Environmental Protection Agency 5

As the major federal environmental regulatory agency,[1] the Environmental Protection Agency's (EPA) greatest influence on environmental technology is through regulation and enforcement, not direct support for R&D. Environmental technology demand is largely driven by regulatory requirements, although some pollution prevention and energy efficiency technologies can be cost-effective even in the absence of strict standards. Environmental laws, regulations, administration of permits, and other policies and procedures sometimes propel and at other times impede environmental technology innovation.

Recognition of the need for EPA to address regulatory or other barriers to technological innovation appears to have grown in recent years. A number of studies, including several by advisory bodies to EPA, have urged the agency to place more emphasis on the potential for innovative technologies to help achieve environmental goals more cost effectively.[2]

The agency has taken some steps to remove impediments and add incentives for technological innovation. A major objective of the agency's recently promulgated Environmental Technology Strategy is to promote innovation (see box 5-1). Another recent

[1] Several other agencies have some environmental regulatory jurisdiction including the U.S. Army Corps of Engineers, Coast Guard, Fish and Wildlife Service, and National Marine Fisheries Service of the National Oceanographic and Atmospheric Administration, among others.

[2] See, for example, U.S. Environmental Protection Agency, National Advisory Council for Environmental Policy and Technology, *Report and Recommendations of the Technology Innovation and Economics Committee: Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation*, EPA 101/N-91/001 (Washington, DC: U.S. Government Printing Office, January 1991).

BOX 5-1: EPA's Technology Innovation Strategy

EPA's Technology Innovation Strategy applies to EPA's own activities and guides priorities for the EPA-led Environmental Technology Initiative. The strategy has four objectives:[1]

- "Objective #l: Adapt EPA's policy, regulatory and compliance framework to promote innovation."
  Strengthen incentives for and remove barriers to innovation in regulatory, permitting, compliance, and enforcement programs at federal, state, and local levels without compromising environmental protection.
- "Objective #2: Strengthen the capacity of technology developers and users to succeed in environmental technology innovation. "
  Work with public and private sector partners to identify and address market inefficiencies and failures affecting environmental technology. Highlight high priority technology gaps. Catalyze innovation and commercialization through "partnerships; providing testbeds, analytical tools, and technical support; and standardizing test protocols to enhance credibility of performance data on innovative technologies. "
- "Objective #3: Strategically invest EPA funds in the development and commercialization of promising new technologies. "
  Directly fund selected technologies that can meet critical needs, offer good breakthrough possibilities, and require timely public financing (and do not supplant private funding).
- "Objective #4: Accelerate the diffusion of innovative technologies at home and abroad."
  Enhance public and private information networks on environmental market needs and technology performance and availability. "Provide technical assistance, training, education, and information management . . . and [strengthen] environmental policy and regulatory framework abroad. " Promote federal procurement of innovative technologies.

As noted, EPA's regulatory and compliance activities have a greater impact on technological change than its direct support of RD&D. Therefore, an objective of the technology strategy is to make the regulatory process more innovation friendly.[2,3] It also suggests greater support for technology performance verifications, test beds, and demonstrations that may help open markets for innovative technology in cases where technology users and permit writers favor old technologies because of perceived regulatory, technical, and economic risks associated with new technology. EPA's strategy also emphasizes partnerships with the private sector as well as with universities, sister federal agencies, state and tribal governments, and localities.

Finally, the strategy recognizes the importance of pollution prevention or cleaner technologies that avoid generation of pollution and waste in the first place. The agency's traditional expertise and regulatory heritage, however, has been in the realm of end-of-pipe control, disposal, and remedial technologies, Indeed, despite EPA's professed emphasis on pollution prevention and its development of several prevention oriented programs, the agency's RD&D resources are still greatest for remediation and restoration. (See table 5-1.)

SOURCE: Office of Technology Assessment, 1995

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[1]This discussion is drawn from Environmental Protection Agency, "Technology Innovation Strategy of the U.S. Environmental Protection Agency," (Washington, DC, external discussion draft, January 1994)

[2]A number of EPA documents discuss this issue including Environmental Protection Agency, National Advisory Council for Environmental Policy and Technology, *Report and Recommendations of the Technology Innovation and Economics Committee: Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation,* EPA 101/N-91/001 (Washington, DC: U.S. Government Printing Office, January 1991)

[3]Also, see discussion in U.S. Congress, Office of Technology Assessment, *Industry Technology and the Environment, Competitive Challenges and Business Opportunities,* OTA-ISC-586 (Washington, DC: U.S. Government Printing Office, January 1994) Another OTA report, forthcoming in the summer of 1995, discusses environmental policy tools from the context of renovation and other factors

activity, called the Common Sense Initiative, seeks consensus among stakeholders in several industrial sectors about ways to accomplish environmental goals more cost effectively, including removal of barriers to technological innovation. Encouraging innovation is also an objective of Clinton Administration's Environmental Technology Initiative (ETI), discussed below, for which EPA has lead-agency responsibilities.

Many of these efforts focus as much or more on removing regulatory impediments to new environmental technology commercialization as they do on providing direct R&D support. The complex relationships, both positive and negative, between environmental regulations and environmental technology innovation, are addressed in other OTA work, to which the reader is referred;[3] this paper focuses primarily on EPA's direct support for environmental technology R&D.

ENVIRONMENTAL TECHNOLOGY R&D SPENDING

EPA's interest in technology development is at least threefold. The agency relies on some kinds of technologies in performing its regulatory mission. Examples include technologies for measuring, monitoring, and modeling transport and fate of pollutants; for determining health and ecological impacts of chemicals, pollutants, and environmental degradation; and for monitoring compliance by regulated entities.

It also makes use of technologies in carrying out environmental compliance activities for which it has direct responsibility. The agency has responsibility under Superfund[4] for cleaning up abandoned hazardous waste sites for which responsible parties cannot be found or are unable to pay for remediation. EPA is also obliged to see that its own laboratories and other facilities meet environmental requirements.

More broadly, the agency is interested in technologies that can help companies, municipalities and other government entities, households, and others meet standards and improve environmental performance. This third interest derives from EPA's need to determine technological and economic feasibility of compliance options as well as the agency's broader mission to promote environmental quality.

As is discussed in chapter 2, estimates of environmental technology research, development, and demonstration (RD&D) spending by EPA and other agencies should be viewed with caution. The line separating environmental technology RD&D from other activities that may have a technological component (e.g., scientific research; technical assistance; risk, health, and ecological assessment; and regulatory support) is often arbitrary. Moreover, a single program may include several of these activities, so that the technological component may be difficult to separate out in a consistent fashion. Also, there can be instances of double counting where resources are shared or transferred among different programs, offices, and agencies.

According to National Science and Technology Council (NSTC) data, EPA spent about $94.2 million on environmental technology RD&D, and an additional $18.6 million on technology scaleup and commercialization activities in FY 1994.[5] For FY 1995, EPA estimates that it will spend $100.8 million for RD&D and $45.9 million for scaleup and commercialization. (See table 5-1.) It should be noted that technology R&D is only a portion of EPA's total R&D; most of EPA's research budget is for environmental and related health sciences,

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[3] See, especially, U.S. Congress Office of Technology Assessment, *Industry, Technology, and Environment: Competitive Challenges and Business Opportunities*, OTA-ISC-586 (Washington, DC: U.S. Government Printing Office, Jan. 1994), pp. 54-59, 81-87, 122-124, 210-220, and 263-289. Another OTA study on environmental policy tools, is forthcoming in the summer of 1995.

[4] Formally, the Comprehensive Emergency Response, Compensation, and Liability Act of 1980 (Public Law 96-510).

[5] National Science and Technology Council, Committee on Environment and Natural Resources and Committee on Civilian Industrial Technology, Joint Subcommittee on Environmental Technology, unpublished data, Apr. 6, 1994.

TABLE 5-1: Estimated EPA Support for Environmental Technology RD&D ($ millions)

Category	FY 1993	FY 1994	FY 1995
Pollution avoidance	17.3	25.8	30.4
Pollution control	12.6	17.9	16.9
Monitoring and assessment	14.3	15.1	16.5
Remediation and restoration	34.3	36.4	37.0
Subtotal	**78.5**	**95.1**	**100.8**
Scaleup and commercialization, all categories	8.3	18.6	45.9
Total *	**86.8**	**113.8**	**146.7**

SOURCES. National Science and Technology Council, Committee on Environment and Natural Resources and Committee on Civilian Industrial Technology, Joint Subcommittee on Environmental Technology, unpublished data, Apr. 6, 1994.

including such activities as toxicological studies, risk assessments, ecological studies, and basic science research. Total EPA R&D spending is estimated to be $535 million for FY 1994 and $589 million for FY 1995.[6,7]

Relative to several other federal departments and agencies, EPA's funding for environmental technology RD&D is modest. It accounted for only about 5 percent of the total spending by federal agencies on environmental technology RD&D in FY 1994 (using OTA's estimate of the total). The Departments of Energy (DOE), Defense (DoD), Agriculture (USDA), and the National Aeronautics and Space Administration (NASA) fund more environmental technology RD&D than EPA.

ENVIRONMENTAL TECHNOLOGY INITIATIVE

EPA is the lead agency for the Environmental Technology Initiative (ETI), which includes participation from DOE, DoD, USDA, the Department of Commerce (DOC), NASA, National Science Foundation (NSF), and other agencies. ETI received $36 million in FY 1994 and $68 million in FY 1995. About $15 million of ETI's FY 1994 spending was passed through EPA to other federal agencies. (See table 5-2.) The Clinton Administration requested $120 million for FY 1996; Bills reported by the House Committee on Science and the House Committee on Appropriations have proposed zeroing out or greatly reducing the ETI budget.

ETI's main FY 1995 solicitation is directed to federal, state, and tribal agencies. Private entities and local governments are able to participate indirectly as partners, grantees, or contractors. Two other solicitations set aside about 6 percent each of FY 1995 ETI funding for advanced stage Small Business Innovation Research (SBIR) projects, and for projects from universities and other nonprofit organizations. About 25 percent of FY 1995

[6] National Science and Technology Council, Committee on Environment and Natural Resources, unpublished data; and Office of Management and Budget, *Budget of the United States Government: Fiscal Year* 1996 (Washington, DC: U.S. Government Printing Office, 1995), pp. 94, T. 7-1.

[7] Congress was still considering FY 1996 authorizations and appropriations for EPA as this report went to press. The House Committee on Science had just reported H.R. 1814, which would authorize $490 mi11ion for EPA's Office of Research and Development (ORD) for FY 1996. The amount includes RD&D and related program management and support by ORD; some R&D by EPA is not conducted by ORD. Funds for technology development activities are not specified. The bill would not authorize funds for the Environmental Technology Initiative, the Climate Change Action Plan, or indoor air pollution research.

The House Committee on Appropriations had reported out a measure to the full House of Representatives, which recommended a one-third reduction in overall EPA funding for FY 1996. Within this total it recommended that $384 million be appropriated for ORD activities—an increase over ORD's FY 1995 appropriation-but proposed no funds for the Environmental Technology Initiative.

TABLE 5-2: Federal Agency Recipients of FY 1994 Environmental Technology Initiative Funding Other Than EPA ($ thousands)

Agency	Funding
Department of Energy	$3,350.2
National Institute of Standards and Technology	2,903.6
Department of Defense[a]	2,731.3
Department of Commerce[b]	1,536.9
Bureau of Mines	1,154.3
Tennessee Valley Authority	1,001.7
Department of Agriculture	900.0
Small Business Administration	703.9
Agency for International Development	309.4
National Science Foundation	180.0
U.S. Coast Guard	120.0
National Aeronautics and Space Administration	30.0
Bureau of Prisons	50.0
Other	75.0
Total	15,046.3

[a] Includes individual services and U.S. Army Corps of Engineers
[b] Other than National Institute of Standards and Technology.
SOURCE: Environmental Protection Agency

ETI funding is designated to support projects under the National Action Plan for Global Climate Change and is not part of the other ETI solicitations.[8]

ETI's FY 1994 program plan enumerates 73 activities falling in four major categories:[9,10]

1) Environmental and Restoration Technologies (24 projects/activities; $11.5 million)
   Research, development, demonstration, testing, and evaluation of monitoring, pollution prevention, control, and remediation technologies. Criteria for selection include meeting critical environmental needs and prospects for technological breakthrough in reasonable time.
2) Clean Technology Use by Small Business (24 projects/activities: $11.3 million)
   Technical assistance for pollution prevention, joint RD&D with industry, and catalyzing design of safer chemicals, products, and processes. Several Design for the Environment projects are included.
3) U.S. Technology For International Solutions (US TIES)
   (11 projects/activities; $10.8 million)
   Promotes use of U.S. technologies and expertise abroad through technical assistance, training, demonstrations, market and needs assessment, and participation with industry in international standards development.
4) Gaps, Barriers, and Incentives
   (13 projects/activities; $1.7 million)
   Identifies environmental technology gaps and needs; identify and remedy regulatory barri-

[8] Environmental Protection Agency, "Environmental Technology Initiative: Program Solicitation Package FY 1995," EPA 542-B-94-010 (Washington, DC: July 1994).

[9] Environmental Protection Agency, *U.S. EPA Environmental Technology Initiative: FY 1994 Program Plan* (Washington, DC: U.S. Government Printing Office January 1994).

[10] Environmental Protection Agency, untitled mimeo listing FY 1994 Environmental Technology Initiative projects, May 1, 1995.

ers; and test and evaluate innovation friendlier permitting, inspection, and enforcement approaches.

In addition, five SBIR projects garnered $771,000 in FY 1994 ETI funding.

ETI's FY 1995 solicitation is divided into six topic areas:

1) policy framework,
2) innovation capacity,
3) environmental technologies,
4) pollution prevention technologies,
5) domestic diffusion, and
6) international diffusion.

These areas are arrayed across the four objectives of EPA's Technology Innovation Strategy. (See box 5-A.)

As with the Technology Innovation Strategy, ETI's activities run the gamut from "hard" technology RD&D to "softer" activities on regulatory and compliance approaches, management and accounting tool development, technical assistance and information dissemination, and other efforts that do not fall strictly under the RD&D category but may be quite important to shaping the climate for technological innovation.

ORGANIZATION FOR ENVIRONMENTAL TECHNOLOGY

EPA's environmental technology responsibilities are shared among several offices. The Office of Policy, Planning, and Evaluation helps develop the agency's technology policies and has lead responsibilities for management of the Administration's Environmental Technology Initiative. R&D is carried out through the Office of Research and Development (ORD) and the agency's media offices: Office of Air and Radiation (OAR), Office of Pesticides and Toxic Substances (OPTS), Office of Water (OW), and Office of Solid Waste and Emergency Response (OSWER) The internal Innovative Technology Council works on crossoffice priorities. EPA's regional offices and offices responsible for enforcement and education may also have some relevance to technology development and dissemination. The Office of International Activities supports international technology diffusion and technical assistance.

ORD, which conducts intramural R&D and supports extramural research, has been reorganized; its laboratories and centers are now grouped under four units:[11]

- National Center for Environmental Assessment;
- National Risk Management Research Laboratory;
- National Health and Environmental Effects Laboratory; and
- National Exposure Research Laboratory.

A National Center for Extramural Research and Quality Assessment is also being established. Of these new units, the National Risk Management Research Laboratory is germane to development and diffusion of pollution prevention, control, and remediation technologies while the National Exposure Research Laboratory is relevant to development of monitoring technologies.[12] The reorganization is designed to consolidate and streamline

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[11] "EPA Begins Reorganizing Labs; Research Panel Endorses Change," *McGraw-Hill's Federal Technology Report*, Mar. 30, 1995, pp. 11-12.

[12] The National Risk Management Research Laboratory oversees EPA's Risk Reduction Engineering Laboratory (Cincinnati, OH), Air and Energy Engineering Research Laboratory (Research Triangle Park, NC), Robert S. Kerr Environmental Laboratory (Ada, OK), and the Center for Environmental Research Information (Cincinnati, OH). The National Exposure Research Laboratory supervises the Environmental Monitoring Systems Laboratories (Las Vegas, NV and Cincinnati, OH), Atmospheric Research and Exposure Assessment Laboratory (Research Triangle Park, NC), and the Environmental Research Laboratory (Athens, GA). National Research Council, Board on Environmental Studies and Toxicology, *Interim Report of the Committee on Research and Peer Review in EPA* (Washington, DC: National Academy Press, March 1995), Figure 3, p. 21.

ORD's operations although at this time EPA claims to have no plans to shut down any of its laboratories or centers.[13]

EPA supports extramural research through individual grants, grants to such organizations as the American Water Works Association Research Foundation and Water Environment Research Foundation, and support for various university-based centers, including six Hazardous Waste Research Centers and several Exploratory Research Centers.[14] Many of the university-based centers focus on treatment and remediation of hazardous wastes. The Center for Clean Industrial and Treatment Technologies at Michigan Technological University is an example of a center emphasizing pollution prevention. In FY 1994, EPA spent $45.5 million on exploratory grants and centers, of which about $14.5 million was estimated to be for environmental technology R&D.[15]

One extramural grant program—and part of ETI—is the NSF-EPA Partnership for Environmental Research, which includes a Technology For a Sustainable Environment component. This component will award up to $6.5 million in FY 1995 for pollution prevention technology research concentrating on 1) industries dominated by small business, 2) manufacturing operations that occur in various industries (e.g., cleaning and degreasing, coatings, and refrigerants), and 3) environmentally preferable process chemistry and materials manufacturing, including process control technology.[16]

ORD's technology R&D effort addresses all environmental media—air, water, and land—from prevention to remediation and disposal, as well as monitoring.

A major technology evaluation component of EPA is the Superfund Innovative Technology Evaluation (SITE) program. SITE was established in 1986 jointly by ORD and OSWER to support demonstration and testing of innovative remediation technologies.[17] In SITE's demonstration program vendors pay to demonstrate their technologies while EPA pays for planning, sampling, and analysis. The reports generated through SITE provide independent information that potential customers—including federal agencies—may use to consider innovative technology purchases. SITE's budget was $17 million in FY 1993. FY 1994's SITE program was between $10 million and $11 million.[18] A Municipal Innovative Technology Evaluation Program (MITE) for municipal solid waste technologies received $1 million in FY 1993 but was zeroed out for FY 1995. Some pollution prevention demonstration and evaluation projects exist within ETI or are supported through other programs such as the Pollution Prevention Incentives to States program.

EPA's media offices also undertake technology development and diffusion activities. Many of these are directly pertinent to supporting regulatory and compliance functions. However, some, such as the Technology Innovation Office (TIO) in OSWER, are focused on facilitating develop-

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[13] "EPA Begins Reorganizing Labs; Research Panel Endorses Change," *McGraw-Hill's Federal Technology Report*, Mar. 30, 1995, pp. 11-12.

[14] A number of university centers are also part of the National Science Foundation's Engineering Research Centers and Industry-University Cooperative Research Centers system.

[15] Environmental Protection Agency, "Environmental Protection Agency Wide Response to FY96 OMB-NSTC/CENR Data Call," attachment 2 (Washington, DC, Aug. 9, 1994, mimeo).

[16] National Science Foundation and U.S. Environmental Protection Agency, *Interagency Announcement of Opportunity: NSF-EPA Partnership for Environmental Research*, (Washington, DC, Feb. 24, 1995, mimeo).

[17] Environmental Protection Agency, "Innovative Hazardous Waste Treatment Technologies: A Developer's Guide To Support Services" (third ed.), EPA/542-B-94-012, September 1994.

[18] S. James, National Risk Management Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH, personal communication, May 3, 1995.

ment and use of innovative environmental technologies relevant to Superfund, Resource Conservation and Recovery Act corrective actions, and leaking underground storage tank remediation.[19] EPA's Innovative Technology Council, which includes representatives from headquarters offices and regional units, provides cross-office review and project recommendations to carry out the agency's Technology Innovation Strategy. Also, Technology Advocates have been designated from each major agency office to facilitate introduction and acceptance of new technologies.

Like other federal research agencies, EPA sponsors a Small Business Innovation Research program. The agency also cooperates with the Small Business Administration and Small Business Development Centers across the country although some of this work is technical and compliance assistance rather than RD&D.

In accordance with the Federal Technology Transfer Act (Public Law 99-502) and subsequent laws to encourage transfer of federally supported technologies to the private sector for commercialization, EPA laboratories have actively engaged in cooperative research and development agreements (CRADAs) as well as patent licensing agreements with corporations. As of July 1994, EPA had 57 CRADAs and 12 patent licensing agreements.[20]

Although not a part of EPA, the National Environmental Technology Applications Corporation (NETAC) was created by EPA in 1988 through a cooperative agreement as a nonprofit subsidiary of the University of Pittsburgh Trust to provide intermediary services to facilitate environmental technology commercialization. Starting with $9 million of seed funds from EPA, NETAC is now financed through contracts with private, state, and federal clients. NETAC provides independent technology evaluation services, and offers technical, marketing, and regulatory assistance to environmental technology innovators.[21]

INTERAGENCY ACTIVITIES

National Science and Technology Council related efforts

EPA participates on the National Science and Technology Council (NSTC), its Committees on Environment and Natural Resources (CENR) and on Civilian Industrial Technology, and the Joint Subcommittee on Environmental Technology (JSET).

Under the aegis of CENR, the Private Enterprise-Government Interaction (PEGI) Task Force, which includes EPA and eight other federal agencies, acts to identify private sector environmental technology R&D and opportunities for federal-private collaboration and data sharing.

EPA and other agencies involved with environmental RD&D are part of the Interagency Environmental Technologies Office (IETO), established under JSET. IETO aims to promote cooperative approaches to development of environmental technologies. Initial activities included consolidation of information on environmental technology needs, research, and expertise across the agencies. IETO is also trying to facilitate public-private collaborations for environmental technology commercialization.

Other Interagency Participation

EPA participates in numerous environmental technology projects and programs in partnership with other federal agencies, states, and other enti-

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[19] Environmental Protection Agency, *Innovative Hazardous Waste Treatment Technologies: A Developer's Guide To Support Services* (3rd ed.), EPA/542-B-94-012, September 1994.

[20] Ball & Associates, "Programs That Support Development and Diffusion of Innovative Environmental Technologies," contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, December 1994, p. I-94.

[21] U.S. Congress, Office of Technology Assessment, *Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities*, OTA-ISC-586 (Washington, DC: U.S. Government Printing Office, January 1994), p. 307.

ties. Major federal partners include DoD, DOE, DOC, the Department of Interior (DOI), USDA, and NSF. As is discussed in chapter 3, EPA and DOE jointly manage the National Industrial Competitiveness through Energy, Environment, and Economics Program. It also participates with DOE and DoD in the Strategic Environmental Research and Development Program and the Committee to Develop On Site Innovative Technologies.