lack adequate infrastructure for wastewater, solid waste, and hazardous waste treatment. Significant efforts are necessary to bring these countries into compliance with EC standards. Their level of environmental investments will depend on economic growth and EC funding.
- Rapidly industrializing countries in Asia—including the four 'tigers' (Hong Kong, South Korea, Taiwan, and Singapore), Malaysia, Thailand, and the Philippines, and the larger countries of Indonesia, India, and China-are now expending more resources on the environment. This region is probably the fastest growing environmental market, due to investments in water, sewer, and waste disposal infrastructure, and from environmental factors now being incorporated into new investments in energy and industrial production. Economic growth is providing many of these countries with the resources to pay for environmental investments.
- Several Latin American countries also have rapidly expanding environmental markets. Mexico and Brazil are the largest. This region, too, offers strong environmental business prospects. As in the rapidly growing Asian economies, investment in public environmental infrastructure is increasing. Tougher regulation and enforcement are creating markets for pollution control equipment. As more countries develop environmental capabilities, the market for monitoring equipment is also growing.

[5] **Ibid.**

- Central and Eastern Europe, including the states of the former Soviet Union, have a legacy of environmental mismanagement. Basic controls of air and water pollution and wastes are often lacking or in disrepair. While the potential market is great, the actual market is limited by lack of financial resources. Political and economic uncertainties inhibit foreign investment.
- Many developing countries in Africa, Asia, and Latin America have limited capacities for managing industrial and urban environmental challenges. Development assistance is a key source for environmental investment in these countries.

As discussed in chapter 5, most environmental goods and services are not internationally traded. Even so, substantial trade occurs; estimates of international environmental business transactions range from the low billions of dollars to over $20 billion annually.

American firms face growing challenges from foreign companies both overseas and in the domestic U.S. market for the provision of both traditional environmental products and cleaner technologies (see ch. 5).[6] Germany, Japan, Austria, the Netherlands, Switzerland, Sweden, France, Britain, and Canada have environmental companies that are competitive with U.S. firms on the world market. Foreign firms also are competitive sources for a variety of cleaner production technologies. In countries like South Korea, Taiwan, and Mexico, environmental industries are developing in response to increased regulation and enforcement, although they remain dependent on OECD-country suppliers for many environmental products and services. Examples of sectors and technologies where U.S. firms maintain an advantage and where foreign firms have gained advantage are discussed in chapter 5.

MARKET DRIVERS

Environmental markets arise primarily when regulations are put in place and enforced.[7] Other factors also contribute; for instance, pollution prevention measures are sometimes cost-effective even in the absence of strong regulation, and corporate concerns about public image can promote demand for EGS. However, regulation remains the driving factor. This is because polluters seldom on their own pick up the costs that pollution and environmental degradation place on third parties and society as a whole. In economic terms, pollution is a negative externality and the services nature provides (e.g., cycling air and water, maintaining soils and biological diversity, and so forth) are free goods. These market imperfections diminish the welfare-maximizing force that free markets can theoretically deliver. In short, without regulation (and enforcement), people will pollute excessively. Externalities and public goods as types of market imperfections are classically justified reasons for government regulation.

Environmental laws and regulations create markets for many kinds of goods and services. Obvious examples include pollution prevention, control, and clean-up equipment and supplies, and operation of waste disposal and pollution abatement systems, Analytical instruments to measure contaminants and monitor pollution, and specialized services (including engineering, management consulting, construction, and laboratory analysis) are also needed. Regulations also stimulate demand for environmental impact assess-

[6] **Cleaner production and energy technologies can be found in virtually all economic sectors. A few examples are direct steelmaking, renewable energy technologies, advanced gas turbines, chromium-free leather tanning, chlorine-free papermaking, no-clean soldering, better industrial controls, less polluting paint applicators and formulations, and improved catalysts.**

[7] **Here regulation includes the use of environmental taxes and charges, marketable pollution allowances, and assignment of liability on polluters, as well as conventional command-and-control approaches that require achievement of performance-based or technology-based environmental standards.**

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Routine environmental services such as refuse collection and disposal, while locally provided, can create trade opportunities for equipment suppliers.

ment, legal, and information services. Furthermore, the force of regulation can lead to demand for substitute or alternative products or processes. Examples include alternative solvents, fuel switching, or no-clean soldering.

Sometimes environmental laws and regulations create markets directly by mandating certain standards. In the case of performance-based standards, a number of environmental technologies and practices might allow achievement of standards. In contrast, technology-based standards require installation of particular environmental devices, thus stimulating large markets for those devices. Innovation may suffer because competing technologies and approaches are not sanctioned.[8] Sometimes regulations are formally performance-based, but, in practice, permitting and administrative procedures still favor specific reference technology.

Regulations can promote environmental markets by making pollution and waste very expensive to generators. For instance, the U.S. Resource Conservation and Recovery Act (RCRA), among other things, places stringent requirements on storage, transport, and treatment of hazardous wastes. This not only stimulates expenditures for hazardous waste handling and disposal, but also encourages waste producers to find ways to cut disposal expenses by minimizing waste.

Similarly, pollution taxes and fees may stimulate environmental technology sales. It is not yet clear the degree to which marketable pollution allowances might spur environmental technology innovation and sales by placing real dollar value on pollution. Companies may avoid environmental technology expenditure-for instance, by switching to low sulfur coal instead of buying scrubbers in the case of electric utilities. (Chapter 8 discusses the implications of different environmental regulatory approaches for manufacturing industries.[9]) Other innovative regulatory approaches, such as utility pricing rules that encourage demand-side management (DSM) in electric utilities, have spurred business opportunities in energy efficient products and related services that may be environmentally preferable.

Threats of future liability are an impetus for environmental markets; the U.S. Superfund law that retroactively ascribes liability for contaminated sites is a noteworthy example. Reporting requirements, like the Toxic Release Inventory (TRI) of the U.S. Superfund Amendments and Reauthorization Act (SARA, Title III), can also stimulate pollution prevention and control efforts. TRI requires manufacturing enterprises to publicly disclose information about their production, release, and disposal of several hundred toxic compounds. These reporting requirements led some companies to adopt aggressive waste reduction goals.[10]

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8 Robert Repetto, *George* Heaton, *and* Rodney Sobin, *Transforming Technology: An Agenda for Sustainable Growth in the 21st Century* (Washington, DC: World Resources Institute, 1991), p. 23.

9 Another OTA assessment, due for completion in late 1994, is examining new approaches to environmental regulation.

10 See Bruce Smart (~.), *Beyond Compliance: A New Industry View of the Environment* (Washington, *DC:* World Resources Institute, April *1992)* for several examples.

Although the combination of regulation and enforcement has been the most potent driver of environmental markets, it is not the only force, The environmental concerns of consumers and investors are a factor, as is the threat of additional future environmental regulation because of unfavorable public image. These concerns explain the potency of TRI in stimulating environmentally favorable corporate action. They also help explain cases of pressure on corporations from peers, suppliers, and customers as forces for environmental investment and cleaner production. The U.S. Chemical Manufacturers Association's Responsible Care program (which is mandatory for members) and similar chemical industry programs abroad, as well as environmental charters of the Business Council for Sustainable Development, the International Chamber of Commerce and the Keidanren (Japan's major industry association), are among examples of business initiatives to promote improved industrial environmental performance.

Finally, as has been noted, some environmental investments in pollution prevention and especially energy efficiency are cost-effective even in the absence of regulations, Markets may develop as these opportunities become better known.

DEFINING THE INDUSTRY AND ITS MARKET

The previous section refers to EGS, cleaner production, and the environmental industry without crisp distinctions. This is because definitions of the industry and its market are inconsistent and sometimes nebulous, and data are often lacking. The reasons why data are inadequate and the differing definitions of the market used by several studies are discussed below. As is discussed in chapter 3, this assessment does not adhere to a rigid definition of EGS.[11] Instead, it examines markets and competitiveness in a number of traditional environmental areas-air, water, and waste management, including services-with illustrative cases from cleaner production important to the energy and manufacturing sectors.

Information on environmental markets and industry size is inadequate for several reasons:

- Little effort has been made by the United States and other countries to track EGS production and trade. U.S. Standard Industrial Classification (SIC) codes and the international Harmonized Code (HC) do not correspond well with environmental product categories .12 Thus, official data on production and trade are of limited value. (See ch. 5 for discussion of environmental trade.) Many products used in environmental equipment and facilities are also used in other applications. It is often not possible to determine whether the end use of a product is environmental.
- Production data are difficult to obtain because of the industry's structure. It has been estimated that about 200 public companies account for roughly one-third of U.S. environmental revenues but that over 58,000 privately held fins, averaging $1.3 million in annual revenues each, account for the remaining two-thirds.[13] Privately held companies are not required by the Securities and Exchange Commission to publicly divulge financial information. There may be over 10,000 environmental fins, mainly small, in Western Europe.

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11 As previously discussed, several important aspects of environmental technologies including agricultural technologies, geophysical and ecological modeling, technologies for assessing health effects, and nuclear-related technologies are not examined in this asessment. Green product design was the subject of another recent OTA assessment, U.S. Congress, Office of Technology Assessment, *Green Products by Design: Choices for a C'/eaner Environment,* OTA-E-541 (Washington, DC: U.S. Government Printing Office, September 1992).

12 One exception is SIC 35646/HC 842139, Selected Industrial Air Pollution Control Equipment. Several other categories partially cover EGS products. Further discussion of this issue is found inch. 5.

13 *Environmental Business Journal*, vol. 5, No. 4, April 1992, p. 7. Over 24,000 of these companies are private water utilities averaging .$400.000 in annual revenues.

- Many environmental companies, including large conglomerates, are active in a variety of industrial sectors; they generally do not report their environmental business separately. Engineering and construction companies have provided design and construction management services for environmental projects for many years. Instrument manufacturers produce lines of equipment for environmental monitoring and analysis. Producers of boilers and power generation equipment sell air pollution control equipment (as well as less-polluting combustion systems and turbines). A number of chemical companies have spun off commercial hazardous waste management businesses in addition to producing specialized chemicals for water, air, and waste treatment. And, with the end of the Cold War, many defense contractors are seeking environmental business opportunities ranging from clean-up of Federal facilities to development of electric vehicles.[14] A few companies in other sectors facing tough times, such as the Pacific Northwest forest products industry, are redirecting their efforts toward the environment (see box 4-A).
- Industrial establishments operate in-house air, water, and waste treatment facilities and services. These operations, while recorded as pollution abatement expenditures in corporate accounts, are seldom included in estimates of environmental goods and services. This partly explains why sales by environmental firms differ from national estimates of environmental compliance cost (see ch. 7). Internal corporate environmental expertise and facilities sometimes provide a basis for new businesses. For instance, Amoco, Dow, DuPont, and Rhone-Poulenc are among the chemical concerns that have established hazardous waste management businesses.[15]

Most estimates of the size of the environmental industry focus primarily on clearly identifiable end-of-pipe pollution and waste control, treatment, and remediation. Even here, however, coverage varies, as is shown in the following studies:

- The OECD divided the market into four equipment and related service sectors—water and effluents treatment, waste management, air quality control, and "other' (which includes land remediation and noise abatement)--plus a separate general environmental services category.[16] Cleaner production or pollution prevention products are not included, although some related consulting services are.
- ECOTEC, a British consulting firm, uses four primary categories: air pollution control, **water** and wastewater treatment, contaminated land reclamation, and waste treatment and disposal (including consulting and analytical services related to these areas) .[17] It does not include municipal solid waste collection, noise abatement, construction of environmental infrastructure, or cleaner production.
- Farkas Berkowitz & Co., a U.S. consulting firm, divides the American environmental industry into air, water, solid waste, hazardous waste, consulting, and "other" (which includes analytical and information services, and landfill liners, among other things).[18] Water supply and solid waste handling equipment (for

14 For analysis of defense conversion issues, see U.S. Congress, Office of Technology Assessment *After the Cold War: Living With Lower Defense Spending,* OTA-ITE-524 (Washington, *DC:* Government Printing Office, February 1992), and U.S. Congress, Office of Technology Assessment, *Defense Conversion: Redirecting R&D,* OTA-ITE-553 (Washington, DC: Government Printing Office, May 1993).

15 *Environmental Business Journal,* op. cit., footnote 13, p. 9.

16 OECD, op. cit., footnote 2, p. 5.

17 ECOTEC Research and Consulting, *Opportunities for the Environmental Protection and Waste Management Industry in Europe* (Birmingham, U.K.: June 1990).

18 Farkas Berkowitz & Co., *The Fifth Annual State-of-the-Industry Report* (Washington, DC: 1993).

Box 4-A–Forest Product Supply Firms and Environmental Business Opportunities

In Oregon, some forest products firms and suppliers are pursuing environmental business opportunities in response to declining forest harvesting and processing.' For instance, the Eugene-based Ross Corp., a designer and manufacturer of heavy equipment used to extract and transport logs, has capitalized on its experience to develop materials-handling equipment for municipal solid waste disposal and recycling. Examples include balers, conveyors, sorting systems, and scrap handlers. The company also designs municipal recovery facilities: one such facility is operating in Washington State. Offices in Canada and New Zealand support international marketing activities.

Another Eugene-based firm, Bulk Handling Systems, has adapted its materials handling machinery expertise, in this case for the lumber, panelboard, and paper industries, to manufacture handling, sizing, and storage equipment for waste and scrap materials. The company also makes equipment for power plants that use agricultural and forestry wastes as fuel. Phoenix Industrial Park in Eugene was a virgin plywood manufacturing facility until a lack of old growth logs put it out of business. The site now houses a plant for reclaiming and processing urban and industrial wood wastes; also at the site is an oil recycling facility. International Resources Unlimited's engineering consulting business used to concentrate on the forest products sector. The firm now works on a wider variety of structural materials. With U. S., Finnish, and Hungarian collaborators, it is developing a number of products using mixed waste paper and mixed paper, cardboard, and plastic wastes to displace virgin wood in panelboard and fiberboard construction materials.

Contraction of the forest products industry in the Pacific Northwest has parallels to declines in defense-related industries. Redirection of economic development and adjustment assistance are urgently needed by displaced workers and their communities. While opportunities in environmental goods and services, as well as environmentally preferable materials, probably will not cancel out declines in the forest products industry, they do provide some options for economic development and growth. This has been recognized by Washington, Oregon, California, and British Columbia, which have all identified environmental technologies and services as a key sector for development.

1 Eugene F. Davis, president, International Resources Unlimited, Eugene, OR, provided information for this and the following paragraph.

instance, garbage trucks) are omitted but municipal refuse services are included. Recycling of municipal solid wastes and hazardous industrial chemicals are listed but recovery of industrial scrap is not.

- One of the most comprehensive estimates, that of *the Environmental Business Journal*, divides the U.S. environmental industry into 12 categories: 19
  1. analytical services,
  2. solid waste management,
  3. hazardous waste management (includes remediation),
  4. asbestos abatement,
  5. water infrastructure (water and wastewater treatment equipment and supplies),
  6. water supply utilities,
  7. engineering/consulting,
  8. resource recovery (includes recycling),
  9. instrument manufacturing,
  10. air pollution control,
  11. waste management equipment, and
  12. environmental energy sources (includes renewable energy and cogeneration).

19 *Environmental Business Journal*, Op. Cit., footnote13.

The journal tracks private companies (publicly and privately held) and publicly owned water and waste utilities. However, the mobile source air pollution control sector is not included.

None of the studies fully account for pollution prevention and cleaner technology-processes and products that use energy and materials more efficiently, that generate less total waste and less hazardous waste, and that decrease use of toxic substances. Unlike add-on environmental technologies, which are additional costs to industry, this mostly invisible environmental sector can sometimes lead to improvements in productivity, efficiency, and product quality. And even when cleaner production and pollution prevention are net costs to business, they are usually less expensive than end-of-pipe pollution control and waste disposal.[20]

Cleaner technologies may be adopted specifically to meet environmental requirements-for instance, replacement of chlorofluorocarbons (CFCs) in light of CFC phase-out laws or new paint applicators stimulated by tough regulations for volatile organic compounds (VOCs)--or they may be chosen for primarily nonenvironmental reasons+. g., low pressure polyethylene production offers advantages (lower cost and avoidance of high pressure reactions) over high pressure polyethylene production while using less organic solvent and saving energy.[21] Environmental performance will remain one of a number of factors--technical performance, cost, consumer preferences, worker safety, and so on—that engineers and managers will consider in production technology choice and product design.

To the extent that cleaner production is not included in estimates of the environmental industry, then environmentally inspired business opportunities will be understated. For instance, in the 1990s, developing country and Central and Eastern European capital investment for the electric power sector may reach $1 trillion.[22] If a study on environmental business opportunities associated with power sector investment were to concentrate on end-of-pipe pollution abatement, waste handling, and restoration of coal mining sites, it would miss very large commercial and environmental opportunities offered by more efficient power generation technologies, electricity and heat cogeneration, cleaner fuels, and renewable energy. A narrow environmental sector definition would also miss the great potential of selling negawatts--or improved energy efficiency—to power users.

In addition, studies that focus only on end-of-pipe technologies may neglect the possibility that such technologies could be displaced by cleaner production approaches. For instance, if organic solvents are replaced by mechanical or aqueous processes (e.g., powder coatings and water-based paints), markets for VOC control devices maybe diminished. As another example, cleaner combustion processes and non-fossil energy sources could dampen long-term demand for add-on emission control equipment, although near-term markets for these devices are robust.

Yet, an all-encompassing definition of environmental technology offers little practical guidance in assessing environmental markets and competitiveness. Nonetheless, the realization that technology-not just environmental goods and services-and environment are intimately bound together has broad implications for the molding of

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20 There are also cases where add-on pollution controls can allow manufacturers to maintain high quality products while meeting environmental requirements—for instance, catalytic converters have allowed automobile engines to be optimized for power or fuel economy while decreasing emissions.

21 William H. Joyce, "Energy Consumption Spirals Downward the Polyolefins Industry," in Jefferson W. Testor, David O. Wood, and Nancy A. Ferrari (eds.), *Energy and the Environment in the 21st Century: Proceedings of the Conference Held at the Massachusetts Institute of Technology, Cambridge, MA March 26-28, 1990* (Cambridge, MA: MIT Press, 1991), pp. 427435.

22 World Bank, *Capital Expenditures for Electric Power in the Developing Countries in the 1990s*, IEN Energy Series Paper No. 21, February 1990, in World Bank, *The Bank's Role in the Electric Power Sector*, Industry and Energy Department, box 5.

technology, environmental, and economic policies.[23] Some long-term technological trends such as ''dematerialization"[24]—which includes the substitution of knowledge-intensive production for resource-intensive production, precision control of processes, and, generally, doing more with less material and energy—have salutary environmental effects. For instance, fiber optics is arguably an environmentally preferable technology because fiber optic cables require much less energy and material per unit of communication than do copper cables (and concommitantly less environmental damage from mining and manufacturing); they have allowed the development of new monitoring and control technologies that can increase production efficiency and decrease waste; and they allow further substitution of communication for transportation.

GLOBAL, REGIONAL, AND NATIONAL MARKETS

The OECD estimates that over 80 percent of the 1990 market for environmental services, pollution control, and waste treatment occurred in the 24 member countries of the OECD.[25] (See table 4-1 and, for European national data, table 4-6.) The remainder is split between Eastern Europe/former U.S.S.R. (7.5 percent) and 'Other' (10.5 percent). The United States is by far the largest national market ($78 billion) followed by Japan ($24 billion), western Germany ($17 billion), and France ($10 billion). The study anticipated higher-than-average growth in Canada, Japan, several European Community countries that need substantial environmental investment to meet Community standards, and the "other' category, which includes the dynamic economies of the Pacific Rim. The lowest growth rates are anticipated in the Nordic countries, Germany, the Netherlands, Switzerland, and Austria, which already possess relatively advanced environmental management capabilities; the U.S. market is expected to expand more slowly than the OECD average. OECD's analysis suggests that Central and Eastern Europe's environmental market will experience above-average growth, although the combined Eastern Europe/former Soviet Union category rate could be below average.

By environmental sector, 24 percent of OECD countries' environmental industry 1990 output was for environmental services, 30 percent for water and wastewater treatment equipment, 20 percent for waste management equipment, 15 percent for air quality control equipment, and 11

Table 4-1--OECD Estimate of Environmental Market Sizes and Growth by Region (in 1990 dollars)

	1990 ($ billion)	2000 ($ billion)	Annual growth (percent)
OECD North America	*84.0*	***125.0***	4.1
United States	*78.0*	113.0	3.8
Canada	7.0	12.0	5.5
OECD Europe[a]	54.0	***78.0***	3.7
OECD Asia-Pacific	***26.2***	*42.0*	4.8
Japan	***24.0***	*39.0*	5.0
Australia	2.0	*2.8*	3.4
New Zealand	0.2	*0.3*	4.1
OECD total	164.0	*245.0*	4.1
Non-OECD total	*36.0*	*55.0*	*4.3*
Eastern Europe/ Former U.S.S.R.	15.0	21.0	*3.4*
Other Non-OECD	21.0	34.0	*4.9*
World total	200.0	300.0	4.1

a See table 4-6 for European national data.

NOTE: Percentage growth was recalculated from the original source as a compound annual rate.

SOURCE: OECD, *The OECD Environment Industry: Situation, Prospects and Government Polities,* OCDE/GD(92)1 (Paris: OECD, 1992).

23 Heaton, Repetto, and Sobin, **op. cit., footnote 11; George Heaton, Robert** Repetto, **and Rodney** Sobin, *Backs to the Future: U.S. Government Policy Toward Environmentally Critical Technology* **(Washington DC: World Resources Institute, June 1992).**

24 **R.** Herman, S.A. Ardekani, **and** J.H. Ausubel, **"Dematerialization, " in Jesse H.** Ausubel **and** H.E. Sladovich (eds.), *Technology and Environment* **(Washington, DC: National Academy Press, 1989), pp.** 50-69.

25 **Data for** these **several paragraphs are from** OECD, **op. cit., footnote *.**

Table 4-2—OECD Estimate of Environmental Markets by Sector (in 1990 dollars)

	1990 ($ billion)	2000 ($ billion)	Annual growth (percent)
Equipment	152	220	3.8
Water/wastewater	60	83	3.3
Waste management	40	63	4.6
Air quality control	30	42	3.4
Other	22	32	3.8
Services	48	80	5.2
Total	200	300	4.1

NOTE: Percentage annual growth was recalculated from the original source as a compound annual rate.

SOURCE: OECD, The *OECD Environment Industry: Situation, Prospects and Government Polices*, OCDE/GS(92)1 (Pans: OECD, 1992).

Table 4-3—Environmental Business International Estimate of the Global Environmental Market

	1992 ($ billion)	1997 ($ billion)	Annual growth (in percent)
United States	134	180	6.1
Canada	10	17	11.2
Mexico	1	2	14.9
Other Latin America	6	10	10.8
Western Europe	94	132	7.0
Eastern Europe/Former U.S.S.R.	14	27	14.4
Japan	21	31	8.1
Australia/New Zealand	3	5	10.8
Southeast Asia	6	13	16.7
Rest of world	6	9	8.4
Total	295	426	7.6

NOTE: Percentage annual growth was recalculated from the original as a compound annual rate.

SOURCE: Grant Ferrier, president of Environmental Business International, presentation at the Environmental Business Council of the United States meeting, Washington, DC, June 8-9, 1893.

percent for other forms of EGS, including contaminated land remediation and noise control (see table 4-2). Within OECD, the highest predicted growth rate is within the service sector and lowest in water and wastewater treatment. Much of the growth in the "other" sector is likely to be based on expanded efforts in contaminated site remediation.

An analysis by Environmental Business International (publisher of the *Environmental Business Journal)* suggests a significantly larger environmental market (see table 4-3). The estimate also is much more optimistic than the OECD about the growth potential of the EGS industry, projecting a 5-year annual average growth rate of between 7 and 8 percent.

These analyses provide only a general indication of the global environmental market, rather than definitive estimates. Furthermore, estimates of national and international environmental markets are not the same as estimates of either environmental compliance costs or the environmental sector's contribution to gross domestic product (GDP). As discussed previously, many environmental expenditures are internal to the firm and do not accrue to the environmental industry. And total environmental firms' revenues do not represent total contributions to GDP because they do not measure final demand or total value added by the environmental industry. Many sales by environmental companies are to other environmental companies; for instance, waste management service companies buy equipment from environmental product manufacturers, and environmental contractors often subcontract jobs to other environmental companies. In other words, total revenues overstate contribution to GDP by double-counting expenditures.

As has been mentioned, pollution prevention and improved energy efficiency are only partly covered in environmental market estimates.[26] An analysis done for the Department of Energy projects annual global energy efficiency export markets at $8.4 billion annually during the years 1990 to 2000, doubling to $16.8 billion annually

26 Environmental consulting related to pollution prevention is often included and the *Environmental Business Journal* includes renewable and co-generated power.

Table 4-4-Environmental Business Journal Estimate of U.S. Environmental Industry Revenue and Growth ($ billions, percent growth)

Segment	1989	1988-1989 growth	1990	1989-1990 growth	1991	1990-1991 growth	1992	1991-1992 growth	1992 Employees
Analytical services	$1.6	23%	$1.7	6%	$1.7	1%	$1.8	3%	20,000
Solid waste management	23.5	14	26.1	11	27.4	5	28.2	3	235,000
Hazardous waste management	12.1	22	13.3	10	13.7	3	14.6	7	127,000
Asbestos abatement	3.8	27	4.0	5	3.0	-25	3.1	3	28,000
Water infrastructure	11.7	7	12.1	3	12.5	3	13.0	4	100,000
Water utilities	18.8	8	20.2	4	21.2	5	21.8	3	136.000
Engineering/construction	10.2	26	12.2	20	13.4	10	14.2	6	158,000
Resource recovery/recycling	14.2	23	17.2	16	15.8	-8	16.1	2	107,000
Instrument manufacturing	1.5	25	1.6	14	1.8	4	1.8	6	15,000
Air pollution control	5.3	-4	5.4	2	5.3	-1	5.4	2	39,000
Waste management equipment	9.8	9	10.4	6	11.0	6	11.5	4	88,000
Environmental energy	1.5	25	1.8	20	2.0	10	2.2	11	20,000
Total	114.6	14	126.0	10	128.7	2	133.7	4	1,073,000
Nominal GDP Growth*		7.0		5.1		2.8		4.8	

*From U.S. Department of Commerce, *Survey of Current Business* and *Statistical Abstract of the United States 1992.*

SOURCE: *Environmental Business Journal,* April 1992 and April 1993.

during the years **2000 to 2010.**[27] About half of the market is likely to be in developing countries. OTA has identified improving energy efficiency as an especially valuable opportunity for simultaneously assisting environmental protection and international development.[28] Descriptions of major regional and national environmental markets follow.

United States

Because of the Nation's large size and its relatively strict environmental regulations, the United States is the world's largest producer and consumer of EGS. Many U.S. environmental firms have focused exclusively on the domestic market. However, the size and relative openness of the U.S. market has made it attractive to foreign competitors, and competition is intensifying (as discussed in greater detail in ch. 5).

As previously noted, estimates of the U.S. environmental market vary, due to differences in definitions, methodologies and interpretations. OECD estimated the market to be $78 billion in 1990. The *Environmental Business Journal* reported U.S. EGS industry revenues of $126 billion in 1990 and $133.7 billion in 1992, although mobile source air control revenues—mainly catalytic converters-of about $8.3 billion in 1990 were not included[29] (see table 4-4). Farkas Berkowitz and Co. produced an estimate of $75 billion in 1992[30] (table 4-5). EPA reported U.S. 1990 environmental expenditures tobe$115

27 U.S. **Department of Energy, ''National Energy Strategy Technical Annex No. 5: Analysis of Options to Increase Exports of U.S. Energy Technologies," 1991/1992, pp. 67-68.**

28 U.S. Congress, Office of Technology **Assessment,** *Fueling Development: Energy Technologies For Developing Countries,* OTA-E-516 (Washington, **DC: U.S. Government Printing Office, April 1992).**

29 *Environmental Business Journal,* vol. **6, No, 4, April 1993, and vol. 5, No. 4, April 1992; U.S. Department of Commerce** in ICF Resources **and Smith Barney, Harris** Upham **and Company Inc.,** *Business Opportunities of the New Clean Air Act: The Impact of the CAAA of 1990 on the Air Pollution Control Industry,* **August** 1992, **p.** I-2.

30 Farkas **Berkowitz & Co., op. cit. footnote 18.**

Table 4-5--Farkas Berkowitz Estimate of U.S. Environmental Industry Revenue

Segment	Percent
Environmental consulting	12
Hazardous waste and remediation	8
Air pollution control (mobile and stationary)	12
Solid waste	37
Water quality	17
Other	14
Total Estimated 1992 Revenue	$75 billion

SOURCE: Farkas Berkowitz & Co., *The Fifth Annual State-of-the-Industry Report* (Washington, DC: 1993).

billion.[31] However, as noted, these are not identical to environmental industry revenues.

Future environmental market growth in the United States could come from several directions. For instance, an analysis of business opportunities offered by the Clean Air Act Amendments (CAAA) of 1990 estimates that cumulative revenue increases (in 1990 dollars) for stationary and mobile source air pollution control equipment producers will be $35 to $49 billion by the year 2000.[32] Engineering, design, and construction firms could bring in another $2 to $4 billion during this period. Makers of instruments and monitoring systems might see revenues grow $1 to $3 billion over the period. The CAAA also is expected to increase revenues for natural gas, low-sulfur coal, and reformulated and oxygenated gasoline producers. In some cases, the ability to switch to low-sulfur coal or natural gas allows managers of electric power plants and other facilities to avoid installing add-on pollution control equipment. (These revenue estimates are sensitive to assumptions about timing of regulations, scope of facilities regulated, technology choices made by regulated industries, and costs of technologies. A slow economy and uncertainties about CAAA implementation make the air pollution control estimates presented above seem overstated.)

The CAAA tightens emissions control requirements for both stationary and mobile sources. It orders major reductions in sulfur and nitrogen oxides (SO_2 and NO_x respectively) emissions from power plants and other major sources; strengthens controls on volatile organic and toxic air pollutants; requires cleaner vehicles and fuel; expands monitoring requirements for power plants; and regulates disposal of CFCs.

State and local air quality requirements (some of which are required by Federal law) will also affect the market for both traditional EGS and cleaner products and processes. Examples include the South Coast Air Quality Management District's tough regulations to control smog in southern California and California's requirements for development and marketing of low-, very low-, ultralow-, and zero-emission vehicles over the decade. Other States are considering adoption of California's automobile standards. (See box 7-B for discussion of some regulated industry responses to California's air regulations.)

Growth in U.S. demand may occur for other environmental sectors. Newdrinking water standards under the Safe Drinking Water Act's 1986 amendments and storm sewer management regulations mandated by the Clean Water Act's 1987 amendments are being implemented. The Clean Water Act, Safe Drinking Water Act, Superfund, and the Resource Conservation and Recovery Act are scheduled for congressional reauthorization. If the laws are strengthened, environmental market growth is likely. Meanwhile, State and local regulation of wastes and recycling increases.

Contamin ation and waste from decades of U.S. military activity and weapons production during the Cold War are now major environmental

31 ICF Resources *and* Smith *Barney,* **op. cit., footnote** *29,* **pp. I-2, I-3, original estimates in A. Carlin and the Environmental Law Institute,** *Environmental Investments: The Cost of a Clean Environment Summary, EPA-230-12-90-084* (Washington DC: U.S. Environmental **Protection Agency, December 1990) were expressed in 1986** dollars **and were inflated 15 percent to derive 1990 dollars.**

32 ICF Resources and **Smith Barney, op. cit., footnote 29, p.** IV-3

issues. Many Department of Defense (DOD) and Department of Energy (DOE) facilities are badly contaminated with various wastes, ranging from radioactive byproducts of nuclear weapons production to spills of common fuels and solvents. This hazardous legacy threatens health and the ecology. Decontamination of decommissioned military facilities is important if those lands are to be made viable for civilian use and commercial investment. Some estimates of the costs for clean-up, decontamination, and waste management of the Nation's nuclear weapons complex reach $75 to $105 billion through the year 2010.[33] DOE's estimated fiscal year 1994 outlay for environmental restoration and waste management will be over $5 billion, while DOD's environmental restoration outlays will be about $2 billion .[34]

Canada

According to OECD, Canada's environmental market was $7 billion in 1990, and might grow to $12 billion by 2000 (5.5 percent annual growth).[35] Environmental Business International estimated a $10 billion Canadian market for 1992, and projects $17 billion by 1997 (1 1.2 percent annual growth).[36] Both studies suggest that the annual growth rate for the Canadian market will be above the OECD-country and global average,

Canadian environmental problems and responses have mirrored those in the United States but, at times, with a lag. The national Green Plan, announced in December 1990, calls for a variety of measures, such as antismog actions, acid rain controls, CFC phase-out, stronger toxic effluent and emissions standards, clean-up of hazardous waste sites, reduced urban wastes, and limits on greenhouse gas emissions. Provincial and local authorities will upgrade sewer and waste disposal systems while continuing to promote recycling.

A study for the Ontario Environment Ministry indicated that U.S. regulatory policies often precede and influence practices in Canada.[37] Some Canadian jurisdictions use U.S. experience with environmental technology for regulatory guidance. And many subsidiaries of U.S. companies operating in Canada may adopt parent company environmental practices.

Trade may eventually lead to greater convergence of U.S. and Canadian standards. Surveyed Ontario industrial firms indicated that the United States was the source for most imported environmental products and services.[38] Canadian environmental firms see the United States as their major export market.

Western Europe

The EC and Western Europe can be divided into three major tiers of environmental priorities and capabilities.[39] The top tier countries already possess relatively advanced environmental management systems, including comprehensive legislation, tight standards, capable administration, and good infrastructure. Denmark, Germany, and the Netherlands of the EC, along with Finland, Norway, Sweden, Switzerland, and Austria, fall into this tier.

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33 U.S. General Accounting Office, *brig-Term Plans to Address Problems of the Weapons Complex Are Evolving,* GAO/RCED-90-219, September 1990. The GAO also includes $50 billion for modernization of the Weapons Complex.

34 Executive Office of the President, Office of Management and Budget, *Budget of the United States Government,* Fiscal Year 1994, *pp.* App.-461, App.-462, App.-570..

35 OECD, op. cit., footnote 2.

36 Grant Ferrier, op. cit., footnote 3.

37 Ontario Ministry of Environment, *Study of the Ontario Environmental* Protection *Industry* (Queen's Printer for Ontario, 1992), pp. 134-35.

38 Ibid.

39 Richard Haines, ' 'Pollution Control Market to Flourish in Post-1992 Europe,' *Pollution Prevention,* vol. 1, issue 2, April 1991, pp. 11-20.

Table 4-6-Western European Environmental Markets ($ billion)

	ECOTEC estimate		Annual rate	OECD estimate		Annual rate
	1990	1995	(percent)	1990	2000	(percent)
Germany (west)	14.4	20.0	***6.7***	17.0	23.0	3.1
France	6.5	9.5	***8.0***	10.0	15,0	4.1
United Kingdom	8.9	11.5	***10.6***	7.0	11.0	4.6
Italy	4.2	6.4	***8.7***	5.0	7.7	4.4
Netherlands	2.2	2.8	***5.3***	2.7	3.7	3.2
Switzerland	1.5	1.8	***4.8***	1.9	2.5	2.3
Spain	1.4	2.5	***12.7***	1.8	3.0	5.2
Sweden	2.0	2.5	***4.8***	1.5	2.0	2.9
Belgium/Luxembourg	0.8	1.2	***8.4***	1.4	2.3	5.1
Austria	1.3	1.8	***6.0***	1.3	1.8	3.3
Finland	1.0	1.3	***3.8***	1.0	1.3	2.7
Denmark	0.7	0.9	*7.0*	1.0	1.2	1.8
Norway	0.7	0.9	*5.3*	0.7	1.0	3.6
Portugal	0.3	0.6	*13.5*	0.4	0.7	5.7
Greece	0.2	0.5	*14.1*	0.3	0.5	5.2
Ireland	0.3	0.4	*8.3*	0.3	0.5	5.2
OECD-Europe*	44.3	64.4	*7.8*	54.0	***78.0***	3.7

•Does not include Iceland and Turkey.

NOTE: ECOTEC's analysis does not include civil engineering work, waste collection costs, and noise abatement included in OECD's estimates. Figures are rounded to nearest $0.1 billion. Percentage growth rates were recalculated from the original sources as compound annual rates.

SOURCE: ECOTEC Research& Consulting, Ltd., and OECD, *The OECD Environment Industry: Situation, Prospects and Government Polices*, OCDE/GD(92)1 (Paris: OECD, 1992).

The middle tier includes Belgium, France, Ireland, Italy, Luxembourg, and the United Kingdom, which now have less rigorous environmental policies. Environmental markets in these countries may grow as they move to meet EC environmental standards.

The bottom tier countries-Greece, Portugal, and Spain-lack sufficient environmental experience, environmental infrastructure, and the ability to enforce strong environmental policies. They need to boost their environmental management capabilities to meet EC standards. Their environmental markets may grow most rapidly of the Western European countries.[40,41]

Two estimates of Western European environmental markets are presented in table 4-6. Table 4-7 presents market estimates by environmental sector. The eastern portion of Germany, an anomolous environmental market where the ruinous environmental legacy of Communist rule meets the economic strength and tough environmental standards of Federal Germany, is discussed in box 4-B.

Western Europe thus includes markets for both cutting edge technologies and catch-up equipment and processes. Both markets may exist even in countries with strong standards. For example, some German air quality standards are more stringent than U.S. requirements; almost all major sources of SO_2 and NO_x in western Germany are well-controlled. Yet Germany is still phasing in automotive catalytic converters, first introduced in Germany 1986 but only now (1993 model year) required for all size classes of new automobiles.

[40] OECD, **op. cit., footnote 2.**

[41] ECOTEC Research & Consulting, *The European Pollution Control and Waste Management Market: An Overview* (Birmingham, U. K.: January 1992).

Table 4-7—Western Europe's Environmental Markets by Environmental Sector ($ billion)

	1990	1991	1995	Annual growth (percent)
Air pollution control	9.6	10.3	12.8	4.3
Water/wastewater treatment	12.8	13.8	21.3	9.1
Contaminated land reclamation	1.0	1.1	2.3	16.1
Waste management	20.9	22,5	28,0	4.5
Total	44.3	47.7	64.4	8.5

SOURCE: ECOTEC Research & Consulting, Ltd. (ECOTEC's environmental market definition does not include construction work, water supply, or municipal waste collection.)

Most other Western European states have not yet reached western German levels of stationary source air pollution control or American levels of mobile source controls, Both will be areas of market growth. It is also possible that future European policymakers may look toward California-type air standards as a model. Industrial VOC controls are another area of EGS demand in Western Europe.

Water and wastewater treatment technologies and markets are relatively mature in much of Western Europe. Yet lack of infrastructure in the southern EC states—where primary and secondary sewage treatment often is unavailable-and investment needs in the UK are reasons for forecasts of significant capital expenditure in this sector. Due to EC directives, most countries will upgrade systems and improve water quality monitoring. Treatment chemicals and advanced treatment technologies, such as use of membranes and ion exchange, are other areas of growth.[42]

In remediation of contaminated lands and hazardous waste handling, Europe lags behind the United States in experience and policy .43 An estimated 62,000 contaminated sites associated with closed industrial facilities and refueling stations are known, with perhaps many more to be discovered. The 1990 market, primarily in Northern Europe, was estimated at $1 billion a year but could shoot to $2.3 billion by 1995, stimulated by more stringent laws. Likewise, markets to treat or dispose of hazardous waste may triple, from $2.5 billion to $7.6 billion by 2000. This would reflect an anticipated rise in landfilling costs due to capacity constraints, stricter controls, greater quantities of hazardous substances generated,[44] and more waste pretreatment requirements.

As with water and wastewater treatment, municipal and hazardous waste treatment is characterized by poor infrastructure--often open dumps—in parts of Western Europe at the same time other areas are advancing the state of the art.

Western Europe's large environmental market has stimulated a very capable environmental industry in some countries and sectors. In 1990, there were an estimated 10,000 environmental firms in the Western Europe; 65 percent of these companies had annual revenues of under $5 million.[45] About one-fourth of Western Europe's environmental companies are German.[46] Another 15 percent are British, 12 percent are French, and 10 percent are Italian. The number of such firms in the Netherlands (7 percent), Sweden (5 percent), Switzerland (4 percent), and Denmark (3 percent) is small but disproportionately high relative to population or GDP. This reflects the relatively strong and well-established environmental regulations in those countries. Other Western European countries each accounted for between 1 and 3 percent of the total. As illustrated in the following chapter, companies from Ger-

42 Haines, op. cit., **footnote** 39; ECOTEC, op. cit., footnote 41.

43 Ibid. **for** data in this **paragraph.**

44 This will occur partly **by definition as more substances are defined** as hazardous.

45 ECOTEC **Research & Consulting, op. Cit.,** footnote **41.**

46 Another estimate suggests that 9,000 **to** 10,000 environmental firms may **be feud** in **German** y **alone.** Ariane Genillard, **"Industrial Clean-up on a Grand Scale, "** *Financial Times,* **Sept. 16, 1993, p. 12.**

Box 4-B-Environmental Needs in Eastern Germany

The "new Laender'-'-the new states of the Federal Republic of Germany--have an environment damaged by decades of abuse under inefficient central economic planning, which gave the environment very little consideration in the course of industrial and agricultural development. The result has been damage to public health and degradation of air, water, soil, and biological resources. One direct environmental consequence of the Cold War is 800 known sites in eastern Germany where old munitions have been buried.[1] Eastern Germany's reliance on low-quality, high-sulfur coal for 75 percent of its energy also produced severe environmental contamination. Emissions of a number of air and water pollutants are comparable to the highest levels occuring in western Germany 20 to 30 years ago; SO_2 emissions are the highest per unit of area of any European country.[2] The Association of German Electricity Producers (VDEW) estimates it will take $25.5 billion over 10 years to bring eastern German power plants into compliance with Federal German environmental standards.[3] Many industries, as well as water supply, wastewater treatment, and solid waste utilities, will require substantial investment to meet Federal German and European Community environmental standards. New facilities must meet Federal standards; existing facilities are subject to a compliance timetable that extends to the year 2005.[4] Some estimates of eastern German environmental needs are great. (See table 4-B-1.)

While the transition of the eastern German economy to a market basis is difficult, the region has an advantage over its eastern neighbors because it is hitched to the most powerful economy in Europe. Even with the German recession of the early 1990s, the flow of money from western Germany, plus the stability of Germany's legal, political, and economic system, make investment and trade with eastern Germany less risky than similar transactions with other former soviet bloc countries in Central and Eastern Europe.

Table 4-B-I-Needed Environmental Expenditures for Eastern Germany 1992 Through the Year 2000

	(billion 1992 dollars)		
Environmental sector	Low	High	Best estimate
Wastewater management	33.9	86.0	80.2
Drinking water improvement	10.8	19.2	10.8
Waste disposal	1.9	22.0	22.0
Air pollution	3.2	22.4	14.4
Contaminated site remediation	1.9	44.8	6.8
Noise abatement	1.3	2.6	1.3
Total	53.0	205.7	135.4

SOURCE: IFO Institute for Economic Research in OECD, *OECD Environmental Performance Reviews: Germany* (Paris: OECD, 1993), p. 91.

Over $3.5 billion in loans and grants were made by the federal government for improvement of the eastern German environment in 1990 and 1991.[5] The federal government may bear 60 percent of $8.3 billion presumed to be needed for remediation of contaminated eastern sites through 1998, with additional funds provided by states.[6] Much remedial work will be associated with privatization of state-owned enterprises. While some American firms may concede eastern German environmental markets to Germany's strongly competitive environmental industry, the market may still be particularly attractive. American environmental firms could even find that acquisitions and investments in Germany can offer a platform for expansion into Central and Eastern Europe.

1 U.S. Department of Commerce, "Market Insight Report: Environmental Market Opportunities in Eastern Germany," March 1992.

2 OECD, *OECD Environmental* Performance *Reviews:* Germany (Paris: OECD, 1993), p. 88-90.

3 U.S. Department of Commerce cable, Sept. 2, 1992, in U.S. Department of Commerce, National Trade Data Bank.

4 OECD, op. cit., footnote 2.

5 Ibid.

6 *Environmental Science & Technology,* vol. 27, No. 8, 1993, p. 1461.

many, Sweden, the Netherlands, Britain, France, Austria, and Switzerland are strong competitors with American and Japanese companies in most of the world, including the domestic U.S. market.

Japan

Behind the United States, Japan has the second largest national environmental market, estimated by OECD as $24 billion in 1990 and expected to grow to $39 billion by 2000.[47] Japan, like the United States, Germany, and several other OECD countries, has stringent environmental regulations. And as in those countries, environmental markets will reflect strengthening of already strict standards in some areas and efforts to match better foreign performance in other areas.

Some air quality markets in Japan are the most developed in the world—Japan operates over three-quarters of the world's stack gas desulfurization and denitrification facilities[48]--yet air pollution control requirements continue to be bolstered. For instance, Japanese diesel truck and bus manufacturers are under pressure to meet NO_x reduction requirements of 17 and 35 percent by 1994-1995 for heavy- and light-duty trucks, respectively, with longer term reduction goals of 38 and 56 percent.[49] However, stationary source VOC emissions and toxic air pollutants are less tightly controlled than under the United States' 1990 Clean Air Act Amendments.

Additional efforts are envisioned in the water and waste sectors. At the end of fiscal year 1990, only 44 percent of Japanese residents were served by centralized sewage treatment, and only 62 percent had flush toilets.[50] The Five-Year Program for Sewerage Construction and Basic Program for Public Investment anticipates sewerage services for 70 percent of Japan's residents by 2000. Meanwhile, improvement of residential septic systems is underway. Although already incinerating three-quarters of its municipal solid wastes, the Japanese waste treatment infrastructure is pressured by lack of space for landfills and for new waste disposal facilities. Recycling and waste reduction-related EGS, and improved incineration and resource recovery are growing needs. Japanese hazardous waste treatment and contaminated land remediation requirements do not appear as strong as those in the United States.

Central and Eastern Europe and the Former Soviet Union[51]

The once centrally planned economies of Central and Eastern Europe and the former Soviet Union have inherited grave economic and environmental problems resulting from decades of grossly inefficient management.[52] The region serves as a cautionary example of the dangers of ignoring the environment when pursuing industrial development. Central planners promoted heavy industry and intensive agriculture, with minimal attention to environmental protection. Therefore, many factories do not have pollution abatement equipment; in other cases, existing

47 OECD, op. cit., footnote 2.

48 Coal Technology Research Institute, "World's Emission Purification Techniques," Japan Ministry of Foreign Affairs, "Japan's Environmental Endeavors," April 1992, p. 10.

49 "Truck Makers Pressed T. Reduce Nitrous Oxide Emissions," *Nikkei Sangyo Shimbun*, Dec. 4, 5, and 6, 1991, in Foreign Broadcast Information *Service, JPRS Report: Environmental issues,* JPRS-TEN-92-001-L, *Mar. 25,* 1992, pp. 17-21. Three-part serial newspaper articles by Hirofumi Tanaka.

50 *Environment and Development Japan's Experience and Achievement*, Japan's national report to UNCED 1992, December 1991, pp. 32-33.

51 Another OTA assessment on environmental and energy technology transfer to Central and Eastern Europe is *underway. U.S.* Congress, Office of Technology Assessment *Energy Efficiency Technologies for Central and Eastern Europe,* OTA-E-562 (Washington, DC: U.S. Government Printing Office, May 1993) is the first report of that assessment; a second report, to be released in 1994, will address issues of energy supply and provide additional analysis of energy efficiency.

52 See box 4-B for discussion of the former East Germany.

equipment is often in disrepair. Reliance on poor quality high-sulfur coal is very high, accounting for 80 percent of Polish and 62 percent of Czech and Slovak energy consumption.[53] Sewerage and effluent treatment is usually inadequate-where present. Safe waste disposal sites are lacking. The list of health and environmental impacts is lengthy—diminished lifespans, high rates of lung disease, extremely high heavy metal levels in children's blood, cities blackened with air pollution, dead rivers and lakes, ground saturated with spilt oil, eroded and saline soils, dying forests, Chernobyl, and so on—and is documented elsewhere.[54]

Industrial production itself is hampered by pollution; reportedly 65 percent of the rivers and streams in the Katowice region of southwestern Poland—and 30 percent nationwide—are so polluted that they are unusable for industrial purposes.[55] The major factors of production-labor, capital, and natural resources-have all been impaired by environmental damage, And, contamination inhibits Western investment.

While the needs are great, the resources are modest. Clean-up of Poland alone might require $260 billion over 25 to 30 years, of which $70 billion would be for pollution abatement and most of the rest for restructuring the energy and industrial sectors.[56] The pursuit of a cleaner environment is handicapped by intense economic and political difficulties in moving to market systems of exchange, and from ethnic friction and warfare in some areas. However there remains interest in improving the environment. For instance, Poland committed about $1 billion to environmental investments in 1991, of which all but $60 million was raised in-country, primarily from environmental fees and fines; these locally raised funds were expected to double in 1992.[57] In addition to local currency funds, which might be translated into export commodities such as oil and gas, financial resources come from the European Bank for Reconstruction and Development, the World Bank, the Nordic Investment Bank, the European Investment Bank, EC's PHARE program, and bilateral assistance agencies of the United States and other countries. Still, many environmental products, as well as expertise, must be imported into the region.

Warsaw Pact forces treated their real estate with less care than U.S. and other Western military forces, and the former Soviet nuclear complex is probably an extraordinary challenge to safety and environment.[58]

Water quality is a major environmental priority. Almost two-thirds of Poland's environmental expenditures in 1991 were for the water sector.[59] Polish environmental spending for 1991-1995 is anticipated to reach $1.29 billion for water

53 1989 statistics, United Nations Statistical Office, U.N. Energy Tapes (New York, NY: United Nations, 1991) in World Resources Institute, *World Resources 1992-93 (New* York, NY: Oxford University Press, 1992), T. 5.1.

54 See, for instance, M. Feshbach and A. Friendly, Jr, *Ecocide in the USSR: Health and Nature Under Siege (New* York, NY: Basic Books, 1992); Bedrich Moldan and Jerald L. Schnoor, "Czechoslovakia: Examining a Critically Ill Environment," *Environmental Science and Technology, vol. 26, No. 1, 1992,* pp. 14-21; Ministry of Environmental Protection, Natural Resources, and Forestry, *The State of the Environment in Poland: Damage and Remedy* (Warsaw, Poland: 1992); World Resources Institute, *WorldResources 1992-93 (New* York, NY: Oxford University Press, 1992), Ch. 5; The World Bank, Environment Strategy Study reports for Bulgaria, Poland, and Czechoslovakia.

55 James F. Manji, "Cleaning up in Eastern Europe," *Automation,* May 1991, pp. 20-21.

56 The World Bank, "Poland Draft Environment Strategy Study," draft summary, conclusions, and recommendations (Washington DC: The World Bank, 1989), p. iii; in World Resources Institute, *World Resources 1992-93 (New* York: Oxford University Press, 1992), p, 57,

57 Marek Nowakowski, Director for International Cooperation, Ministry of Environmental Protection of Poland, presentation at GLOBE '92, Vancouver, BC, Canada, Mar. 19, 1992.

58 See U.S. Congress, Office of Technology Assessment, *Dismantling the Bomb and Managing the Nuclear Materials,* OTA-O-572 (Washington DC: U.S. Government Printing Office, September 1993) for discussion of environmental, health, and safety issues related to dismantling and disposing of military nuclear materials.

59 Kenneth J. Macek and Gregory K. Schwartz, "Domestic Environmental Products and Services Sectors: Poland," TMS Management Consulting, Framingham, MA, October 1991. Municipal solid waste or equivalent was not a listed category,

supply, $3.05 billion for water protection, $2.67 billion for air pollution, and $360 million for industrial waste. Hungary intends to spend over $1 billion on water supply and sewerage treatment infrastructure out of a total $2.5 to $3.5 billion environmental investment in 1992 -1996.[60]

Air pollution is a very visible problem. Baghouses and other filters, cyclones, and electrostatic precipitators are relatively simple, low-cost, and effective means of controlling the health threats posed by particulate found in smoke and dust. Coal-cleaning technologies can improve combustion efficiency. Heavy reliance on high-sulfur brown coals leads to a market for desulfurization technologies. Control or prevention of NO_x and VOC emissions for both stationary sources and vehicles are additional needs.

The large stock of obsolete and inefficient capital provides an opportunity for the provision of cleaner production and energy efficiency technologies for both retrofit and new facilities. A recent study estimates that six former Eastern Bloc countries (Poland, Hungary, Bulgaria, Rumania, Czech Republic and Slovakia, and the former Yugoslavia) offer a $19.4 billion potential market for industrial-sector energy-efficiency equipment—meters, analyzers, thermometers, steam traps, fluorescent lights, combustion equipment, insulation, and others.[61] This estimate was derived from results of a U.S. Agency for International Development (USAID) energy assistance program in which 48 industrial facilities in these countries had energy audits and were provided with over $1 million of U.S.-manufactured energy-efficiency equipment. The equipment provided was low-cost and was chosen to offer simple payback within 3 years, although most installations yielded much faster payback—in some cases measured in days.

Monitoring and control technologies, including industrial process control and residential thermostats, offer large environmental and commercial opportunities in these countries.[62] For instance, some urban areas are heated from district heating plants, which in principle can offer superior efficiency because of the opportunity to cogenerate electricity and useful steam. District heating also obviates the need for separate heating plants in each building served. However, in Moscow and other cities, apartments lack thermostats, so overheated apartment-dwellers open their windows in mid-winter, while those in apartments further down the steam line have insufficient heat; the result is tremendous energy waste and discomfort.[63] Companies such as Honeywell are investigating opportunities in this area.[64] Business opportunities for energy service companies (ESCOs) may also arise. ESCOs, pioneered in the United States, identify and provide equipment and services for improved energy efficiency to industrial and commercial clients. Their earnings come from a portion of the money saved from clients' energy bills.

In some cases, existing facilities are so inefficient as to be beyond salvage. This leads to the possibility of phasing out dirtier methods of the past-open hearth steelmaking and mercury-consuming chlor-alkali production, for instance—and introducing cleaner production technology, In the long run, gas turbines burning the region's plentiful natural gas may produce electricity more cheaply and with less pollution than existing

60 Kenneth J. Macek, "Domestic Environmental Products and Services Sectors: Hungary,' TMS Management Consulting, Framingham, MA, January 1992.

61 Mark Hopkins, *Business Opportunities in Eastern Europe for Energy-Efficient Industrial Products* (Washington, DC: The Alliance to Save Energy, January 1992).

62 U.S. Congress, Office of Technology Assessment, *Energy Efficiency Technologies for Central and Eastern Europe*, op. cit., footnote 51, pp. 55, 65-67.

63 Ibid., p. 65.

64 Ibid., pp. 88-89.

plants. Similarly, fluidized-bed combustion and other clean coal technologies are likely to prove superior to air pollution controls on existing power plants. Long-term markets for more economically efficient and environmentally preferable industrial production technologies may far exceed the demand for retrofitted pollution abatement and waste treatment equipment. Some new facilities will be needed before others; for example, capacity to produce unleaded gasoline and low-sulfur motor fuels will bean early need if the region adopts EC-like vehicle standards.

Latin America

Growing environmental awareness and liberalizing of trade are opening up Latin American environmental markets. The region is characterized by a heretofore modest commitment to environmental protection and by continuing poverty in both rural and urban areas. However, the traditional view of environment and development as in opposition is softening. And some countries, have committed growing financial, legal, and administrative resources to environmental matters; for example, the Mexican environment agency's budget grew from $4.3 million in 1988 to $78 million in 1992, essentially doubling yearly in real terms.[65] In April 1992, Mexico, with World Bank aid, began a $126 million program to strengthen environmental management capacity at federal, state, and local levels.[66] Mexico and Brazil are and will continue to be the region's largest environmental markets.

Mexican environmental markets are of particular interest to the United States because of a long shared border, environmental issues associated with the proposed North American Free Trade Agreement (NAFTA), and growth of commercial ties (e.g., American-owned maquiladora plants) and trade. Extreme air pollution in Mexico City and a 1992 disaster in which portions of the Guadalajara sewer system exploded, resulting in significant loss of life, are among the situations that have raised the visibility environmental issues in Mexico and have aroused the interest of EGS exporters and investors abroad. Significant funds are now available for environmental protection; for instance, $4.6 billion is budgeted for a 4-year Mexico City air pollution control program that started in 1991, and $4.5 billion is planned for water/wastewater investments during 1990 to 1994[67] (see tables 4-8 and 4-9). An additional $460 million over 3 years is being committed for the Mexican side of the U.S.-Mexican border

Table 4-8-Mexico City Air Pollution Control Program ($ million)

By category of expenditure	
Clean fuels/fuel substitution	**2,153**
Rehabilitation & expansion of public transport	1,536
Emissions control and monitoring	639
Reforestation	327
Training and R&D	27
By source of funding	
Mexico	**3,671**
Japan Overseas Economic Cooperation Fund	**689**
Japan Export-Import Bank	**228**
Interamerican Development Bank	**46**
World Bank	**44**

SOURCE: Comprehensive Pollution Control Program for the Mexico City Metropolitan Zone, April 1991 in U.S. AID, *Energy and Environment* Market *Conditions in Mexico* (Washington, DC: U.S. AID, March 1992).

65 Sergio Reyes Lujan, Subsecretary of Ecology, SEDUE (Secretariat for Ecology and Urban Development), Mexico, presentation at GLOBE '92, Vancouver, B. C., Canada, Mar. 19, 1992. The Mexican environment agency is *now* part of SEDESOL—the Secretariat for Social Development.

66 U.S. Agency for International Development *Environmental Market Conditions and Business Opportunities in Key Latin American Countries,* Business Focus Series, (available through USAID, Arlington, VA), October 1992.

67 U.S. Agency for International Development Office of Energy & Infrastructure, *Energy and Environment Marker Conditions in Mexico*, Business Focus Series, (available though USAID, Arlington, VA), March 1992.

68 Jan Gilbreath Rich, "Financing Environmental and Infrastructure Costs Under a North American Free Trade Agreement With Emphasis on the Texas-Mexico Border," draft presented to the Institute of the Americas conference "Latin American Environment and Technological Cooperation' La Jolla, CA, Nov. 17-19, 1991.

Table 4-9—1 990-94 Water Supply and Sanitation Sector Plan ($ million)

	1990	1991	1992	1993	1994	Total	(%)
Water supply	206.1	674.1	695.6	690.8	728.1	2,994.7	(66.5)
Sewerage	63.7	232.6	252.1	247.0	238.0	1,033.4	(23.0)
Treatment	16.0	121.5	107.5	112.9	117.6	475.5	(10.5)
Total	285.8	1,028.2	1,055.2	1,050.7	1,083.7	4,503.6	

NOTE: Does not include Mexico City, Guadalajara, Monterrey, and some U.S.-Mexico Border Plan water and wastewater investments. The inter-American Bank has loaned $300 million for Guadalajara and $325 million for Monterrey that are not included in the figure. Mexican projects in the U.S.-Mexico Border Plan allocate an addition $220 million for "wastewater treatment and recycling projects."

SOURCE: World Bank, 1991 and U.S. AID, *Energy* **and** *Environment Market Conditions in Mexico* (Washington, DC: U.S. AID, March 1992)

region.[68] The World Bank recently signed an agreement with Mexico to provide $1.8 billion in loans, matched by $1.2 billion from the Mexican government, for environmental clean-up during the years 1994 to 1996.[69]

A special facility for financing environmental infrastructure projects along the Mexican-United States border region has been proposed as part of an environmental side agreement to NAFTA. (Congress had not yet voted on NAFTA when this report went to press).

Table 4-10 provides a partial estimate of Mexico's environmental market size. Of an estimated 1992 total environmental market of $614 million, imports accounted for $150 million, of which $85 million (about 56 percent of imports) came from the United States.[70] U.S. Department of Commerce data from 1989 indicate that U.S. companies garnered about a quarter of Mexico's air pollution import market. Other major players included Germany, Japan, and Switzerland. U.S. producers dominated equipment imports for water pollution (60 percent of imports) and solid and hazardous waste (over 70 percent of imports) in 1989; German, Japanese, French, and Swiss firms were prominent rivals .71 Although not included in these figures or table 4-10, a U.S. Department of Commerce analysis found that the Mexican solid waste handling equipment market (garbage trucks, waste compactors, street cleaners, and other equipment) amounted to $500 million in 1991 and was expected to reach $625 million in 1992; U.S. suppliers of this equipment sold $233 million (69 percent) of the $337.5 million Mexico imported in 1991.

Table 4-10—Mexican Environmental Markets ($ million)

	1990	1991	1992 (est.)	1993-95 (est.)
Air pollution	78	90	104	119-157
Water pollution	105	126	400	500-780
Solid/hazardous waste"	83	95	110	127-167
Total"	266	311	614	746-1104

•See text for discussion of environmental products that maybe omitted from these figures,

SOURCE: U.S. Department of Commerce in U.S. AID, *Environmental Market Conditions and Business Opportunities in Key Latin American Countries* (Washington, DC: U.S. AID, October 1992).

There are significant environmental markets elsewhere in Latin America. Tables 4-11 and 4-12 present 1992 estimates of the six largest markets and their imports. Environmental spending is expanding for the provision of public water, sewer, and refuse disposal services as well as for industrial environmental activities. Major buyers of air and water pollution control equipment

[69] **Gary Lee, "World Bank, Mexico Agree on Pollution Cleanup Funds,"** *Washington Post,* **Sept. 29, 1993, p.** A18.

[70] **U.S. Agency for International Development,** *Environmental Market Conditions and Business Opportunities in Key Latin American Countries,* **op. cit.,** foomote 66.

[71] Ibid.

Table 4-1 l—Major Latin American Environmental Markets in 1992($ million)

	Air	Water	Solid/Hazard	Total
Argentina	53	100	15	168
Brazil	120	845	50	1,015
Chile	195	350	15	560
Colombia	20	15	10	45
Mexico"	104	400	110	614
Venezuela	25	9	10	44
Total	517	1,719	210	2,446

•See table 4-10 for details and note.

SOURCE: U.S. Agency for International Development *Environmental Market Conditions and Business Opportunities in Key Latin American Countries* (Washington, DC: October 1992).

Table 4-12—Major Latin American Environmental Import Markets in 1992 ($ million)

	Total imports	Percent of total	Imports from U.S.	Total
Argentina	42	25	11	168
Brazil	190	19	92	1,015
Chile	500	89	200	560
Colombia	35	78	10	45
Mexico	150	**24**	**85**	**614**
Venezuela	**43**	**97**	**38**	**44**
Total	**960**	**39**	**436**	**2,446**

SOURCE: U.S. Agency for International Development *Environmental Market Conditions and Business Opportunities in Key Latin American Countries* (Washington, DC: October 1992).

include chemical, petroleum refining, steel, pulp and paper, food, textile, and other process industries. For instance, Brazil's steel, pulp and paper, and cement sectors plan environmental investments that could reach $300 million a year or more.[72] The electric power sector is another important market for environmental equipment. Economic liberalization and loosening restrictions on foreign investment in energy and other industries may assist in the diffusion of cleaner production technologies to the region.[73] Multinational firms from the United States and Europe are major purchasers of environmental equipment and services.

As in Central and Eastern Europe and the former Soviet Union, cleaner production opportunities in Latin America arise from the building of new facilities and introduction of cleaner processes. For instance, the Chilean copper industry is considering investment in new and modernized smelters, copper dryers, and sulfuric acid recovery units that will prevent air pollution.[74] Pemex, the Mexican national oil company, has been adapting refineries to produce unleaded gasoline and low-sulfur fuels.[75] One low-sulfur fuels project, costing $450 million in 1992, involves transfer of technology from U.S. companies (HRI, Texaco, and Foster Wheeler) to several Mexican refineries. Anticipated 6 to 8 percent growth in annual electricity demand in Mexico through 2000[76] could produce markets for cleaner and more efficient electricity generation and end-use technologies as well as for pollution abatement equipment. These examples are illustrative and could apply generally to other expanding industrial sectors throughout the region.

South Korea and Taiwan

South Korea and Taiwan are the two largest of the four East Asian ''tigers,' the other two being Hong Kong and Singapore. These Newly Industrialized Countries (NICs) have engineered sustained high rates of economic growth. Their

[72] **Ibid., p. 41.**

[73] Birdsall and Wheeler **provide limited empirical evidence from Latin America that relatively open economies adopt cleaner technologies more readily than relatively closed economies. Nancy Birdsall and David Wheeler, "Trade Policy and Industrial Pollution in Latin America: Where are the Pollution Havens?," Patrick Low (cd.),** *International Trade and the Environment* **(Washington DC: The World Bank, Aprit 1992) pp. 159-67.**

[74] U.S. Agency for International Development, *Environmental Market Conditions and Business Opportunities in Key Latin American Countries,* **op. cit., footnote 66.**

[75] **Ibid., p. 27.**

[76] U.S. Agency for International Development, *Energy and Environment Market Conditions in Mexico,* op. cit., footnote 67.

Table 4-13—Republic of Korea Environmental Investment Plan 1991-95 ($ million)

	1991	1992	1993	1994-95	Total
Air pollution	$1,384.2	$1,342.5	$598.9	$1,094.0	$4,419.7
Water pollution	622.5	872.0	1,110.4	1,624.7	4,229.7
Waste management	204.7	364.5	493.6	1,890.0	2,952.8
Soil conservation	12.6	15.4	17.7	47,6	93.3
Marine conservation	21.9	25.3	24.0	13.3	84.5
Nature conservation	0.3	0.7	1.3	3.2	5.4
R&D	2.7	12.0	12.7	25.7	53.1
Total	2,248.9	2,632.5	2,258.7	4,698.3	11,838.5

SOURCE: Ministry of Environment (Republic of Korea), *White Paper 7990, 1991,* in Ral Woo Lee, "Perspective of Environmental Industry in Korea," paper presented at GLOBE '92, Vancouver, BC, Canada, Mar. 16-20, 1992. (Categories may not add to total due to rounding off.)

export-led strategies of industrialization are models for other developing countries. Neighboring countries Thailand, Malaysia, and Indonesia aspire to be the next tigers, while other countries in Asia, Latin America, and Africa try to distill the tigers' formulae for success and adapt them to their own contexts. However, the tigers' economic success has occurred with significant adverse impacts on environmental quality.

Inadequate or nonexistent sewerage and industrial effluent treatment facilities, improper handling of municipal and hazardous wastes, and poor control of air emissions affect the health and well-being of Koreans and Taiwanese. Drinking water resources are threatened, as are coastal fisheries (which are also overfished).

Both countries have substantially boosted their environmental protection efforts in recent years. The Korean Ministry of Environment has outlined a $10.5 billion, 5-year program of public and private environmental investment from 1991 to 1995[77] (see table 4-13). The Korean environmental investment plan includes large allocations for SO_2 controls, waste landfills and incinerators, and wastewater treatment. Investments in cleaner fuel infrastructure, such as liquefied natural gas facilities, are part of Korea's air quality investment plans. The plan includes construction of 60 wastewater treatment plants and 55 incinerators by 1995. Thirty-four sanitary landfills may be built over the next two decades.

In 1991, South Korean businesses spent about $732 million on pollution control facilities, of which $375 million was for the water sector, $314 million for air quality, and $37 million for noise abatement.[78] Reportedly, $181 million of EGS were imported to South Korea in 1991, with the U.S. share accounting for 14 percent.[79] As stricter air and water pollution standards come into effect in 1995 for air and 1996 for water, environmental investments could grow from $1.25 billion in 1992 to $4.5 billion in 2000, according to sources from South Korea's Energy and Resources Ministry.[80] Requirements for catalytic converters in new automobiles will create large markets. Growing environmental concerns have led to an expanding Korean environmental industry--over $750 million of environmental projects were

77 Ministry of Environment (Republic of Korea), *White Paper 1990, 1991,* in Tal Woo Lee, "Perspective of Environmental Industry in Korea," paper presented at GLOBE '92, Vancouver, BC, Canada, Mar. 16-20, 1992.

78 "Businesses Spend More on Pollution Facilities in 1991," Yonhap (S. Korean news agency), Mar. 9, 1992, in Foreign Broadcast Information Service, *JPRS Report: Environmental Issues, JPRS-TEN-92-O08,* May 5, 1992, pp. 45-46. Business expenditures on solid waste facilities were not noted.

79 "Korea Needs U.S. Equipment; Problems Remain," *NewsACTION,* vol.7, *No.* 1 (spring 1992), pp. 16-17.

80 "Businesses Spend More on Pollution Facilities in 1991," Op. cit., footnote 78.

Table 4-14-Selected Environmental Projects in Taiwan

Wastewater treatment	**$4.7 billion**	**21 projects**
Solids waste disposal	**3.5 billion**	**23 projects**
General projects/other	1.6 billion	9 projects[a]
Air **and noise pollution**	**532 million**	**7 projects**
Environmental monitoring	**256 million**	**5 projects**
"Environmental sanitation" and toxic wastes	**53 million**	**3 projects**

a One project of the Chinese Petroleum Corporation for "Industrial Pollution Control" accounts for $1.3 billion in this category.

SOURCE: International Business Development, Northwestern University. (Peter Hage, "U.S. Execs Hear Details of Taiwan's Hot Market," *NewsACT/ON,* vol. **7, No. 1** (spring 1992), pp. **5-7,** published by the International Business Development program, Northwestern University.)

awarded to 631 registered environmental firms in South Korea in 1991.[81]

The Taiwan Six-Year National Development Plan for 1992 to 1997 lists $305 billion of public infrastructure and state-owned industrial projects.[82] Of these 775 projects, 68 (accounting for $10.7 billion) are under partial or complete purview of the Taiwan Environmental Protection Administration or local environmental agencies (see table 4-14). Additional projects of the Taiwan Six-Year Plan that are environmentally significant call for installation of cleaner production technologies, including combined-cycle gas turbine generators for Taiwan Power Co., cogeneration and heat recovery projects for the state oil and steel companies, fuel desulfurization facilities, and various efficiency upgrades in state-owned industrial fins.

Taiwan's environmental market was $907 million in 1991, of which imports supplied 68 percent, including $210 million for U.S. goods and services.[83] Details are summarized in table 4-15.

Table 4-15-Taiwan Environmental Equipment, Instruments, and Services Market and Trade ($ million)

	1989	1990	1991	Est. Real Ann. Growth (percent)
Total market	645	745	907	20-25
Imports	450	520	620	20
Exports	3	5	8	
Local production	198	230	295	
1990 import market share (percent):				
U.S.		34		
Japan		29		
W. Germany		17		
Sweden		5		
United Kingdom		4		

SOURCE: U.S. Department of Commerce and American Institute in Taiwan.

India and China

The two most populous nations in the world, China and India, face major challenges in meshing economic development and environmental protection. The two Asian giants suffer from insufficient water, sanitary, and refuse disposal services for their populations. The industrial sectors of both nations are growing fast, including highly polluting sectors such as chemicals, metals, electric power, and cement. Both countries rely on large deposits of cheap coal that create significant pollution problems, particularly when both fuel combustion and energy use are inefficient. These countries are struggling to provide basic environmental services at the same time they face growing toxic and hazardous threats posed by modern industry. The tragic toxic chemical release at Bhopal, India in 1984 focused attention on environmental safety in the growing Indian chemicals sector.

81 "Stricter Guidelines for Environmental Protection" *The Korea Times,* Aug. 18, 1992, in Foreign Broadcast Information Service, *JPRS Reports: Environmental Issues,* JPRS-TEN-92-017, Sept. 21, 1992, p. 29.

82 American Institute in Taiwan, "Listing of Taiwan's Six-Year Development Plan Projects (Partial List) & Status Report on Selected Major Projects," August 1991.

83 American Institute in Taiwan and U.S. Department of Commerce, International Trade Administration Market Research Reports: Taiwan-Pollution Control Equipment, July 1991.

Environmental markets in these two countries are modest by industrial nation standards. The U.S. Department of Commerce estimated that the total Indian market for pollution control equipment in 1990 was $400 million, of which imports accounted for 20 percent ($80 million).[84] The great majority of environmental equipment is made in-country by Indian firms, a number of which are affiliated with U. S., Swedish, and German EGS suppliers via licensing or partnership arrangements. British, Japanese, and Swiss EGS suppliers are also active in the Indian market. About 45 percent of pollution control equipment demand in India is thought to come from the electric power and chemical sectors. Indian environmental equipment markets are projected by the U.S. Department of Commerce to grow 25 to 30 percent annually over the following several years. Estimates of demand for environmental consulting and other services were not available.

China's environmental investments are increasing. The Five-Year Plan for 1991-95 allocates about $15 billion for environmental protection, or about double the spending allocated in the 1986-90 Plan.[85] The government goal is for state spending on environment to reach 0.8 percent of GDP by 1995. Much of the money is likely to be spent on countering pollution from coal-burning by means of fuel switching and improving heating system efficiency, as well as end-of-pipe emissions controls. Japan has targeted part of its Green Aid toward Chinese power plants for leasing and adaptation of flue-gas desulfurization technology.[86] American clean coal technologies might meet some of China's needs.

Water quality spending in China is considerable, with an equipment and instrument market estimated at about $433 million in 1991.87 However, imports accounted for less than $50 million of this market; Japan (40 percent), Austria (25 percent), and the United States (8 percent) were major suppliers.[88] Solid and hazardous waste handling and disposal are also acute needs; China has few landfills or incinerators that can meet industrial country standards for environmental protection. As in the case of India, an indigenous environmental industry is developing. Over 4,000 enterprises with an estimated output of $1 billion comprise the Chinese environmental industry.[89]

Other East Asian Markets

Environmental markets elsewhere in Asia are also expanding. Like Taiwan and South Korea, the Association of South East Asian Nations (ASEAN) countries (Brunei, Indonesia, Malaysia, the Philippines, Singapore, and Thailand) have been experiencing rapid economic growth and industrialization. But environmental degradation accompanying industrialization has become significant and recognition of the problem is only recent. A very rough estimate of the 1993 aggregate ASEAN environmental market is $1.8 billion.[90] (Environmental issues related to for-

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84 U.S. Department of Commerce, International Trade Administration, Market Research Reports: India-Pollution Control Equipment in the Chemical & Power Generation Sector, July 1991 for all information in this paragraph.

85 "China Battles Hard To Clean Up Environment," *China Daily*, Oct. 8, 1992, p. 4, in Foreign Broadcast Information Service, *JPRS Reports: Environmental Issues, JPRS-TEN-92-021, Nov. 12, 1992*, p. 6.

86 "Japan To Propose China Lease Equipment To Trap Sulfur From Coal-Burning Plants," *International Environment Reporter, May 19, 1993*, p. 375.

87 U.S. Department of Commerce, International Trade Administration, Market Research Reports: China-Urban Water Sanitation—ISA9109, Dec. 23, 1992.

88 Ibid.

89 Xinhua news agency, "First Market for Environmental Protection Products," Aug. 9, 1993 in Foreign Broadcast Information Service, *JPRS Report: Environmental Issues, JPRS-TEN-93-022*, Sept. 3, 1993, p. 2.

90 Jonathan Menes, Acting Assistant Secretary for Trade Development, U.S. Department of Commerce, written testimony before the Subcommittee on Environment and Natural Resources of the House Committee on Merchant Marine and Fisheries, Feb. 25, 1993.

estry are very important in this region but are not discussed in this assessment.)

Singapore has instituted relatively strong environmental requirements, which accompany a relatively advanced economy. The country Ministry of Environment has allocated $609.3 million to environmental programs for 1992 and aspires to take regional leadership in the environmental industry.[91] Unleaded fuels and stricter emission requirements have been introduced, and CFC substitution for the country's electronics industry is underway. Hong Kong, another city-state (and not an ASEAN member), has emphasized landfills and sewage treatment. Browning-Ferris Industries (U.S.), for example, was recently awarded a joint venture contract valued at $400 million over 25 years to build and operate a landfill in Hong Kong.[92] A $15 billion sewerage infrastructure program is in progress, with extensive British business involvement.[93] Hazardous wastes are also a growing concern in this rapidly industrializing region; Hong Kong, Singapore, and Indonesia have integrated hazardous waste facilities in operation or under development by Waste Management International, subsidiary of WMX Technologies (U.S.), and Malaysia has recently awarded a contract for such a facility to I. Kruger (Denmark).

Water and wastewater treatment, including industrial effluent treatment, are priorities through most of ASEAN.[94] River water is often highly polluted, sewerage service and safe tap water are often unavailable. Oil and chemical spills are another concern in this region because of a high concentration of petroleum production and refining facilities. The World Bank and Asian Development Bank have over $2.5 billion of urban water and wastewater projects under development in Indonesia, although that country's 1992 market for water pollution control equipment was estimated at only $23 million.[95] Malaysia's 1991-1995 development plan allocates over $1.5 billion for water resources, of which about a quarter is for sewerage and urban drainage.[96]

Air emissions are also of growing concern. Clean coal and other cleaner energy technologies are important features in Thailand's environment and development plans. Recent Thai utility awards of flue-gas desulfurization contracts to Japanese suppliers and gas turbine power plants to U.S. companies are examples of energy and air quality business opportunities in the area. Vehicles emissions are becoming more problematic and it is not unreasonable to believe that other nations of the region will follow Singapore, South Korea, and Taiwan in adopting cleaner motor fuels and vehicles.

Again, as illustrated in previous sections, rapid development creates opportunities for the provision of both traditional environmental products and cleaner industrial and energy technologies.

Near East

Environmental protection is an emerging concern in the Near East as human populations, industrial activity, and agricultural production increase in scale and concentration. In most countries of the region, environmental regulations are still at an early stage of development.

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91 Vincent Yip and Brian Fliflet, "China, Hong Kong, ASEAN Countries Are Frontier Markets," *NewsACTION*, vol. 7, No. 1 (spring 1992), pp. 14-16.

92 "Browning-Ferris Gets Contract to Operate a Hong Kong Dump," *Wall Street Journal*, June 29, 1993, p. A8.

93 Yip and Fliflet, op. Cit., footnote 91+

94 U.S.-ASEAN Council for Business and Technology, "A SEAN Environmental Markets: Opportunities for U.S. Equipment and Service Companies" (Washington, DC: 1991).

95 U.S.-ASEAN Council for Business and Technology, "ASEAN Wastewater Treatment Markets: Opportunities for U.S. Companies," draft, 1992.

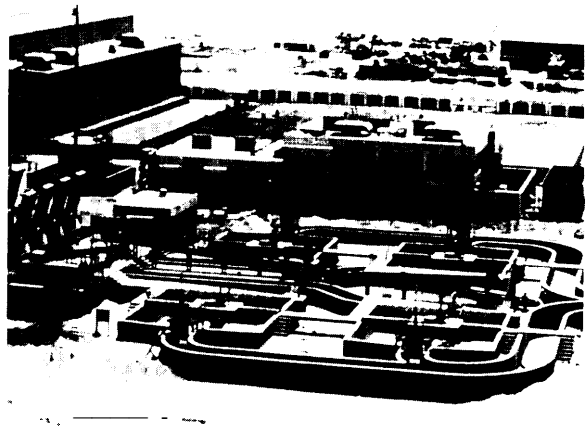
96 Ibid.

Table 4-1 6—Egypt's Estimated Environmental Market ($ millions)

	1992	1997
Municipal water and wastewater treatment	*350'*	*550-700*
Waste recycling	*5*	*8-10*
Industrial wastewater treatmt	*9*	100-150
Air pollution control	NA[b]	100-150
Water purification systems	*30*	50-60
Municipal solid waste	NA	NA
Renewable energy (mainly wind)	12	20
Mobile source air pollution	0	10
Air/water monitoring/testing	6	10
Environmental consulting	15a	40
Total	430	890-1,150

a Current spending chiefly from development assistance.
b NA denotes information not available.

SOURCE: Project in Development and Environment and U.S. AID, *Profile of the Environment Business Sector in Egypt* (Arlington, VA: October 1992).



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Abu Rawash Wastewater Treatment Plant, Egypt. Many newly industrialized and developing countries, and nations in Central and Eastern Europe, plan large investments in water related infrastructure development, often with support of international aid agencies. These projects offer business opportunity for suppliers of equipment and engineering and construction of firms.

Water is the major environmental concern of the region. Estimates of Egypt's environmental market indicate that water and wastewater treatment is by far the greatest priority in that country (see table 4-16). Currently, 90 percent of Egypt's effluents are untreated.[97] Twenty percent of Morocco's 1988-1992 National Investment Budget was dedicated to sanitation.[98] Efficient water use and wastewater recycling are important components of Israeli environmental practice; 66 percent of sewage is reused for irrigation and drip irrigation apparatus is employed to minimize spread of water borne pathogens.[99]

Waste management is a public health concern particularly in urban areas. Greater Cairo has landfill and comporting capacity to handle only 22 percent of wastes generated; most wastes in smaller Egyptian cities are not collected.[100] Turkey reportedly has no modern landfill or waste incineration capacity.[101] With growing industrial production, lack of hazardous waste treatment and disposal capability is also an issue. Air pollution is a major concern in urban areas as industry, motorized transport, and electric power generation increase.

Other Developing Countries

Environmental markets in most of Africa, other parts of Asia, other parts of Latin America, and the small island nations are not well-documented. Environmental needs vary with the level of industrialization and urbanization. For most developing countries, provision of basic water,

97 Project in **Development and** Environment **and U.S. Agency for International Development,** *Profile of the Environment Business Sector in Egypt* **(Arlington, VA: October 1992), p. 9.**

98 U.S. Department **of Commerce, Market Research Reports, Morocco--Water Sanitation** Equipment, Dec. **23,** 1992.

99 Yoram Avnimelech, **'Irrigation With Sewage Effluents: The Israeli Experience,'** *Environmental Science & Technology,* **vol.** *27, No. 7,* July *1993,* pp. *1278-1281.*

100 Project in Development and Environment **and U.S. Agency for International Development, Op. Cit.,** footnote **97, P.** 10.

101 International Finance Corporation, *Investing* **in** *the Environment: Business Opportunities* **in** *Developing Countries* (Washington, DC: **World Bank and International Finance Corporation 1992), p. 16.**

sewer, and refuse disposal services are the major environmental priorities. Often in these countries, techniques and technologies appropriate for rural village application (which are not examined in this assessment), such as improved cookstoves, forest management, and improved agricultural practice, are of great importance.

Relative to larger or more industrialized developing countries, these national environmental markets are small. Environmental regulations and enforcement are often weak and the availability of technical and managerial expertise limited. Most less-developed countries must rely on assistance from multilateral institutions and bilateral donors to build their environmental management capabilities and their environmental infrastructure. For environmental product and service providers, aid and foreign investment are likely to be the major funding sources for environmental business.

CONCLUSIONS

Markets for environmental goods and services, including cleaner production technologies, are growing throughout the world. The character of these markets depend on the environmental and economic situations in each country. Perceptions of risk and available resources-financial, technical, and others-determine what environmental markets will be like.

The largest markets are in the industrialized nations. A leading tier of countries (including the United States, Japan, and Germany) continues to toughen their relatively stringent regulations while some other industrial nations play catch-up. Even within the leading tier, regulatory stringency varies-a country may have the strictest regulations for some pollutants and more lax ones for others.

The NICs (South Korea, Taiwan, Singapore, and Hong Kong) and advanced developing countries, including several countries in ASEAN and Latin America (especially Brazil and Mexico), have recently made environment a prominent feature of governmental attention and national investment. The industrialized nations and the more prosperous of the newly industrialized states have the money to spend on environment and will likely dominate environmental market growth in the decade ahead. A number of low-income countries, including China, India, and Indonesia, also present environmental business opportunities.

Central and Eastern Europe and the former Soviet Union have enormous environmental problems and financial resources that are sparse in comparison--except for eastern Germany, which can rely on the wealth, stability, expertise, and strong currency of its western compatriots. While nations like Poland are now dedicating local currency resources and adopting policies (like rational energy pricing) that are more conducive to improved environmental performance, the region's unstable institutions of business, property, law, and governance may dissuade some foreign investment. However, foreign assistance from development banks and bilateral programs is significant, and innovative investors might take returns in the form of oil, gas, fertilizer, and other export products. Political and social unrest make portions of the region financially and even physically unsafe (e.g., former Yugoslavia, the Caucasian republics) for investment. An advantage the region has over much of the developing world is their highly educated workforce and highly trained technical and scientific talent.

Most of the developing world is struggling to deal with the environmental stresses often exacerbated by a lack of basic environmental infrastructure and services, like running water, sewerage, and refuse collection. In less-developed countries, environmental product and service exporters and investors may find profitable options limited to projects financed through foreign assistance. Careful investment, however, may produce successful local enterprises.