CDIE
Impact Evaluation
United States Agency for International Development

REDUCING URBAN AND INDUSTRIAL POLLUTION IN INDIA

An emerging industrial power, India faces major pollution problems. USAID has undertaken to help abate the release of emissions and effluents into the air and water using American technologies—thus helping U.S. firms as well. Significant success has been observed, but lack of solid baseline data obscures the actual extent of USAID's role.

SUMMARY

In 14 of India's 20 largest cities, citizens breathe air the government deems "dangerous." Six cities endure levels of airborne particulates at least three times the World Health Organization standards. A thriving industrial base and rapid economic growth—about 5 percent a year—account for much of the severe pollution, which costs India an estimated $9.7 billion a year in environmental damage.

A decade ago, following India's leap into industrialization, USAID designed a major industrial pollution project, Trade in Environmental Services and Technologies. The five-year TEST project had two objectives: (1) to develop U.S.–India business linkages that would lead to increased trade opportunities for American companies and (2) to improve environmental conditions in India. By the end of the project, TEST had provided technical assistance to 92 Indian enterprises. Twelve of them had entered into a partnership with American companies and received loans from the Industrial Credit and Investment Corporation of India (ICICI), the collaborating partner for the project.

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TEST ended in 1997. Its successor, the Clean Technology Initiative, has similar goals (developing U.S.–India business linkages and improving environmental conditions), but it concentrates on helping leaders of Indian industry become more competitive in international markets through environmental initiatives. CTI is also working with industry associations, and it has introduced the concept of greening the supply chain, whereby manufacturers require their suppliers to employ environmentally sound practices in the production of components.

A third project, Financial Institutions Reform and Expansion, touches specifically on urban (as distinct from industrial) pollution. FIRE supports the development of environmental infrastructure, such as sanitation, water supply, and solid-waste management.

In May–June 2000, a four-person team from USAID's Center for Development Information and Evaluation (CDIE) visited India to assess the results of the three projects. The team found progress on a number of fronts—but lack of baseline data often prevented them from ascribing it definitively to USAID initiatives. Among their findings:

- TEST engendered 14 U.S.–India business deals valued at $35 million. Of this amount, the project financed 26 percent; ICICI financed the rest.
- In 1991, American suppliers were exporting $6 million of environmental equipment to India annually, 4 percent of the total $135 million market. In 2000, these companies were exporting $150 million of such equipment. How much of this increase is attributable to TEST cannot be determined.
- It is impossible to quantify overall changes in net air and water quality resulting from the imported technologies. However, data provided by one of the U.S.–Indian joint ventures shows impressive reductions in particulate emissions: 6,300 tons per day in 1999 at 13 companies in 4 industries.
- It can be assumed that urban pollution measures under FIRE—such as potable water and trash pickup—are bound to have improved human health. Beneficiaries have reported reduced water stagnation and fewer visits to doctors and hospitals. But hard data to substantiate these claims are unavailable.

Not surprisingly, one of the central conclusions reached from the evaluation was that solid baseline data are needed to assess a program's impact. Lack of such data severely restricts the ability to conduct an accurate assessment. Another observation is that companies will not invest in pollution control technologies or environmental management systems unless they believe that doing so is in their business interest. That leads to a third observation: strict government enforcement of environmental standards is a strong incentive for companies to acquire pollution control technologies.

BACKGROUND

India is among the 10 most industrialized countries in the world. It has the world's eighth largest economy. Stimulated by a program of economic liberalization beginning in 1991, India's economy grew by 5 percent a year, on average, during 1992–97. However, rapid economic and industrial growth is causing severe urban and industrial pollution. A 1995 World Bank study conservatively estimated India's annual environmental damage at $9.7 billion, or 4.5 percent of gross domestic product (in 1992 prices). Of this, $7 billion was due to air and water pollution.

Data from India's National Ambient Air Quality Measuring Network show that 14 of the country's 20 largest cities have air quality that is "dangerous." Bombay, Delhi, and Ma-

dras are among the 10 most polluted cities in the world. In these and three other large Indian cities (Ahmedabad, Kanpur, and Nagpur), the annual average level of total suspended particulates in the atmosphere is at least three times World Health Organization standards. Industrial water pollution is also a serious problem. The main source is the nearly three million small and medium-size enterprises scattered throughout the country.

State pollution control boards are India's primary pollution control enforcers. They prescribe discharge standards and inspect equipment, industrial plants, and manufacturing processes. However, their effectiveness is limited. They often lack the technical capacity to monitor hazardous wastes. Moreover, they must rely on time-consuming judicial remedies to close down polluting industries. Poor enforcement is also due to political interference: in India, corruption is pervasive.

In 1992 the government of India formulated a policy on pollution abatement. Consistent with the country's shift to economic liberalization, the policy supported pollution prevention through both stronger regulations and market-based instruments. Also in 1992, USAID designed a major industrial pollution project, Trade in Environmental Services and Technologies (TEST). A follow-on project, the Clean Technology Initiative (CTI), was then designed. A third USAID project, Financial Institutions Reform and Expansion (FIRE), supports environmental infrastructure development in urban areas and, like CTI, is an ongoing activity.

Trade in Environmental Services and Technologies

TEST was designed to help Indian industries adopt environmentally sound practices while promoting sustainable linkages between American and Indian firms. Thus, TEST was not just an environmental project; promoting trade was equally important. TEST authorized $25 million over five years (1992–97); by September 1997, USAID obligations totaled $19.4 million, and total expenditures were $9.78 million. The Industrial Credit and Investment Corporation of India represented the Indian government during project implementation and was responsible for the financing component of TEST.

ICICI had been established in 1955 by the World Bank and representatives of India's financial establishment as a development financing institution. Today it is listed on the New York Stock Exchange and operates on a commercial basis. Of the original $25 million of TEST funds, $20 million was to be loaned by ICICI to Indian companies that needed financing to procure environmental services or pollution prevention technologies from American companies. The remaining $5 million was slated for a U.S. contractor to identify American suppliers of environmental technology and facilitate commercial transactions between American and Indian firms.

The prospective success of TEST was based on a number of assumptions. Among them: (1) There was growing market demand for environmental services and technologies not available in India. (2) The United States had technically and economically competitive know-how in at least several environmental technologies. (3) A shortage of financing options hindered the transfer of commercial environmental technology from the United States to India. (4) Strong regulatory and market incentives were in place in India to induce Indian industries to invest in pollution control technologies. Unfortunately, some of these assumptions, critical to project success, proved invalid.

Clean Technology Initiative

After an external evaluation of TEST in January 1997, CTI was designed as a follow-on project. Total authorized funding was increased from

$25 million to $29.95 million; the project assistance completion date was extended by five years to September 2002. CTI was about half completed when the CDIE team visited India in May 2000 to evaluate the three projects.

When CTI began, environmental regulation was shifting away from command-and-control approaches to market-based strategies in India and elsewhere. The regulatory paradigm, based on emissions limits that industry had to meet (by installing scrubbers, filters, and other end-of-pipe devices), relied on government enforcement of regulations—and India's enforcement capabilities were weak. By contrast, the modified approach, emphasizing pollution-prevention and polluter-pays paradigms, was grounded on business self-interest. CTI has two main components: (1) promoting industrial environmental management and (2) promoting adaptation and transfer of cleaner technologies.

The first component targets specific, highly polluting industries: automobiles, cement, textiles. It provides U.S. technical assistance to promote improved environmental management through four market-based initiatives: (1) ISO 14001 certification (for compliance with internationally agreed-upon standards), (2) greening the supply chain (whereby manufacturers require their suppliers to employ environmentally sound practices in the production of components), (3) benchmarking techniques (whereby companies can assess their environmental performance against that of other companies), and (4) industrial extension services (similar to agricultural extension services) to deliver information on environmental technologies and best practices. The success of these four initiatives is grounded in the belief that environmental performance has become a competitive factor globally and that profitability depends increasingly on how well businesses integrate sound environmental management into their business practices.

The second, trade-oriented component of CTI, like TEST, offers financing to Indian companies to procure cleaner process- and energy-efficient technologies from the United States that help reduce greenhouse gas emissions. To achieve this objective, CTI supports business exchanges and information networks to identify American sources of environmental services and technologies. Unlike TEST, though, which worked with individual companies, it uses the "wholesale" approach (working with trade associations of the strategically targeted industries) to facilitate knowledge transfer.

Financial Institutions Reform and Expansion

Unlike TEST and CTI, both designed to address industrial pollution, FIRE addresses urban pollution. It has two components: FIRE-R for "regulatory" covers government regulation of the stock market; FIRE-D for "debt" covers the debt market. The original FIRE project was implemented over five years (1994–98). It was extended for another five years with an ending date of September 2003. FIRE-D addresses two issues. The first concerns mechanisms to finance urban environmental infrastructure. The second concerns actual delivery of infrastructure to benefit the urban poor. This assessment examines primarily the second issue.

The FIRE project is supported by up to $125 million in loans from USAID's Environment Credit Program, formerly the Housing Guaranty Program. The loan funds seek to finance urban environmental infrastructure, including water supply, sanitation, solid-waste management, and area development. USAID loan funds for any infrastructure project must be matched with an equal amount of funds raised through the Indian capital market. Additionally, household income of at least half the project beneficiaries must be below the median income. USAID loan funds are supplemented with development

assistance funds for technical assistance and training. At the end of fiscal year 1998, $7.72 million had been obligated under FIRE's urban environmental infrastructure objective, and $11.78 million had been obligated under its financial development objective, for a total of $19.5 million.

PROGRAM ELEMENTS

Many USAID-funded urban and industrial pollution programs support interventions in one or more of five areas: economic policy reform, environmental regulations and standards, education and awareness campaigns, institution building, and technological change. In India, technology (American technology) was key.

Economic Policies

In 1991 the Indian government began to introduce significant economic reforms and greater liberalization. New policies encouraged foreign investment and private sector participation in areas previously reserved for the public sector. The government also began to recognize that earlier policies promoting rapid industrialization often had adverse environmental effects. For example, the government had subsidized the price of water, energy, and raw materials. When material inputs are priced artificially low, industries tend to use them intensively and expand capacity beyond what is economically justified. But that can increase pollution.

To address these problems, the government has encouraged competition through deregulation and has reduced subsidies and tariffs. It has also introduced various market-based instruments to encourage industries to implement pollution control measures. For example, in 1992 the Ministry of Environment and Forests increased effluent charges levied against industries by a factor of 5 or 6. If these charges accurately reflect the social and economic costs of pollution, they will be high enough so that waste treatment and disposal becomes the least-cost alternative. Other market-based instruments adopted by the government include tax holidays and duty exemptions, accelerated depreciation allowances, and easy financing for purchasing pollution equipment.

Government Regulations and Standards

India was the first nation to provide for environmental protection explicitly in its constitution. In 1948 a law was enacted prohibiting factories from discharging effluents into the water. Since the early 1970s, the government has enacted 16 legislative measures that provide guidelines for protecting and improving the environment.

India's 1992 policy statement on abating pollution called for integrating environmental considerations with decision-making at all levels. Pollution would be reduced through cleaner manufacturing processes and pollution prevention (where effective) and end-of-pipe measures (as necessary). The "polluter pays" principle was adopted to help carry out the policy. That meant the government needed to establish discharge standards for industry, with the intent of shifting from concentration-based standards (which can be easily circumvented) to load-based standards. Increased charges for the consumption of resources were also needed. Higher water charges, for example, would remove the incentive for polluters to dilute effluents.

Although India has made considerable progress in developing environmental legislation, the government's capacity and willingness to enforce the laws has often been wanting. Since 1995, judicial activism has become the key driver in forcing companies to adopt pollution prevention and control measures. The courts have a huge backlog of environmental enforce-

ment cases, many brought before judges ill prepared to understand complex technical arguments. Nevertheless, such activism has led to company closures until mitigation and remediation measures were implemented.

Since the 1992 Earth Summit in Rio de Janeiro, India has elected four governments. The fundamental goal of each has been economic growth, discounting the environmental costs of its development plans. Some forward-looking industries will invest in pollution prevention equipment and cleaner technologies. But if there is a perceived trade-off between a sound economy and good environmental practices, India's politicians and industrial leaders are likely to opt for fewer environmental controls and less environmental enforcement.

"Since 1992 India has elected four governments. The fundamental goal of each has been economic growth."

Education and Awareness

TEST, CTI, and FIRE have all relied heavily on informal training programs such as seminars, case studies, and international study tours to introduce new approaches and technologies. TEST and CTI conducted much of this educational work through India's two leading business associations, the Confederation of Indian Industry (CII) and the Federation of Indian Chambers of Commerce and Industry (FICCI). Both organizations disseminated information about TEST to their members, and CII prepared a comprehensive overview titled "Environmental Business Opportunities in India," which was made available to both American and Indian industry. CTI has promoted U.S.–based and other international voluntary business initiatives for environmental management, especially among business leaders and factory managers.

CTI has benefited from a powerful new educational tool—the Internet. Internet resources were in their infancy when TEST was designed in 1991–92. By the end of TEST, in 1997, information on environmental technologies that had been compiled by FICCI for CD–ROM access became the core of a new Web site. FICCI's efforts have been continued under CTI, with the creation of a world-class Web portal on clean technology.

The FIRE project has skillfully and patiently worked with a variety of target audiences in several Indian cities to introduce the concept of private financing of public infrastructure. As a result, municipal bonds, the first in South Asia, were issued successfully in Ahmedabad. Respondents from both the public and private sectors remarked on the management changes that are sweeping the nation's major cities—giving high marks to the contributions made by USAID's educational campaign. In addition, FIRE's contractor team has compiled a series of concise summaries of the project's experience, which will help ensure that the lessons are widely shared. The project has also helped develop a network of institutions where municipal officers throughout the country are trained in urban and environmental management.

Each of these bilateral projects has drawn upon international travel fellowships and exchange programs available through the U.S.–Asia Environmental Partnership (US–AEP). Most of these exchanges have benefited Indian nationals going to the United States, but some were for U.S. experts and entrepreneurs visiting India. Since 1992, well over 200 US–AEP / India exchanges have been conducted, several of which were of critical strategic importance to TEST.

Building on that experience, CTI included business facilitation exchanges to parallel those provided under the ongoing US–AEP.

Institution Building

Strong public and private institutions are indispensable to ensuring clean air and water in any country. When TEST was designed, the World Bank was already active in helping to strengthen key public sector environmental agencies. It therefore made sense for USAID to concentrate on the private sector. Both TEST and CTI have worked with the Industrial Credit and Investment Corporation of India and helped strengthen several national-level industry associations, primarily the Confederation of Indian Industry and the Federation of Indian Chambers of Commerce and Industry.

ICICI has developed the capacity to assess the financial capability of Indian companies to manufacture and market a range of environmental technologies. It is now a well-established and competently managed financial intermediary. The Confederation of Indian Industry has played an increasingly important role in advocating greater environmental commitment by its members. The confederation has also taken the lead in promoting adoption of ISO 14001 certification by Indian factories. Similarly, the Federation of Indian Chambers of Commerce and Industry has developed a highly sophisticated information center responsive to its members' needs.

Over the past decade the Indian Supreme Court and the country's state courts have become active in pollution control cases. Generally that has been without any formal training or professional experience in environmental technology or direct familiarity with precedents from environmental law in other countries. Through a grant to the U.S.–based Environmental Law Institute, CTI has exposed a number of court justices and state lawyers to modern judicial environmental management strategies and a range of environmental issues.

The FIRE project has worked with an expanding group of municipal governments and several national-level urban agencies—the Housing and Urban Development Corporation, the National Institute of Urban Affairs, and Infrastructure Leasing and Financial Services Ltd. FIRE has also helped privatize services previously performed by poorly staffed and equipped government agencies. The use of professional architects and planners to prepare municipal development plans is one such example. FIRE has also supported the work of several nongovernmental organizations. They include the Self-Employed Women's Association and Exnora International, organizations committed to working with slum communities, and the Ahmedabad Municipal Corporation, which is delivering environmental infrastructure to the city's slums. Working with NGOs, city governments, and academic institutions, FIRE has helped develop efficient urban environmental management tools such as environmental mapping, status reports, risk assessments, and action plans.

Technological Change

A 1991 market survey identified technology gaps in the control of both air and water pollution. TEST assumed that American technologies, once introduced, would be attractive to Indian industry and replicated throughout the country, thereby filling the gaps. All that was needed, at least initially, was to match American suppliers with Indian customers. Various types of technologies and services could then be introduced. USAID assistance was intended to accelerate the process of converting need to demand, demand to identification of technology, and identification of technology to commercialization that would be profitable to the American supplier as well as the Indian user.

It soon became clear that the Indian market could not and would not pay U.S. prices for finished products or services having high American-made content. In most cases, the manufacturing capability resided in or could easily be developed in India. Successful U.S. counterparts adjusted accordingly: they engaged in joint ventures or licensing agreements with Indian partners, even though this meant lower margins than hoped for.

Unlike TEST, the CTI project targeted companies of specific industries (cement, automotive, textiles). The expectation was that demonstrations of successful pollution reduction technologies would be replicated at other companies in the same industry. Unfortunately, the range of approaches and technologies that could be considered for USAID support was limited in May 1998 because of U.S. sanctions imposed against India as a result of its nuclear detonation. Approaches approved for U.S. assistance included business exchanges, benchmarking techniques, accounting for carbon emissions, rating environmental performance by industry, analyzing the life cycle of products, and greening the supply chain management.

According to a 1996 estimate, up to 80 percent of India's industrial capacity in 2010 will not have existed in 1996. If this estimate is accurate, there are significant opportunities to incorporate more efficient and cleaner technologies in India's new and retooled manufacturing base. The country has over 100,000 industrial enterprises with output in excess of $100 billion a year. Thus there is enormous scope for investment in technologies for pollution control and process efficiency, and the potential environmental impact is significant.

IMPACT

Urban and industrial pollution prevention programs can have at least three effects: economic, environmental, and health. How were these effects manifested under TEST, CTI, and FIRE-D?

Economic Impact

The Industrial Credit and Investment Corporation was charged with converting business linkages between American and Indian firms into actual trade deals. To this end, ICICI sent letters to over 900 Indian firms (environmental service providers, engineering companies, and major industries) explaining the TEST program. It also responded to requests for information from 781 Indian companies. It sponsored four seminars targeted to potential TEST clients and hosted a booth at four different promotional events. It identified potential U.S. environmental technologies for 60–65 Indian companies drawn from a short list of 212 companies that seemed serious about the TEST program. Finally, ICICI prepared special reports for 17 of these companies, each of which had demonstrated its commitment to pollution control by paying 25 percent of the cost of the report.

At the same time, the American technical assistance firm aggressively marketed TEST in the United States. It sponsored a series of investment tours to the United States for representatives from 33 Indian companies, some in collaboration with US–AEP, as well as nine technical assistance tours that brought American advisers to India. It also prepared 23 research reports for individual American companies assessing the strength of the Indian market for U.S. pollution control equipment and services. The American firms paid a portion of the cost of the reports, which was estimated at $5,000 each.

By 1997, TEST had provided technical assistance to 92 Indian companies, of which 25 were identified for potential trade deals. Ultimately, ICICI approved 14 loans to 12 different Indian companies that entered into trade agreements with American firms. (Two of the 12 companies, Kirloskar American Air Filter and TTG Industries, received two loans each.)

The 14 U.S.–India linkages were of three types: (1) licensing agreements with American com-

Table 1. Estimated Value of Kirloskar's Sales, 1992–99

Type of Equipment	Number of Orders	Value (millions of rupees)	Value (millions of dollars[a])
Air Pollution Control Equipment			
1. Baghouse, bag filters, and scrubbers	70	1,075	31.16
2. Electrostatic precipitators	25	735	21.30
3. Machinery filtration and acoustic systems	615	475	13.77
Total	710	2,285	66.23
Water Pollution Control Equipment			
1. Effluents and wastewater treatment plants	39	830	24.06
2. Sewage treatment plants	2	10	0.29
3. Raw water treatment and demineralization plants	9	310	8.98
Total	50	1,150	33.33

[a]Average exchange rate during 1992–99 was US$1=Rs34.5.

Source: Kirloskar American Air Filter Ltd., "A Report on Environmental Impact Through KAAF," 25 May 2000.

panies under which pollution control equipment was manufactured in India to sell to Indian companies (nine loans), (2) joint ventures between American and Indian companies (three loans); and (3) direct purchase of equipment or environmental services by Indian companies from American companies (two loans). The 14 business deals completed by the end of 1997 were valued at $35.0 million (about Rs1.2 million, using an exchange rate of US$1=Rs34.5). TEST financed $9.4 million, or 26 percent of total costs; ICICI and the individual companies financed the remainder.

Interest rates were subsidized at 1.5 to 3.0 percentage points below the market rate. That was to encourage Indian companies to risk investing with American partners in the manufacture of new pollution control technologies, untried in India. According to the 1997 evaluation, all borrowers were repaying their loans on schedule as of September 1996. As of May 2000, however, this was no longer the case. Of the 14 loans, 2 had been repaid in full, 6 were being repaid, 2 had been restructured, and 4 had been canceled or were in litigation.

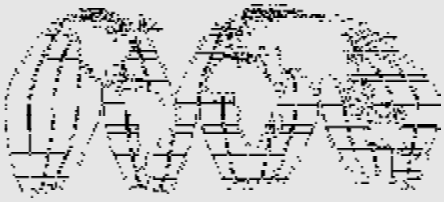
Sales

Except for 2 of the 12 Indian companies that received loans under TEST (TTG Industries and Kirloskar American Air Filter), sales of pollution control equipment and services were not tracked. The CDIE team visited Kirloskar, which was formed as a joint venture between the Kirloskar Group of India and American Air Filter International of Louisville, Kentucky. Although its experience may not be representative, it is illustrative.

Table 1 summarizes Kirloskar's total sales of both air and water pollution control equipment during 1992–99 as reported by the company. For air pollution equipment, total sales were $66.2 million spread over 710 individual orders from Indian companies. Clients included six companies in the iron and steel industry, five in the cement industry, and one in both the pulp and paper industry and the acrylics industry. Primarily because of a downturn in the iron and steel and pulp and paper businesses, Kirloskar's sales of air pollution control equipment slid by 44 percent between the period

1992–95 and the period 1996–99 (from Rs1,465 million to Rs820 million).

For water pollution control equipment, Kirloskar's sales were $33.3 million spread over 50 individual orders from companies in 10 industrial sectors: 5 in the iron and steel industry, 3 in the automobile industry, and 1 in each of 8 other industries. Kirloskar's sales of water pollution control equipment more than doubled from Rs355 million during 1992 through 1995 to Rs795 million during 1996 through 1999.



"As of early 1996, the United States had the largest share of environmental joint ventures with Indian enterprises (40 percent)."

The CDIE evaluation team also visited Agro Pulping Machinery Private Ltd. Using loan funds provided by TEST, Agro Pulping set up a demonstration unit showing that American technology for fluid bed chemical recovery provided a promising solution for small agrobased paper-pulping units throughout India. Under its 10-year license from Enders Process Equipment Corporation of Illinois, Agro Pulping agreed to pay a 12 percent royalty fee for every system sold during the licensing period. Savings achieved through use of the Enders equipment were estimated at $14,000 per month. Some 200 paper mills in India are potential beneficiaries of this technology.

D.I. Filter Systems in Haryana received a $500,000 loan under TEST in 1994. This enabled the company to manufacture filters for gas turbine engines under a joint venture between Mundratech of New Delhi (a UK-based group of nonresident Indians) and Donaldson, Inc., of Minnesota. Taking advantage of the close working relationship between Donaldson and General Electric Power Systems, D.I. Filter provides air filtration systems to 97 gas turbine projects throughout India, with annual sales of $7 million. The company also sells air filtration systems to the automobile market (valued at $10 million annually) and to the industrial dust collection market (valued at $3 million annually).

While not necessarily representative of the overall TEST project, the collective experience of these companies—Kirloskar, Agro Pulping Machinery, and D.I. Filter Systems—provides at least anecdotal evidence of the financial benefits of investing in industrial pollution control measures in India.

Trade

In 1990 the Indian market for environmental technologies (air pollution control equipment, wastewater treatment systems, and toxic and hazardous waste disposal technology) and environmental management services was only $220 million. By 1994, estimated demand had increased to $1.9 *billion*, according to the Confederation of Indian Industry, and by 2000, it had increased still further to about $2.5 billion, according to the Commercial Service of the U.S. Embassy in India. Moreover, growth in demand is estimated at 15 percent annually.

Evidence suggests that the United States has been able to take advantage of this expanded Indian market. American exports of environmental equipment to India increased by 29 percent per year during 1992–95. As of early 1996, the United States had the largest share of environmental joint ventures with Indian enterprises (40 percent). According to the U.S. Commercial Service, American companies are expected to meet about 6 percent of the $2.5 billion demand projected for 2000, or $150 million. These are impressive results. However, it is difficult to assess the extent to which USAID tech-

Table 2. Average Daily Reduction In Air Pollution for Industries Served by Kirloskar, 1999

Industry	Emissions Reductions (tons of particulate matter per day)
Iron and steel	1,212
Cement	4,944
Pulp and paper	60
Acrylics	96
Total	6,312

Source: Kirloskar American Air Filter Ltd., "A Report on Environmental Impact Through KAAF," 25 May 2000.

nical assistance and financing provided under the TEST project contributed to the increased U.S.–India trade.

Environmental Impact

Pollution control devices or process changes, once installed or implemented, no doubt resulted in reduced emissions into the atmosphere and effluents into the water. However, without baseline data, continuous sampling of air and water quality, and source attribution studies, it is impossible to quantify changes in net air and water quality resulting from the new technologies. As indicated in the final report for the TEST project, not enough money was earmarked for monitoring program impact.

Environmental data provided by Kirloskar American Air Filter show substantial reductions in emissions of particulate matter after installation of the company's technologies. Reductions were 6,312 tons a day, on average, in 1999 at 13 companies in four industries: iron and steel, cement, pulp and paper, and acrylics (see table 2). Most of these reductions, 78 percent, occurred at five cement factories. Table 3 shows equally impressive reductions in water pollutants made possible by treating industrial effluents using technology supplied by Kirloskar.

Thus, Kirloskar has successfully marketed pollution control services and products to large industrial facilities in India. Regulatory requirements, particularly those affecting foundries and major industries that burn dirty coal, have been the primary market driver. Sales at Kirloskar and similar companies are likely to grow in response to continued high levels of air and water pollution and increased public awareness of poor environmental quality. The growth in sales, however, may be slowed by the apparent inability of the government to enforce environmental compliance.

Health Impact

Analysis of changes in human morbidity and mortality in response to changes in environmental quality requires not only environmental data but also health surveillance data. No such information was collected under TEST, CTI, or FIRE-D to estimate the incremental health effects of these USAID activities. One can assume, though, that provision of basic services such as

Table 3. Average Daily Reduction In Water Pollution for Industries Served by Kirloskar, 1999, Parts per Million

Industry	BOD	COD	SS	O&G	TSS
Dairy	1,170	1,950	400	390	—
Food/beverage	1,970	3,750	450	—	—
Copper	—	—	2,400	—	—
Oil, gas	1,585	3,900	—	3,490	—
Detergent	220	150	—	990	—
Petrochemical	550	800	—	490	—
Aluminum	—	—	—	—	49
Power	—	—	400	45	—
Iron, steel	—	—	13,500	480	—
Automobile	570	950	450	6,480	—

Key: BOD = biological oxygen demand, COD = chemical oxygen demand, SS = suspended solids, O&G = oil and grease, TSS = total suspended solids.

Source: Kirloskar American Air Filter Ltd., "A Report on Environmental Impact Through KAAF," 25 May 2000.

potable water and trash pickup and of environmental infrastructure including sewer systems and electric power in low-income areas where FIRE-D is being implemented is bound to improve human health.

The USAID-supported "slum networking" project of the Ahmedabad Municipal Corporation is illustrative. Ahmedabad is the seventh largest city in India, with a population of 3.2 million. Forty percent, 1.25 million people, live in 2,412 slums or near-slums. On average, 93 families (of 5–6 persons each) live in each of these slums. The slum networking project provides physical infrastructure (drainage, household toilets, individual piped water, underground sewerage) at an average cost of about $365 per family. Most of these costs ($255 per family) are covered by the Ahmedabad Municipal Corporation using funds raised on the bond market with support from FIRE-D and USAID's Environment Credit Program. The remaining costs are covered by private industries and nongovernmental organizations ($60 per family) and by beneficiaries ($50 per family). Infrastructure has been completed in eight slums. It is currently under construction in nine other slums and is in the planning stage in three more.

Systematic monitoring procedures are not in place and no "before" and "after" surveys have been undertaken. However, beneficiaries interviewed by the CDIE evaluation team reported considerable improvement in the slum areas affected. Household toilets, in particular, have reduced water stagnation and the menace of mosquitoes. Beneficiaries also reported fewer visits to doctors and hospitals, but hard data to substantiate these claims are not available.

Thus, efforts to assess the economic, environmental, and health impacts of USAID-funded urban and industrial pollution projects in India were seriously hampered by lack of basic data. Monitoring short-term outputs (number of organizations assisted, number of tours, volume of sales) is necessary not only to satisfy reporting requirements but also to facilitate evaluation of long-term impact. According to the 1997 evaluation of TEST, the key lesson learned may be the need to strengthen design, monitoring, and reporting of project indicators. The evaluation states: "TEST certainly contributes to achieving strategic objective 4—'improved air and water quality at selected industrial sites and municipalities'—but there is presently no way to measure specific impact."

PROGRAM PERFORMANCE

Program performance is normally assessed in terms of (1) its effectiveness, (2) whether benefits were sustained after donor funding ended, and (3) the extent to which activities were replicated beyond the project.

Effectiveness

Effectiveness is a measure of how successful an intervention is in achieving program objectives. Were benefits significant? Were they generated through a strategy that worked with the right people and industries? Was the approach the best way to use USAID resources to get the job done? The job in the case of TEST was to accelerate the development of India's environmental services and technology sector while promoting business opportunities for American companies. The follow-on CTI project has similar goals but concentrates on helping leaders of Indian industry become more competitive in international markets through environmental initiatives. FIRE-D, also ongoing, uses innovative financing to support construction of urban environmental infrastructure that benefits the poor. The overall effectiveness of these projects, particularly of TEST, is mixed.

Although the preproject market survey identified several environmental technologies in which the United States apparently had clear superiority, it soon became clear that import-

ing finished pollution control equipment from the United States was unattractive. This is reflected by the fact that 12 of the 14 ICICI loans were for U.S.–India joint ventures or licensed production arrangements. Only two were for Indian companies to import services or products directly from the United States.

The 1997 evaluation concluded that, contrary to a key project assumption, concessional financing was not critical in making the transaction happen and that many of the business collaborations almost certainly would have proceeded even without TEST. Acceptable financing would have been available from sources other than TEST, though perhaps not as quickly or on terms as favorable. The companies interviewed indicated that TEST financing was helpful because it accelerated business transactions, but that it was not essential. The World Bank canceled the credit component of its pollution prevention project after concluding that financing was not a major obstacle.

The lending criteria of ICICI may have favored larger Indian companies. Such companies tended to be strong financially, and they already had access to both the domestic capital market and external sources of funding. Moreover, it was primarily the large "champion" industries (those that were export oriented or whose investments in cleaner technologies and waste minimization offered a real prospect of achieving operational and process efficiencies) that made such investments. By contrast, smaller companies often *did* need financing but could not meet ICICI's lending criteria. Thus, the effectiveness of the TEST approach is questionable.

The approach would probably have been more effective if the state pollution control boards had improved their capability to enforce environmental regulations as the project had assumed in 1991. At that time, the World Bank initiated activities designed to improve enforcement, but the bank now indicates its efforts had only limited success. Corruption and lack of political will still impede enforcement of industry's compliance with environmental standards. The judicial system (rather than the state pollution control boards), acting in response to an increasing number of public interest lawsuits, has become an important source of enforcement actions. Thus the effectiveness of TEST was compromised in part because critical project assumptions (see page 3) proved invalid.

Sustainability

Sustainability concerns the extent to which a program continues to deliver benefits after development assistance ends. TEST will prove sustainable if the 12 companies that received loans from ICICI are able to meet market demand for their products and services—in other words, if they stay in business. This depends in part on the expansion of the Indian market for such services and technologies, which in turn hinges mainly on the extent to which the government enforces its environmental standards and regulations. Pollution problems are worsening in India, judicial determinations are continuing, and public awareness is growing. This suggests that pressure for enforcement will increase.

The Clean Technology Initiative is ongoing, making it too early to assess its sustainability. But forward-looking export-oriented businesses, the kind targeted by CTI, may take their own "voluntary" initiatives in response to global competition.

In the case of FIRE-D, using the private capital market to raise funds to construct urban environmental infrastructure was an entirely new concept for India's business and government leaders. Considerable time was required—more than anticipated during project design—to change the mind-set of these leaders and gain their acceptance of the use of municipal bonds to finance public sector projects.

Though time consuming, this acceptance has now been achieved. Infrastructure projects have been initiated in two municipalities, and construction is likely to proceed smoothly elsewhere.

Yet to come, though, is a new set of formidable challenges. For example, water charges must be established that are financially sound yet politically acceptable. User fees must be efficiently collected. Investors in municipal bonds must be repaid on time. Only then will it be possible to assess the sustainability of FIRE-D.

Replication

Replication, in the case of Trade in Environmental Services and Technologies, concerns the extent to which the TEST model was adapted by other Indian firms. Two indicators can help assess replication. First, to what extent has the Indian market for American environmental services and technologies grown? Second, to what extent have Indian companies turned to commercial lenders, especially lenders other than ICICI, to secure financing for environmental services and technologies?

As previously noted, in 1991 American suppliers were exporting about $6 million of environmental equipment to India annually, or about 4 percent of the total market estimated at $135 million. In 2000 they were exporting $150 million of pollution control equipment and services, 6 percent of the much larger $2.5 *billion* Indian market. Thus, the American *share* of the Indian market for environmental equipment and services increased modestly, but the overall Indian market increased substantially. As a result, the volume of U.S. exports to that market is 25 times larger today than it was in 1991. Moreover, the market is expected to grow by 15 percent a year. It is difficult, though, to determine how much, if any, of this increase in U.S. market share and in total American exports might be attributed to the Trade in Environmental Services and Technologies project and the Clean Technology Initiative.

Have Indian companies turned to commercial lenders to secure financing for pollution control equipment? TEST and CTI together with US–AEP have no doubt boosted awareness of market opportunities in India for environmental services and technologies. However, the extent to which improved market information has stimulated other ventures—not to mention the commercial financing of other ventures—cannot be determined. The credit fund created by USAID at ICICI is a viable lending source as long as it remains solvent and as long as it continues lending for pollution control.

Although FIRE-D is an ongoing activity, it appears that replication is already occurring. Following the example of Ahmedabad, the first municipality in India certified as creditworthy for the purpose of issuing unsecured commercial bonds, 13 other municipalities have sought fiscal review to obtain a credit rating.

CONCLUSIONS AND LESSONS LEARNED

During the 1990s, USAID supported three bilateral urban and industrial pollution programs in India. One was completed in 1997, and two are ongoing. What lessons emerge from this experience?

1. Changing the mind-set. *Changing the mind-set of key business and government leaders with respect to environmental management takes considerable time, but is essential if pollution control technologies, environmental management systems, and urban development are to be widely adopted.*

The FIRE-D project introduced the concept of private sector financing of public sector environmental infrastructure. Professional urban planning is another new concept supported by

FIRE-D. USAID is widely praised by Indian counterparts for carefully nurturing these ideas. However, the process of changing the mind-set of a wide array of Indian stakeholders has delayed implementation considerably—by more than three years—in establishing on-the-ground demonstration projects. The situation is similar though not as dramatic with the CTI project. Extensive seminars and information exchange have increased industrial awareness of various environmental management techniques including benchmarking, greening the supply chain, and ISO 14001 certification. Local champions are now bringing credibility, continuity, and public support to urban development, environmental management, and pollution control, and tangible accomplishments have begun to emerge.

2. Financial benefits. *Companies will not invest in pollution control technologies or environmental management systems unless they perceive it in their business interest to do so.*

Purchasing and operating pollution control technology is expensive. To justify the investment, companies need to recover capital and labor costs. Some companies may adopt environmental management initiatives when environmental performance is a competitive factor in gaining access to international markets. In 1999, 150 Indian companies were ISO 14001 certified, compared with only 25 in 1997—and many of those companies learned about the certification process through CTI. By 1999, a major Indian company had adopted a program of greening the supply chain, again with CTI assistance. CTI also introduced benchmarking techniques to India. The techniques helped companies understand how to optimize financial returns by reducing both production costs *and* pollution emissions. By 1999, CTI had supported 12 demonstration projects in benchmarking.

3. Regulation. C*ompanies are more likely to acquire pollution control technologies if there is strict enforcement of environmental standards and regulations.*

Financial benefits alone are rarely sufficient to justify investments in pollution control technologies and environmental management systems. Instead, companies invest primarily to avoid being shut down or paying fines for noncompliance with environmental regulations. Although environmental standards and regulations are well established in India, enforcement generally remains lax because political will and public pressure are weak. Therefore, companies often decide not to comply with pollution standards and instead take remedial action only in response to litigation and judicial rulings (which can take years). Moreover, the cost of noncompliance is typically small relative to the cost of investing in end-of-pipe controls. Compliance is likely to become more widespread when companies adopt pollution prevention technologies that address process and management changes. These technologies, emphasized by CTI, often have greater financial as well as environmental benefits.

4. Trade. *Both supply-side and demand-side barriers hamper U.S.–India trade in environmental services and technologies.*

On the supply side, American companies often have legitimate concerns about the time, effort, and risk involved in tapping the Indian market for environmental services and technologies. On the demand side, Indian companies are reluctant to buy American pollution technologies or process techniques unless demonstrations have shown they are suitable for local conditions—and Indian financial institutions are reluctant to lend funds for the purchase of untested technologies. Moreover, American pollution technologies are typically too expensive to find widespread acceptance in the In-

dian market. American companies that have been most successful in India generally have formed joint ventures or licensed their technology for local production, in both cases reducing the delivery price. Companies relying on the outright sale of pollution equipment have been less successful.

5. Credit. *Lack of financing is typically not a constraint for large Indian firms that want to procure pollution reduction technology. However, it does often hinder individual small and medium-size firms and municipalities that want to finance environmental infrastructure.*

The TEST project assumed Indian companies would be unable to purchase pollution reduction technology from American suppliers without financing. The project therefore included a $20 million credit component with loans subsidized at 1.5 to 3.0 percentage points below the market rate of interest. After five years, Indian companies had borrowed only $9.78 million. Similarly, the World Bank provided a line of credit under its industrial pollution prevention project, but lack of demand prompted the bank to cancel the credit component of the project. Although large Indian companies (or clusters of small companies) are able to secure financing to procure pollution control technology, individual small and medium-size companies often do require financing. However, TEST did not concentrate on these companies, perhaps because they could not satisfy the lending criteria established by ICICI or because of high transactions costs. India's municipalities also require financing—for urban environmental infrastructure. FIRE-D has successfully assisted several municipalities, including Ahmedabad, in tackling this problem.

6. Replication. *A key to replicating technology transfer projects is careful targeting with an eye to sharing and spreading successful results.*

TEST used the "retail" approach to introduce pollution control technologies in India. Specific industries were not targeted. Instead, any company of any size from any industrial sector located in any part of the country was eligible to apply for a loan from ICICI. By contrast, CTI is using the "wholesale" approach. Companies have been strategically targeted. Export-oriented companies from three industrial sectors are receiving priority, including a small, a medium, and a large company from each sector. In addition, CTI, unlike its predecessor, TEST, works with industry associations. These organizations are often able to facilitate the sharing of information among companies within the same industry. CTI is also introducing the concept of greening the supply chain, which can be a powerful force in replicating environmental management systems from one company to numerous supplier companies. Both approaches can promote replication as long as the companies receiving assistance are explicitly encouraged to help spread successful results.

7. Baseline data. *Baseline data are needed to assess program impact.*

Baseline data were typically not gathered under the TEST, CTI, or FIRE-D projects before project implementation. Data on environmental quality in Indian cities, discharge rates from industrial sectors, and epidemiological and other health data for populations located near industrial zones or participating companies were not available. Lack of baseline data greatly reduces the ability to conduct an accurate assessment of environmental and health impacts.

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