

ENVIRONMENT

ABSTRACT

The U.S. environmental industry is a diverse collection of services and technologies struggling in a highly competitive and mature domestic market. Today, U.S. environmental practices are not simply the products of a distinct industrial sector, but rather reflect good business decisions in all sectors. The shift to prevention rather than cleanup has resulted in a flat domestic U.S. market. This has forced the environmental industry to look internationally for growth and opportunities, primarily in developing nations. These nations have huge demands for infrastructure projects, especially solid waste disposal, wastewater treatment, and the production of potable water. Because of cultural differences, limited resources, and uncertainty within the market, however, U.S. industry does not appear to have a competitive advantage.

LTC Kurt Andrews, USA
CAPT John Scott Atkinson, Jr., USN
Dr. C. David Brown, Dept. of the Army
Col Guy Dahlbeck, USAF
Mr. Ronald C. Eller, Dept. of the Army
Lt Col Michael A. Giroux, USAF
Mr. Milton E. Hill, Dept. of the Interior
Mr. J. Phil Huber, Dept. of the Army
LTC William R. Johnson, USA
Mr. James D. Love, Dept. of the Air Force
Colonel Pat Ongartitthichai, Royal Thai Armed Forces
LtCol Mark R. Savarese, USMC
Mr. Edward A. Tomchick, Dept. of Labor
Ms. Maureen E. Wylie, Dept. of the Army

Dr. Greg Foster, faculty
Mr. Michael Habib, faculty
Ms. Holly Wise, faculty

PLACES VISITED

Domestic

Aberdeen Proving Grounds, MD
Aerovironment, Simi Valley, CA
ARCTECH, Inc., Chantilly, VA
Bank of America, San Francisco, CA
Bechtel Group, San Francisco, CA
Boeing Company, Seattle, WA
California Environmental Business Council, Redwood City, CA
CH2 M Hill, Santa Ana, CA
Chevron Corporation, San Francisco, CA
Earthtech, Long Beach, CA
EMCON, San Jose, CA
Foster Wheeler Environmental Corporation, Los Angeles, CA
Pacific Northwest National Laboratory, Richland, WA
Port of Los Angeles, CA
Siemens Solar, Camarillo, CA
Sierra Club, San Francisco, CA
Sunshine Makers, Inc., Huntington Harbor, CA

International

ADEG Engineering Consultants, Rio de Janeiro, Brazil
Ambio Engineering, Rio de Janeiro, Brazil
Aracruz Cellulose, Rio de Janeiro, Brazil
Bechtel Corporation, Mexico City, Mexico
CEGESTI, San Jose, Costa Rica
Comision Nacional del Agua, Mexico City, Mexico
Costa Rican–American Chamber of Commerce, San Jose, Costa Rica
Rica
DuPont Corporation, Mexico City, Mexico
Environmental Finance Corporation, San Jose, Costa Rica
FEEMA (State Environmental Agency), Rio de Janeiro, Brazil
ICF Kaiser, Rio de Janeiro, Brazil
Johnson Wax, Rio de Janeiro, Brazil
KS Engineering, Inc., Rio de Janeiro, Brazil
National Center for Cleaner Production, San Jose, Costa Rica
National Institute for Biodiversity, San Jose, Costa Rica
U.S. Filter, Mexico City, Mexico
WWP Continental, San Jose, Costa Rica

INTRODUCTION

The U.S. environmental industry is multidimensional and complex. The term *environment* entered the language of public policy debate only in the late 1960s. Accordingly, the definition of environmental industries remains fluid, with older, more established industrial enterprises and newer, technology-based firms referring to themselves as “environmental industries.” These industries continue to evolve concurrently with the legal, political, and cultural mechanisms that define any given nation’s environmental requirements—laws and regulations, the marketplace, or customs. The environmental industry differs from other traditional industrial sectors in that its products and services have resulted from government mandates that, in turn, resulted from international treaties and federal, state, and local legislation and regulations.

The industry contains both traditional and nontraditional components. Identified by Standard Industrial Classification (SIC) codes, traditional components include laboratory services; consulting services; and air, water, and waste pollution control services. Nontraditional components include an array of non-government organizations that act as policy advocates for single or multiple issues or that assist in emergency or developmental activities in which no traditional business is interested because of significant associated risks or minimal profit opportunities. Both traditional and nontraditional components of the environmental sector affect other major sectors such as the energy, chemical, and automobile industries.

The environmental industry in the United States is at a critical juncture. What was a high-growth industry is now clearly an industry in transition. Most major industrial sectors in the United States have achieved substantial compliance with existing environmental regulations. That, coupled with the adoption of fewer new regulations, has diminished industry demands for environmental services and products. Thus, the U.S. environmental industry has gone through a transition as industry at large has learned that sound environmental practices can be profitable. The most cost-effective way to deal with waste is not to produce it.

National environmental policy is moving the environmental industry toward sustainable development—a policy that fosters concurrent economic growth and environmental stewardship. The U.S. environmental industry is focusing on research and improved technologies, and is seeking out new markets, primarily in the developing countries.

Environmental issues have major national security ramifications. The current U.S. national security strategy makes the link between environmental degradation and national interests clear:

Decisions today regarding the environment and natural resources can affect our security for generations. Environmental threats do not heed national borders and can pose long-term dangers to our security and well-being. Natural resource scarcities can trigger and exacerbate conflict. Environmental threats such as climate change, ozone depletion and the transnational movement of hazardous chemicals and waste directly threaten the health of U.S. citizens.¹

THE ENVIRONMENTAL INDUSTRY DEFINED

The 1999 *U.S. Industry and Trade Outlook* defines the environmental industry as one that advances “sustainable development by reducing risk, enhancing cost-effectiveness, improving process efficiency, and creating products and processes that are environmentally beneficial or benign.” The industry includes “air, water, and soil pollution control; solid and toxic waste management; site remediation; engineering, design, and consulting services; environmental monitoring; recycling; and industrial and clean process technology.”²

CURRENT CONDITION

Although relatively flat in the United States, the market for environmental business is one of the fastest growth sectors worldwide. The most authoritative estimates available suggest that the global environmental market will have grown from about \$420 billion in 1995 to approximately \$600 billion by the year 2010.³ There will be some growth in U.S. and Western European markets, but these markets will continue to decline as a percentage of world market share (Table 1). The largest growth as a percentage of the world market will be in Asian markets (not including Japan).

Although this global picture appears promising, the U.S. environmental industry is in a period of mergers and acquisitions due to overcapacity, a mature market, and intense foreign competition. The environment in the United States has improved dramatically over the past 20 years, causing environmental issues to take a back seat to other concerns. As a result, market demand—driven by environmental legislation, regulations, standard setting, and enforcement—is shrinking. In 1995, the U.S. environmental industry employed about 1.3 million

Table 1: Global Environmental Market⁴

Region	1995		2000		Growth (%)
	1995 (\$B)	Share (%)	2000 (\$B)	Share (%)	
United States	172.1	40.3	209.4	38.5	-1.8
Western Europe	132.3	31	161.2	29.7	-1.3
Japan	67.8	16	81.7	15.0	-1
Canada	11.3	2.6	14.5	2.7	0.1
Latin America	7.4	1.7	13.0	2.4	0.7
Eastern Europe/Russia	6.9	1.6	10.2	1.9	0.3
Australia/New Zealand	6.5	1.5	8.3	1.5	0.0
Middle East	4.0	.9	5.4	1.0	0.1
Africa	2.0	.4	3.2	0.6	0.2
Rest of Asia (less Japan)	16.6	3.8	36.4	6.7	2.9
	426.9		543.3		

people (1 percent of the U.S. workforce) and produced more than 23,800 new jobs. According to estimates from Environmental Business International, the U.S. environmental industry reached \$176 billion in revenues in 1995, a 4.3 percent increase over 1994. Current figures released by the Department of Commerce show annual revenue growth slowing to 1.2 percent by 1998, however.⁵

Because of a dearth of new federal regulations and lax enforcement of existing regulations, there are likely to be few opportunities for expansion in the U.S. environmental market. In its 1999 industry survey, Standard and Poor's (S&P) portrays a lackluster, fragmented U.S. environmental industry that is suffering from sluggish demand and commoditylike offerings that are typical for a mature market.

U.S. Domestic Picture—Industry at Capacity?

Standard & Poor's divides the U.S. environmental industry into four major segments: water supply and treatment, solid waste management, air pollution control, and environmental remediation.⁶

Water Supply and Treatment. The largest of the four segments is the \$82 billion water supply and treatment industry, which is growing at about the rate of inflation. The only ways for companies to grow in this mature market are either to acquire regulated water utilities or to expand into nonregulated markets. In recent years, U.S. Filter-American Water Works—the largest U.S. investor-owned water supply company, with revenues of \$995 million—has acquired more than 20 water supply

operations. The intense foreign competition is quite evident in the municipal water treatment subsegment where the giant French water utilities, Vivendi (with revenues of \$28 billion) and Suez Lyonnaise des Eaux (with revenues of \$15 billion), as well as several British water companies, have been purchasing U.S. water treatment plants. Competition in this sector currently favors foreign firms that have more experience with plant operation and are often able to bring additional “tied aid” or self-generated financing to the table.

Solid Waste Management. The \$39.5 billion solid waste management segment of the U.S. environmental industry struggles in a slowly growing market characterized by weak demand, increasing capital costs, an overabundance of landfill capacity, intense competition, and increasingly stringent federal and state regulations. In response to these weak fundamentals, many smaller, investor-owned and municipally run operations are being forced either to close or to sell their operations to large, publicly traded firms.⁷

Air Pollution Control. Weak markets continue to hold back the mature and low-margin \$12.5 billion air pollution control segment. Both the automotive emissions control and smokestack pollution control subsegments face an uncertain regulatory environment. Federal legislative support for new regulations that would give this industry segment a boost has not been forthcoming. In the past few years, Congress has dramatically reduced the number of new air pollution regulations passed. The lack of an infusion of any new monies due to budgetary constraints has forced both the federal Environmental Protection Agency (EPA) and state-level environmental agencies to curtail the enforcement of existing regulations.⁸

Environmental Remediation. The \$8 billion environmental cleanup (remediation) industry is also suffering from a weak market and low-margin, commoditylike service offerings. The U.S. government, which initially was a primary source of business for this segment, has been reducing its funding over the last several years. Currently, government remediation funding is used mainly to finance cleanup of old military and Superfund sites, although the effort to restore ecosystem health is also receiving some attention.⁹

It is in this arena—ecological restoration—that there is some potential for market growth. Scientific advances in the understanding of complex ecosystems have come as traditional compliance and remediation business is leveling off. In this market, government agencies with land management responsibilities will be the largest customer, although private firms are likely to increase their restoration efforts as well. There is room for both large firms with engineering and

construction experience and smaller, more ecosystem-focused firms in this market.

As in the environmental industry as a whole, firms in the ecological restoration niche are generally small companies.¹⁰ There are a few firms that span market segments; for example, some of the large engineering and consulting firms have added ecological restoration to their remediation planning and management business. As part of the overall slowdown of the environmental industry as it matures, however, large firms are consolidating or downsizing. This change is fueling the number of small, niche firms positioned to act as subcontractors to leaner large firms.¹¹ Ecological restoration work is ideal for smaller, subcontracting firms that may specialize in baseline surveys and analysis, design, plant material development and supply, or installation.

Forest products, mining, and agribusiness firms are all potential customers for ecological restoration products and services. For example, large forest products companies such as Georgia-Pacific and Weyerhaeuser not only intensively plant trees in plantations, but also are often required to undertake riparian restoration to ensure that water quality standards are met. Hard rock and strip mining firms are required to clean up mine wastes and restore sites. Agribusiness is involved in soil conservation, water quality management, and wetlands permitting.

There is also a growing international market for ecological restoration services. The market outside the United States is strongest in Canada, Europe, Australia, and Japan. In addition, there is a demand for ecological services or restoration expertise to address problems such as deforestation, desertification, or soil erosion on disturbed sites in the developing world.

Global Picture—Help Needed for U.S. Industry?

If the U.S. environmental industry is to grow, it must seek developing world markets. In the world market, however, the successful company is the one that offers a wide range of affordable solutions to infrastructure problems and tailored packages, ranging from consultation to complete operational management of a site or project. Success in the world market also requires companies to be flexible. In general, U.S. environmental companies have not competed well internationally because they typically do not provide total solution packages; rather, they provide solutions only to part of the customer's problem. This is a challenge that U.S. environmental companies must overcome if they are to renew the health and growth of the industry in the United States.

Developed and developing countries may have different types of impediments to U.S. access or increased market share of their environmental business. Developed countries may inhibit U.S. access by use of conventional market barriers or by use of nontariff barriers (e.g., requirements for technology-specific performance or performance-specific equipment). Developing countries may have limited or no control over the forces that restrict demand in or access to their markets. In such countries, the absence of environmental regulations or enforcement fosters a low demand for environmental technologies. Many native companies may not comply with environmental laws or may choose to pay fines instead of investing in pollution prevention/control equipment or services. Developing countries are also more reliant than developed countries upon external financing from development assistance or multilateral development banks to pay for their environmental investments.¹²

Federal government intervention could assist U.S. environmental companies in competing more successfully in the tougher international markets. The U.S. government could help by guaranteeing payment and liability protection to U.S. firms that provide environmental industry services to developing nations. By doing so, the government could stimulate the U.S. environmental industry abroad while, at the same time, achieving international environmental objectives. Government could also assist by providing economic offsets to developing nations that meet strict environmental goals.

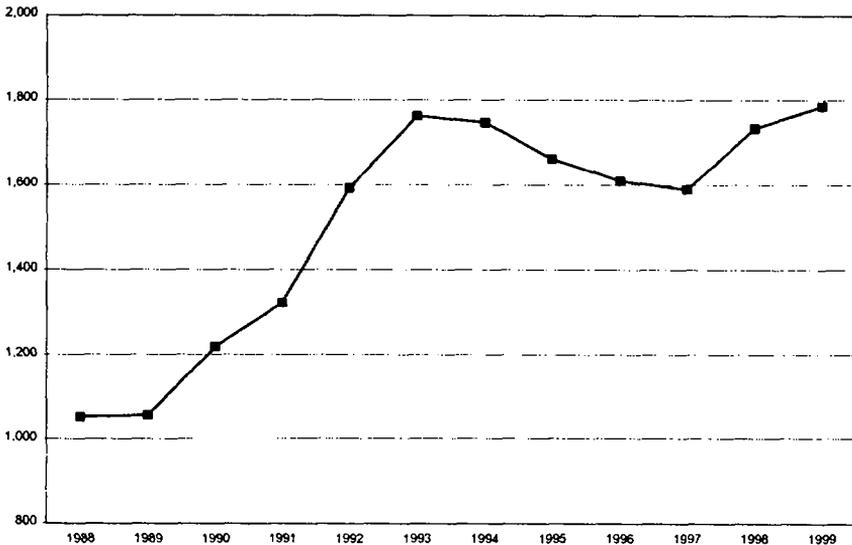
To energize the environmental industry, the United States must regain the sense of urgency and emphasis on the environment that it had in the 1960s and 1970s. One way to provide that stimulus for industry growth is through a greater emphasis on research and development (R&D) for environmental technologies. The United States has been a leader in R&D for most technologies; however, other countries are rapidly catching up. If the United States is to stay ahead of other countries and increase its share of the world market, the nation must take the lead in innovative environmental technologies.

Low rates of private and public investment in environmental technology R&D, a lack of coordination between researchers in the government and private sectors, and inefficiencies in the investment of government R&D resources reduce the rate of environmentally beneficial technology innovation. The rate of environmental companies' investment in R&D, particularly basic research, for new products and services is very low compared with that of other industries. Many U.S. engineering, environmental infrastructure, and service companies make no investments in technology R&D and product development. The

number of companies on the equipment side investing in research continues to decline because of market uncertainties, and companies in this segment invest only about 3 percent of their revenues in research, most of it for short-term product development projects. By contrast, companies in such high-growth industries as semiconductors invest about 10 percent of revenues in R&D.¹³ Without public sector support and new policies, this shortfall in environmental R&D will continue to be the case.

The need for more public sector support has been and remains of concern to the environmental industry, as well as to those manufacturing industries heavily affected by environmental issues. These industries need more cost-effective and innovative ways to address environmental issues. Although R&D is the leading edge for those new and innovative solutions, federal R&D budgets have not shown that the country is seriously concerned about the environment. Even though there have been increases in R&D budgets for Fiscal Year 1998 and Fiscal Year 1999 (Figure 1), these increases have been primarily for applied product development rather than early basic research. Even with the increases, the federal environmental R&D budget for 1999 is only 1.3 percent above that of 1993. The energy industry is among those most directly

Figure 1: Environment Research and Development (in millions)



Source: *Standard & Poor's*, 1998.

affected by this trend: "New technologies on the horizon are likely to have profound effects on the future structure and operation of the electric power industry. Many of the technologies will not come about unless new ways can be found to expand investment in basic technology research."¹⁴

Trends

Two trends are particularly noteworthy in the shape of the U.S. environmental technology sector today. The first is in the nature of environmental technology itself. In the past, the focus was on controlling releases and cleaning up past pollution: building scrubbers that remove sulfur dioxide from a smokestack, for example, or cleaning up contaminated waste sites. Increasingly, environmental technology is emphasizing ways to avoid pollution altogether. Energy systems are shifting toward cleaner fuels, such as natural gas or renewable sources. Manufacturing firms are adopting products and processes designed from the outset to minimize the use of raw materials and the output of pollutants. The resultant effect of this trend is to move from "end-of-pipe" solutions to environmental problems to "at-the-source" solutions by focusing on new fuels, more sustainable technologies, and "green production methodologies."¹⁵

The second trend is related to the markets for environmental technologies, particularly overseas.¹⁶ Major U.S. foreign competitors include Germany, Japan, the United Kingdom, and France. These countries have a strong export orientation because they have relatively small domestic environmental markets; consequently, they must export in order to realize economies of scale in their production of environmental goods.

In world markets, U.S. firms lead in remediation and management of solid and hazardous waste; European firms are especially strong in soil and water treatment; and Japanese firms lead in air pollution control. Many U.S. competitors receive significant government support. In Mexico alone, Germany committed \$3.5 million in 1994 to promote its environmental technologies exports. Japan has committed \$2.2 billion over 10 years to finance exports of Japanese environmental industry. These commitments become more important as state and local governments privatize infrastructure to avoid up-front capital expenditures. Firms are increasingly expected to bring their own money or their government's money to new projects.

Public and private expenditures on environmental technologies in the United States will almost surely change significantly in the future.

Technology trends alone make it clear where the United States must be in 2040 to maintain a competitive posture. In the early 2000s, investments in remediation will have cleaned up a large proportion of existing hazardous waste sites. Increased expenditures in technologies to avoid environmental harm should have paid off significantly by that time. Manufacturing processes will be more efficient in the use of resources; consumer products will be designed with the environment in mind; and the infrastructures that supply energy, transportation services, water, and food will be more resource-efficient and environmentally benign. By the year 2040, most industries should be at or near zero discharge of pollutants, although some control technologies may still be required to deal with residual discharges. Investments in large, macroscale monitoring systems and new microsensors will permit continual assessment of the environment in ways not now possible. At some point before 2040, the United States will move from an environmental paradigm based on cleanup and control to one based on anticipation, avoidance, and assessment.¹⁷

Several industry researchers and expert observers have speculated on the future of environmental technology. One of the more respected forecasts comes from the Department of Energy's Pacific Northwest National Laboratory (PNNL). Researchers there have identified the ten most important technological breakthroughs, which they believe will lead to a cleaner environment while providing major benefits to consumers over the next decade. Foremost among these technologies are preventive ones that PNNL researchers believe will provide major technical advancement, meet a serious need, and/or create an entire new industry within the environmental technology field.¹⁸

Two of the more significant such technologies are smart water treatment, and enviromanufacturing and recycling. Smart membranes, or filters, will improve water treatment at sewage plants and municipal water supplies by adjusting simply or even automatically to unclog themselves. Membranes and other techniques will remove organic compounds that currently can produce undesired reactions with chlorine. Spongelike grains of sand will attract and hold nitrates and heavy metals to further protect drinking water in large and small systems.

In 10 years, "green" companies will emphasize enviromanufacturing and recycling. They will create products that are environmentally friendly from cradle to grave. Plastics, paper, beverage containers, inks, cars, and computers will be more biodegradable or recyclable. Also, newer processes, such as dry cleaning with liquid carbon dioxide, will minimize or eliminate waste. Not only will cleaners cease to use

hazardous chemicals to clean clothes, but also they will capture and recycle the carbon dioxide so as not to add to atmospheric carbon.

Other key future technologies identified by PNNL researchers include agrogenetics (genetic plant engineering), renewable energy sources, micro-engineering, advanced display systems to reduce paper consumption, molecular material design, bioprocessing, real-time environmental sensors, and lightweight cars.

The environmental technology industry today is in serious need of a comprehensive national R&D policy. The United States does not currently have the technology to efficiently and effectively clean up its more than 300,000 dangerously polluted soil and groundwater sites. Because first-generation technologies will require decades and billions of dollars to remove only a fraction of the pollutants, significant portions of the pollutants will remain within the soil and groundwater. Without a national emphasis on environmental technology R&D, it will be virtually impossible to develop the technologies needed to increase the effectiveness, reduce the time, and minimize the costs of these cleanup efforts. Moreover, the United States will not be able to take the lead in the world markets of tomorrow.

CHALLENGES

Environmental challenges affect virtually all major industries. The materials used in manufacturing processes and the processes themselves have enormous effects on air and water pollution, for example. A review of three major U.S. industrial sectors—energy, chemical, and automobile—and their efforts at environmental compliance and stewardship shows that each of these sectors has dealt with significant environmental issues in the past and faces more environmental challenges in the future.

Energy Industry

Energy, particularly oil, is critical to the security of the United States. As former Secretary of Energy Federico Pena has observed, “Energy plays a vital role in our economy, accounting for over 7.3 percent of our gross domestic product, or about \$2,000 per year for every man, woman, and child in the United States.” Pena goes on to say that the national security of the United States depends on affordable sources and abundant supplies of energy. This is particularly significant in view of the fact that the United States depends on oil for about 40 percent of its primary energy needs. Oil becomes even more important as U.S.

dependence on foreign oil seems likely to grow from approximately 50 percent today to 60 percent by 2010.¹⁹

While oil is critical to the security of the United States, it is also an industry facing difficult times. Crude oil prices have dropped over the past 2 years by more than 40 percent. The abundant supply and weakening world demand, especially in Asia, contribute to the lowest world oil prices since the early 1970s. Weak oil prices are an immediate concern of oil and gas executives, but most have adapted to the volatility in modern energy markets and have used technology to reduce costs in exploration, recovery, and refining. Any treaty or regulation reducing greenhouse gas emissions would have a significant monetary impact on petroleum producers—an impact that they are not eager to accept.

At the 1998 annual meeting of the American Petroleum Institute (API), members were urged to get involved in human rights and ethical issues in the countries where they work and to find solutions to such issues as the environment. Gregg Easterbrook, senior editor of *The New Republic* and a vocal critic of environmental doomsayers, told API members, “Environmentalists are never going to like you, but the important question is: Will the public like you?” Whereas the public has the impression that environmental quality is declining, in reality, the environment is actually improving. In Easterbrook’s words, “It takes 25 years of continuing good performance to get the message to the public. Regulation gets a lot of credit for dramatic improvements in air and water quality . . . and society will need more regulation in the future.”²⁰

Global warming and the final outcome of the Kyoto Protocol to reduce greenhouse gas emissions will have a significant impact across the U.S. energy landscape. The global warming issue is an emotional topic, and many advocates argue that severe measures must be undertaken at the earliest opportunity. A growing body of scientific data, however, suggests that the problem is not as clear-cut as first thought and that the economic consequences of the proposed solution to the alleged problem far outweigh the potential benefits. Regardless of the debate, it seems clear that global warming is a constructed, if not an actual, reality from which there is no turning back. Large companies like Chevron, Boeing, and others have already reduced their emissions below the 1990 levels required by the Kyoto agreement. These early actions, which have allowed such companies to accumulate emissions credits, are both noteworthy from an environmental standpoint and shrewd from a business standpoint. The credits have huge potential value to the company that holds them, but the value will be realized only if the United States eventually ratifies the treaty. With enough companies pursuing this strategy, there will be increasing pressure for ratification.

Chemical Industry

Environmental regulators and environmentalists probably watch the chemical industry closer than they watch any other sector. The chemical industry touches everyone's lives in one way or another. Strategically, it is the largest of all manufacturing sectors in the United States. In 1997, the industry accounted for 11.5 percent of the U.S. manufacturing gross domestic product (GDP) and almost 2 percent of the total GDP. It experienced a \$19.1 billion trade surplus and employed more than 1 million workers.

The industry's reporting via the Toxic Release Inventory (TRI) reflects the environmental progress in this sector. From 1988 to 1996, the chemical industry reduced releases of core chemicals by 51 percent, or 535 million pounds. In 1996, toxic releases by the industry totaled 785 million pounds—50 percent air emissions, 11.5 percent water emissions, 25.5 percent underground injections, 8.7 percent on-site land releases, 0.3 percent landfill releases, 4 percent transfers for off-site disposal. Of the air emissions, seven chemicals accounted for two-thirds of all releases—ammonia, methanol, carbon disulfide, ethylene, propylene, toluene, and hydrochloric acid.

The chemical industry's environmental progress has resulted not only from regulatory compliance efforts, but also from voluntary efforts to decrease toxic releases. It has cooperated with the EPA and has created a management program for improved environmental performance. From 1988 to 1992, the chemical industry spent nearly \$20 billion for pollution abatement. In recent years, industry expenditures on the environment have been on the decline. In industrial chemicals, the largest chemical subsector, 3.6 percent (\$5.7 billion) of company sales were spent on environmental protection in 1992. The figure fell to 3 percent (\$5.1 billion) in 1994 and 2.7 percent (\$4.9 billion) in 1996. The largest chemical firm, DuPont, reported environmental expenditures of \$1 billion in 1993, \$950 million in 1994, and \$800 million in both 1995 and 1996. This reflects the industry's move away from large capital investments for pollution abatement and toward more economical and efficient methods for dealing with chemical pollution.

Environmental industry opportunities associated with the chemical industry will depend on the environmental challenges facing the latter. These challenges are threefold: new EPA programs focused on the chemical sector; better performance metrics; and the industry's reorientation toward sustainable development. The chemical industry

will look to the environmental industry to provide information systems and software to find the best and most cost-effective solutions to ecoproblems.

Automobile Industry

The United States is a major player in the world's automobile industry. In an age in which environmental protection and recycling are socially acceptable and increasingly mandatory, the automobile industry remains one of the largest environmental offenders. Some air quality-monitoring groups blame automotive emissions for 60 percent of all air pollution in U.S. urban areas, and yet our lives revolve around the use of the automobile. This industry is also key to the U.S. economy. This industry is large enough and geographically widespread enough that a production slowdown for any reason, from a labor strike to a downturn in sales, has a significant negative impact on the U.S. economy. The principal environmental legislation regulating the automotive industry is the Clean Air Act of 1970, with amendments in 1977 and 1990. All three bills look toward transportation to reduce air pollution, and automobiles are the most numerous vehicles in this class. State implementation plans addressing measures and milestones are mandatory under the 1990 Clean Air Act Amendments.

Since the passage of the Clean Air Act in 1970, aggregate emissions have declined for virtually every pollutant that EPA monitors. The reduction in hydrocarbons and nitrogen oxides is important because they are precursors of ozone. Significantly, the amount of lead in the air has been checked substantially, dropping 75 percent between 1987 and 1996 due to the removal of lead from gasoline. The greatest boon to the decline in mobile source emissions has been the gradual ratcheting of vehicle emission standards, lowered targets that the automobile industry has consistently met. While advances in technology have held emissions in check, other emission control strategies, such as reformulated gasoline, oxygenated gasoline, and inspection and maintenance programs, have found little success, despite high costs.

Economic Impacts Beyond the Environmental

Environmental requirements are based on health standards, available technologies, and the use of standard procedures and prescriptive processes. Accordingly, any business or government activity that wants to minimize environmental degradation by virtue of compliance or economic efficiency must use a combination of services, techniques, and

management strategies to accomplish the dual goals of being a good environmental steward and operating efficiently. Environmental programs are expensive and require significant capital investments, as well as long-term maintenance programs, to be effective. On the average, businesses invest 1–2 percent of their annual expenditures for environmental concerns. Not all governments are equal in their abilities to achieve these goals. To this end, global environmental issues present a much more daunting and significant challenge for the world's nations to resolve—integrating legal, technical, financial, cultural, and other national systems both intrastate and interstate.

CONCLUSION

The U.S. environmental industry that exists today is multidimensional and complex. This industry grew feverishly, driven by government actions such as the ratification of international treaties and the passage of domestic legislation, the promulgation of executive requirements, and the adoption of standards established by professional and public interest organizations. The pace of new legislation and regulations has declined, however, and this rapidly changing industry is facing the challenges of maturity by seeking ways to maintain competitiveness domestically and globally. Parts of the industry as it is today will disappear in the United States as the requirement for end-of-pipe compliance or large-scale remediation disappears.

Government has a key role to play in increasing U.S. competitiveness. To give the United States the lead in 21st century environmental technology, there must be greater emphasis on R&D. Not only will the emphasis on technology play to U.S. strengths, but also technology is the key to sustainable development in both the developed and developing worlds.

The U.S. environmental industry must prepare for the shift away from compliance and remediation in its core market. Although interested parties continue to call for additional regulation and enforcement, this approach is short-sighted in light of the gradual movement to market-based compliance and pollution prevention. A commitment to emerging technologies and potential overseas markets is essential, despite the short-term risks. Government can help by providing risk management resources, such as profit liability protection and more environmental technology-based assistance to developing countries.

The environmental industry can be instrumental in achieving the goal of sustainable development around the world. If U.S. industry wishes to play the leading role, it must look beyond business practices that

generated past successes. Instead, it must assume greater risk, fund the development of innovative technology, and search for total package solutions to customer needs. These changes will not come easily. Accordingly, the U.S. environmental industry will find it difficult to maintain a competitive advantage into the next millennium.

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- ³ U.S. Department of Commerce, *U.S. Industry and Trade Outlook 1998* (New York: McGraw-Hill, 1998), Chapter 20.
- ⁴ U.S. Congress, *Environmental Industry Study* (Washington, DC: Government Printing Office, 1998).
- ⁵ U.S. Department of Commerce, *U.S. Industry and Trade Outlook 1998*.
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- ⁸ U.S. Department of Commerce, *U.S. Industry and Trade Outlook 1998*.
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- ¹¹ John R. Kane, "Northwest Boom Masks Environmental Slowdown," *The Seattle Daily Journal of Commerce*, August 20, 1998.
- ¹² U.S. Department of Commerce, *U.S. Industry and Trade Outlook 1998*.
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- ¹⁸ Pacific Northwest National Laboratory, "Environment Wins in Technology Forecast," News Release, April 20, 1998.
- ¹⁹ U.S. Department of Energy, *Comprehensive National Energy Strategy*, April 1998.
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