Urban and Industrial Pollution Programs

Chile Case Study

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Contents

Summary

THE CHILE ENVIRONMENTAL Pollution Prevention Project (EP3) was a $1.3 million, three-year demonstration effort. It successfully introduced the concepts of pollution prevention and clean production to Chile's industrial sector. Nearly 2,500 people were trained in industrial-pollution prevention techniques, and 26 Pollution Prevention Diagnostic Assessments were completed at individual factories. The 26 firms invested a total of $1.4 million, which generated annual savings of $1.9 million. The savings continued every year for many of the companies. They reduced their pollution emission load by 32 percent. Compared with "end of pipe" pollution treatment, firms found that with EP3 pollution prevention they could save money while also reducing environmental pollution.

In April 2000 a three-man team from USAID's Center for Development Information and Evaluation (CDIE) completed an assessment of EP3. It found that EP3 was successful at selling the pollution-prevention message, but there were missed opportunities. The project failed to institutionalize the effort. So once USAID funding ended, both sustainability and replication were serious problems. The effort also faltered because Chile lacked effective environmental regulations. Without the pressure of environmental fines, many firms were reluctant to make pollution-prevention investments.

This Working Paper provides the complete analysis of the Chile assessment. A short summary of the assessment is also available in a November 2000 Impact Evaluation Report: "Reducing Urban and Industrial Pollution in Chile." The Impact Evaluation (PN-ACG-619) may be accessed electronically from www.dec.org/usaid_eval.

1. Introduction and Background

Urban and Industrial Pollution In Chile

A CIVILIAN GOVERNMENT TOOK OVER from the Pinochet military regime in March 1990, ending years of authoritarian political oppression. Political change and the emergence of democracy were dramatic. There was also a major change on the environmental front. During the years of military rule, the government had little interest in the environment. Environmental regulations and controls were almost nonexistent. Industrial investment and production were encouraged, with hardly a thought given to the impact of the rapidly rising pollutant level.

With the return of democracy things changed. Just as before, the people can see the bad air and taste the bad water. But now they realize the government can do something about it.

They have pressured the government and it has responded. An initial environmental law was passed in 1993. In that same year the Commission for the Promotion of Municipal Sanitation was established. In 1994 the "Charter Law on the Environment" greatly strengthened environmental standards. It provided a foundation for a system of environment standards and regulations. It also required environmental impact assessment for all new investment projects. This was a major change. Previously anyone could build a factory without concern for the environment. Now they have to do an environmental impact assessment, which local and national government agencies examine. In early 1995 CONOMA, the National Environmental Commission, began operations as the coordinator of all governmental policies and programs on the environment. In 1997 the Charter Law was further strengthened. Even with new environmental regulations, environmental quality did not improve. Real GDP growth averaged a remarkable 7 percent a year from 1991 to 1997 and dropped to 2 percent during the recession of 1998 and 1999. With strong growth in output, pollution increased at an even faster pace.

While the Chilean Government was slow to respond to its environmental problems, it has now moved forcefully to clean up years of neglect. The next step might be a rationalization of environmental laws and procedures. Chile did not create a U.S–style Environmental Protection Agency (EPA) to develop and enforce regulations, but rather created CONOMA as a coordinator of pollution policies of government agencies that actually enforce the rules. By some estimates there are now over 1,000 laws and regulations on the books and some 36 governmental organizations with a role in pollution control. So many laws and organizations (some with conflicting agendas) increases the potential for lack of focus, confusion and delay.

The Chile Environmental Pollution-Prevention Project (EP3)

EP3 Chile was USAID's first project in a nine-country pollution-prevention program. As the first country, it identified problems and alternative solutions. But being the test case does have drawbacks. Mistakes and problems provide lessons for other country programs, but the Chile program bears the learning costs. In addition, it had a short project life—only three years. It started in September 1993, slowly geared up, moved into rapid implementation, and then closed down in October 1996, without any follow-on program. This was because

Chile graduated from USAID assistance in 1996, bringing EP3 to an end.

EP3 came to Chile when environmental concerns were just surfacing. The few pollution abatement efforts that existed focused on "end of pipe" treatment—reducing pollution at the smokestack or drainpipe. A different approach is to prevent or reduce pollution at its source by improving the production process. If the production process is more resource efficient, it produces less waste. EP3 used this approach of pollution prevention, also referred to as waste minimization or clean production. Firms that adopted resource-efficient production processes were able to reduce their costs while reducing environmental damage and improving public health.

The project was designed to reduce pollution at its source by improving "industrial housekeeping," changing industrial production processes, and reducing and reclaiming industrial waste: Water, dyes, and chemicals are recovered and recycled back into the production process rather than being flushed down the drain. Electricity, steam, and raw materials are used more efficiently, and improved process controls reduce waste and improve product quality.

To prevent pollution at its source, industrial firms must be convinced that pollution prevention pays—that it is financially beneficial. Industrial firms do not want to harm the environment, but they are in business to make a profit. They want to avoid fines and the prospect of being shut down by the government for causing excessive pollution. But they also are motivated by positive incentives. If low-cost, environmentally sensitive investments and changes in production processes will reduce costs and increase profits, they may take action. The motivation is profit, but the environment simultaneously benefits. That was the EP3 strategy.

As noted in the previous section, Chile began to deal with its environmental problems only recently. The first laws and regulations were passed in 1994 and it took several years to develop standards and enforcement mechanisms. That had implications for the USAID project. When EP3 was being designed in 1992 the Chilean Government lacked environmental laws, regulations, and institutions. In many countries firms are encouraged to reduce pollution by a carrot-and-stick approach. The carrot is cost savings and the stick is the threat of environmental fines or a plant shutdown. In Chile the threat of punitive measures did not exist. A decision was made to go the private sector route and to focus on cost savings for firms, rather than attempting to meet environmental regulations, which were not yet in place.

In contrast to some other USAID environmental projects, EP3 was not implemented directly with a government agency and there were no resident American project managers or engineers. Chilean pollution engineers ran the project with short-term temporary-duty assistance from U.S. experts. The American Chilean Chamber of Commerce (AmCham) was selected to implement the project but it had management problems. After a year, implementation was moved to a private Chilean pollution-consulting firm, which effectively marketed and implemented the EP3 approach over the final two years of the project.

While EP3 organized and ran most of the training, CIPMA, an environmental nongovernmental organization (NGO) and CONOMA, the Government environmental coordinator, assisted in training. The training helped spread the pollution-prevention message and encouraged firms to participate in EP3 Pollution Prevention Diagnostic Assessments (PPDAs).

PPDAs are audits of a factory's production process designed to identify cost savings that will

also have environmental benefits. The assessment consists of several steps: an initial planning phase; the assessment phase when a team of U.S. and Chilean pollution experts spends a week at the factory identifying specific pollution-prevention opportunities; an implementation phase when local EP3 staff and consultants work with the factory managers to implement the recommendations; and follow-up over the next year until all recommendations are adopted.

The 26 PPDAs generated estimated total annual savings of $1.9 million from a one-time investment by firms of $1.4 million. The pollution-prevention investment costs were recovered in just 9 months. Pollution emissions were reduced by 32 percent and annual water savings were 1.4 million cubic meters. Based on site visits of a sample of firms by the assessment team, it is clear that many of the firms continue to realize these savings year after year.

2. Program Elements

USAID URBAN AND INDUSTRIAL pollution-prevention programs generally support interventions in one or more of the following five areas: economic policy reform, environmental regulations, institution building, knowledge and awareness campaigns, and technology change. EP3 Chile concentrated on technical assistance and training to build knowledge and awareness of pollution prevention and to encourage the adoption of pollution-prevention technology by industry. It did very little in the areas of policy reform, regulations, and institutional development.

Education and Awareness

EP3 Chile faced a difficult task when it was launched in 1993. Environmental regulations were almost nonexistent or woefully out of date (e.g., one of the main laws, the Law on Liquids, was written in 1916). What little pollution knowledge existed was focused on end-of-pipe treatments. The project took on the task of educating industry, government, NGOs, academia, and local consultants on a new concept—the value of pollution prevention. Since pollution regulations were lacking, EP3 could not count on the threat of fines as a motivational tool. It had to convince industry that it would save money through pollution prevention. It also had to train local environmental consultants to implement the program and carry it on after usaid assistance ended.

Training and outreach to transfer industrial pollution prevention and environmental management skills was a central part of EP3. Initially, the project concentrated on selected industrial groups to build interest in pollution prevention and to identify opportunities for environmental audits. A second stage was aimed at specific sector training to develop interest among a wide range of industrial firms: chemicals, food processing, hospitals, mining, printing, tanneries, and textiles. The third stage was based on thematic training, outreach and awareness building to disseminate lessons learned and to replicate the experiences among other industrial groups, supporting governmental institutions, academia, and NGOs.

Critical to this last stage of training was the establishment of a pollution-prevention information clearinghouse at CIPMA, a policy-oriented NGO. CIPMA was also to serve as the locus for postproject training as well as the repository for reports on industry-specific applications, training materials, and EP3 reports and case studies.

Some 2,497 people were trained in industrial pollution-prevention concepts, pollution diagnostic methods, and the tools and skills needed by pollution consultants: 1,061 from industry, 752 from universities, 309 from government, 252 from NGOs, and 123 environmental consultants. The train-the-trainers program helped develop local capacity to extend the training program to others outside EP3. A continuing benefit has been the emergence of a dynamic and viable environmental consulting industry. They are generally well respected by industry and are continuing to work on pollution-prevention engineering issues.

When EP3 was initiated, pollution prevention was not a well-known concept in Chile. While it is hard to draw a direct causal linkage between the project's knowledge and awareness efforts and pollution prevention, it is clear that the concept is now fully accepted by industry and government. The project helped stimulate the change through the pollution-prevention message it preached, the people it trained and the strong cadre of pollution consultants it helped create.

Technological Change and Assistance to Industry

Pollution Prevention Diagnostic Assessments, which recommended specific production process changes, were completed at individual factories. USAID funded the costs of the audits and the costs of pollution-prevention investments were the responsibility of the factory owner.

Recommended technologies ranged from low-cost and no-cost housekeeping, maintenance and process changes such as recycling rinse water or recovering waste materials, to major capital investments such as new production equipment. Government financial incentives such as subsidies, tax relief or accelerated depreciation were not available. The attractiveness of any measure was based solely on its potential to increase operating profits in the short term.

While acceptance of recommended changes averaged 40 percent, it varied greatly among firms. Some firms accepted nearly all recommendations while others adopted only a few. The key to acceptance depended upon the quality and suitability of the audit recommendations, the size of the investment, the cost–benefit ratio of the investment, and the skill and business savvy of the owner and manager. Surprisingly, some factory owners were reluctant to implement changes even when cost savings and all other indicators were strongly positive. This may have been due to an unwillingness to experiment in an already marginal enterprise, or the firm was unsure about the course of future environmental regulations.

Table 2.1. Examples of Successful Pollution-Prevention Measures

Factory	Measure	Benefit
Cement	Baghouses to collect fine particle emissions.	Reduced emissions of particulate matter. Recovery and reuse of raw materials.
Textiles	Conversion to natural gas for boiler fuel.	Reduced emissions or particulate matter and Sulfur Dioxide. Increased Fuel efficiency.
Tanned leather hides	Recovery of chrome-based tanning solution.	Reduced loss of chrome in wastewater from 40 percent to 4 percent.
Milk and cheese products	Recovery of liquid waste from cheese making processes.	Sale of liquid waste to swine farmers. Reduced biological oxygen demand of wastewater input to river.
Commercial printing	Collection and incineration of waste VOC and odorous gases.	Reduced odor and VOC emissions.
Metal electroplating	Reuse of rinse bath water and chemicals.	Reduced water use and chromium discharge.
Paint manufacturing	Recycle wash water, reduce evaporation of VOC.	Save chemicals. Reduce wastewater load charges.
Slaughterhouse	Burn noxious gases, collect grease and fats.	Reduce complaints from neighbors. Sell grease and fats. Reduce wastewater sewage charges.
Primary healthcare	Water use reduction practices.	Minimal but measurable savings on water bills.

VOC = Volatile Organic Compounds

A typical case of a small, marginal enterprise was an electroplating factory that faced steadily declining sales because it had lost a major production contract and did not adjust to new market demands. It was running down its equipment and slowly going out of business. Other factories were reluctant to implement changes because the direction of future environmental regulations was unclear. They were unsure what CONOMA would demand in the near future in the way of pollution reductions.

Implementation was further slowed by the fact that in many instances it is less expensive to pay the disposal fees to the sewage utility or landfills than to install clean production technologies. This is changing, however, with increased fees being charged for landfill disposal, special processing fees for hazardous or toxic wastes, and increased frequency and size of fines for noncompliance with sewage discharge standards. A summary of successful EP3 supported pollution-prevention measures are listed in table 2.1.

EP3 did not consider end-of-pipe (EOP) measures or the effects of upstream production changes. These are important because EOP technologies may be adversely affected or need to be modified as a result of changes in the waste stream caused by pollution-prevention measures. Further, in most processes regardless of how clean or efficient, there will still be wastes to recycle, reclaim, treat, or dispose of.

As regards EOP measures, many industries in Chile have already invested in pollution-control equipment, such as baghouses, venturi scrubbers, flares, filters, and effluent neutralization systems. These systems must be considered and optimized as part of an integrated approach to pollution reduction. Cross-media effects must also be considered. Solving a water-quality problem may result in the creation of an air-quality or solid-waste-disposal problem. For example, collection of organic vapors by a wet scrubber results in a liquid waste that must be reintroduced to the process or disposed of, and air stripping of organics from water results in emissions of those organics to the air. One problem may simply be traded for another—but not identified in a program such as EP3 if the purpose of the program is exclusively pollution prevention.

The assessment team found these problems in Chile:

- A cement company is removing fine particles from the air but is creating solid waste, which creates a new disposal problem at the landfill.
- A slaughterhouse is scrubbing organics and particles out of its exhaust stack, but now has created a new problem by disposing of those pollutants in its wastewater.
- A metal plating company is putting less chrome and copper waste into the sewer, but is taking the solid waste and putting it into a landfill which is probably unlined, and the leachate may eventually run into the water supply.
- A hospital is burning its pathogenic wastes, rather than sending them to the landfill. However, if the burning is incomplete, there will be airborne distribution of pathogens.

What is needed is life cycle analysis, an integrated approach that considers the industrial process from start to finish as well as product end use. The approach considers process inputs, cost-effective pollution-prevention measures, the sometimes necessary end-of-pipe applications, and disposal or recycling of the product after it has been used. The desired result is a cost-effective net reduction in pollutants.

Economic Policies

Key Chilean Government policy managers were trained at the University of Chicago, which is noted for Milton Friedman and its free-market approach to economic development. The Chicago-trained economists remade the Chilean economy into a free-market model. Chile relies almost completely on private enterprise and free markets to drive its economy. Government price and market controls, incentives, and subsidies are almost nonexistent.

World market prices prevail for virtually all industrial inputs. The economy is free of price distortions or subsidies that would encourage environmentally harmful activities. On the other hand, a result of such an approach is that pollution-prevention subsidies, concessional loans, or investment credits do not exist and are dismissed by both the government and industry as bad policy.

For industrial wastewater there is a pollution-prevention incentive. The Santiago water and sewage utility (which is a private company) imposes water charges based on the volume and concentration of wastes in the industrial effluent. There are also upper limits on key pollutants. Firms pay the sewage company for the cost of receiving their wastes, which provides a strong incentive to reduce wastewater pollution.

The assessment team visited 18 firms, 10 that had received EP3 assistance and 8 that had not. Basically, the economic foundations of EP3 were sound; the market provided the financial incentives necessary for pollution prevention to succeed. The project showed that firms were motivated to undertake pollution-prevention actions to save money from increases in efficiency, reduced waste, reduced input costs, improved product quality, recycling and by avoiding the costs associated with excess waste disposal. There were several key factors that influenced pollution-prevention investments:

1. Firms that were successful at pollution prevention had physical plants that were clean and well organized. Management was aware of production costs, was developing new products, was interested in innovations, and was aware of what the competition was doing. In contrast, dirty firms had a chaotic factory layout and were not on top of costs or new product developments. The willingness to adopt clean production measures is positively correlated with a prior history of good management practices. The good owners and managers are most likely to have a better and more productive operation and clean production, and pollution prevention is a natural part of an efficient operation.

2. The assessment team was surprised at the number of factories that were making pollution-prevention investments as a means to avoid future problems. Factory managers who expected the future cost of waste disposal to increase were adopting such measures. Anticipated cost increases are due to more strict governmental regulations or expected increases in the cost of wastewater treatment or landfill disposal.

3. The adoption of pollution-prevention technologies appears to be accepted when businessmen believe that costs of noncompliance will be equitably imposed on others in the same business. In other words, action is conditional on there being no environmental "free riders" who might gain a competitive advantage. This supports an industrywide approach to the introduction of pollution-prevention technologies and transparent environmental regulations.

4. Most businesses that participated in EP3 were owner-managed small or medium-sized firms. Being frugal managers they were reluctant to make long-term investments and

generally went with low or no cost pollution-prevention measures. These were all internally financed. Of the EP3 participants reviewed by the evaluation team, none cited lack of finance as a barrier to adoption of pollution-prevention measures.

Since the end of the USAID project, a new financing source has become available. Financing for higher cost pollution-prevention measures or innovation and modernization of industry to meet specific environmental objectives is available through the banking system at commercial rates. Firms and banks are linked together by Chile's Production Development Corporation (CORFO). CORFO can also co-finance technical consultants on pollution prevention. The CORFO programs are new, and only two of the firms the assessment team met had used CORFO assistance for an audit.

Other CORFO instruments are available to promote clean production among groups of similar industries. For example, this program has provided group training and implementation of environmental management systems and certification of ISO 14000, as well as group programs for waste minimization, including the identification of waste recycling and the use of waste by-products by others in the group.

Government Regulations And Standards

Chile's environmental regulatory program began to take form in 1990, with the formation of the Special Commission on the Decontamination of the Metropolitan Region (Santiago). This was followed closely by the formation of the National Environment Commission in 1990, which was to design and implement environmental laws. In 1993 regulations were put in place requiring an environmental impact assessment for all investment projects. In 1994 the General Environmental Guidelines Law created a legal framework for environmental management. It formally created CONOMA, which was charged with coordinating the Environmental Units of all other ministries. Enabling legislation created Regulations for Establishing Standards of Environmental Quality and Emissions (1995), Regulations for the Creation of Environmental Prevention and Decontamination Plans (1995), and Regulations for the Environmental Impact Evaluation System and Participation of Citizens (1997).

Zoning is another way to regulate pollution. Industry wants to be in metro Santiago to have access to labor, inputs and markets. The government wants the most polluting industries to locate elsewhere and has adopted incentives to encourage them to move. Several of the small and medium-sized factories that participated in EP3 are in residential areas. Governmental zoning regulations restrict new investments by such firms. They can stay where they are but cannot expand production. In the case of a tannery it had to use cleaner technologies, a less polluting process, and move the dirtiest part of production outside of Santiago.

EP3 was by design an industry-oriented program with little emphasis on governmental policy or regulatory development. As EP3 progressed, it became apparent that even though the cost–benefit ratio for pollution-prevention measures was strong, regulations were needed to spur industry interest. Unfortunately, Chile's environmental regulations were under development in parallel with EP3, but received minimal EP3 input. Very little of the information developed under EP3 was used by the government as it developed its regulatory framework. Only a portion of EP3 information was forwarded to CIPMA, which was nominally the EP3 information clearinghouse. CIPMA could have been an excellent source of public domain pollution-prevention-based solutions for environmental compliance issues. The need for development of policies and regulations, the involvement of government, and broad dissemination of results

should have been recognized early in the EP3-Chile project. The failure to take those actions reduced project effectiveness.

Institution Building

The National Commission on the Environment (CONOMA) became fully effective after EP3 ended in 1996. CONOMA serves as a coordinating body directed by a Board of Governors composed of 13 cabinet ministers. It sets policies but has no enforcement powers. The organizational framework is in line with the overall strategy of strengthening key institutional functions and appropriate units in the line ministries and not the replacement of their functions. CONOMA is expected to play a catalytic role in helping to define the broad policy framework and provide selected service functions (such as environmental data collection, analysis, and training in environmental impact assessment) to the rest of the public sector. In theory, while it favors environmental policies based on market-based instruments, in practice command-and-control regulation is still the most common approach. Regulations are enforced mainly through the Ministry of Health and the Superintendency of Sanitary Services.

During its implementation, EP3 focused almost entirely on the private sector. It did very little to institutionalize EP3 lessons in the emerging Chilean environmental agencies. As a consequence, national institutions and policy cannot be directly related to EP3. This is not to say that the concepts of pollution prevention, waste minimization or clean production are not well known inside government circles. They are. What is important is that within the government's own Public–Private Partnership for Clean Production, established in 1998 scarcely two years after EP3, the assessment team met senior staff who have never heard of EP3, its functions or what it accomplished.

Now there are several dozen government, ngo and private sector organizations dealing with the environment. During the time of EP3, only a few were in place. In one sense EP3 was ahead of its time and the institutions were not ready to take on pollution problems. Some might argue, though, that the inchoate nature of environmental institutions in Chile during EP3 made it difficult to identify which institutions would develop and become effective. Such efforts might have diffused EP3 technical efforts that were raising pollution-prevention awareness in the private sector. On the other hand, new institutions can often provide new opportunities to exercise a positive influence. A more proactive effort to engage government policymakers might have reaped benefits.

3. Impact

Economic and Financial Impact

THE BASIC CONCEPT UNDERLYING pollution prevention is to generate less waste at the end of the pipe. Any in-plant practice that reduces or eliminates the amount or toxicity of pollutants before they enter the waste stream will generate positive environmental benefits, improved health and safety for employees, and fewer environmental externalities. Just as important, the pollution-prevention processes provide financial benefits to the factory. Financial returns are generated in three ways: first, by lowering operating or input costs (through recovery of raw materials or increased efficiency in the use of energy, water, or steam); second, by reducing compliance and enforcement costs (by lowering fees and penalties for contaminants discharged); and third, through improved process efficiency (either through increased output or by recycling or recovery of what was formerly waste). In addition, financial returns may also accrue if the processes result in increases in product quality, fewer rejects, greater productivity of workers, less downtime from equipment repair, or less downtime from safer operations.

Twenty-six Pollution Prevention Diagnostic Assessments (PPDAs) were completed covering 7 industrial sectors: tannery (3), textile (3), printing (4), food processing (4), hospital (2), mining (4), and chemical (6). About 40 percent of the EP3 recommendations were implemented. These recommendations resulted in estimated total annual savings of $1.9 million against total one-time investments by industries of $1.4 million. The pollution-prevention investment costs were recovered in just 9 months. Pollution was reduced by 32 percent and annual water savings were 1.4 million cubic meters. The average saving per facility was $72,000 with an average one-time investment cost of $53,000. While the savings were important to all of the factories, there were some big winners. Food processing and mining generated 91 percent of the investments and 91 percent of the savings.

Site visits by the evaluation team to one third of the EP3 participating firms found that they were interested in no- or low-cost investment because of: (1) small operating budgets, (2) short planning and accounting horizons, (3) unwillingness to move away from time-tested patterns of production or lack of knowledge about new production technologies, (4) lack of management resources to supervise new procedures, and (5) high risk aversion.

The greatest financial returns accrued to the larger firms. These firms were willing to undertake higher cost investments. Many had linkages to or were owned by foreign firms, which encouraged pollution prevention. For example, among those receiving the greatest returns were a dairy, partially owned by a French firm, and a fishmeal company with linkages to Japanese aquaculture firms. Other successful participants, such as a tannery and a textile firm, have moved into production for export. What distinguishes these firms is not that they readily implemented most of the EP3 recommendations, but that they had the financial capacity to shift their production either into a more diverse product line or invest in newer, more productive technologies. A weak market and increased competition from local as well as international firms resulted in some firms abandoning pollution-prevention measures previously adopted (a metal processing company), or limiting production so severely that recommended pollution-prevention measures were no longer relevant (a chrome plating company).

Table 3.1 summarizes costs and benefits, conservatively assuming that 40 percent of recommendations were actually implemented. These recommendations resulted in an estimated annual savings of $1.9 million. The average savings per facility are $72,000 per year, with an average one-time investment of $53,000. Typical savings included reductions in chemical use, improvements in raw material recovery, energy savings, improved product quality, and productive use of waste materials.

Average annual financial returns were conservatively estimated at 5 to 20 percent by owners and plant managers of the one third of the participating firms examined by the evaluation team. On the other hand, masked in these averages are some postproject cost savings resulting from waste management early in the industrial process and not at the end of the pipe. Decisions to introduce new methods of waste recovery at the dairy resulted in avoided costs of approximately $1 million by eliminating the need for construction of new primary sewage treatment facility.

As an example of cumulative financial savings, it was reported by one of the tanneries that water use was reduced by 40 percent for a savings of about $4,000 per annum; decreases in the use of fuel saved about $2000 a year, and an additional $30,000 per annum was saved by decreasing losses from chrome tanning from 40 percent to a 4 percent loss. Not included in the EP3 recommendations was an enzyme process for biological treatment of hides in lieu of increased use of chemical washing. Savings were $3,000 per annum with significant decreases in both COD (chemical oxygen demand) and BOD (biological oxygen demand) in the waste stream. Clean production improved the quality of leather to allow a higher grading which commands about an 8 percent higher price.

Given the small number of firms participating in the project, and limited replication, one cannot generalize from these data to assess the financial impact of EP3 on Chile as a whole. Moreover, economic events (a major recession, changes in market demand, etc.) appear to have had even greater impacts on profitability than pollution-prevention measures.

Table 3.1. Costs and Benefits From Recommended Pollution-Prevention Measures

Sector	No. of Firms	% of Options Implemented	% of Pollution Reduction	Annual Water Savings (m^3)	Investment Size (US$)		Annual Saving	
					Average per Facility	Total	Average per Facility	Total
Chemical	6	57	35	168,140	3,441	20,650	6,856	41,136
Food	4	44	22	295,035	78,396	313,585	127,740	510,960
Hospitals	2	37	40	0	n.a.	n.a.	n.a.	n.a.
Mining	4	26	23	757,440	237,500	950,000	300,445	1,201,780
Printing	4	18	16	0	818	3,275	1,987	7,950
Tannery	3	48	49	107,500	29,066	87,200	32,050	96,150
Textiles	3	50	22	91,440	1,187	3,563	7,044	21,132
Total	26			1,419,555		1,378,273		1,879,108
Average		40	32		53,010		72,273	

n.a. = data not available

An indication of the positive financial impact of pollution prevention to the nation's economy is indicated by the decisions taken by the Ministry of Economy together with CORFO, Chile's Development Promotion Corporation, to initiate its own Public–Private Committee for Clean Production. The members have agreed upon a Clean Production Agreement—which outlines the common environmental aims between industry and the public agencies responsible for regulation, and commits both to achieving concrete environmental objectives through clean production processes. The Agreement calls for the establishment of a network of Cleaner Production Technology Centers, which will establish a national system of technical certification of clean technology and environmental services. The ultimate aim of the centers is to build a philosophy of industrial self-monitoring whereby enforcement agencies will take up new roles in counseling and advising business in the search for economically sound environmental solutions.

Environmental Impacts

EP3 project managers estimated that pollution-prevention recommendations would reduce pollution by 32 percent at the 26 factories. The problem is a lack of actual before and after pollution measurements. There were no baseline or postproject measurements of air and water pollution emissions. While actual net air and water quality improvements attributable to EP3 measures are not known, based on the sample survey conducted for this assessment of one third of the firms, the 32 percent pollution reduction estimate at these firms appears reasonable.

Air Quality

Santiago is situated at the bottom of a topographic bowl, or a deep and full ashtray of polluted air, as it is locally described. Atmospheric inversions are common particularly during the winter months. An inversion takes place when a layer of cool air forms on top of warm ground-level air, trapping suspended particles and gases. The polluted air is trapped and cannot rise or move out of the area. As these conditions occur most frequently during the Winter, air quality is worst during April through July.

Air pollutants were not a significant factor in most factories participating in EP3. Volatile Organic Compounds (VOCs) were emitted by some. A more important pollution source was the fuel used in the production process—wood, coal, or oil. A number of firms have switched to natural gas and are also burning VOCs in the exhaust stack. The switch was driven mainly by the lower price of gas and to a much lesser extent to regulatory pressure, and has resulted in lower particulate matter and SO_2 emissions.

Based on 1998 data, the most notable improvement has been in the reduction of ambient sulfur dioxide (SO_2). During 1998 emissions did not exceed of any of the Chilean Federal standards, which are comparable to the U.S. EPA and the more stringent California State standards. This is due almost solely to industrial conversion to natural gas and the use of natural gas for local power generation. The natural gas is delivered by pipeline from Argentina.

Ozone (O_3) is a photochemically formed oxidant implicated in respiratory disease. It occurs at moderate levels in the metropolitan Santiago area. Oxides of nitrogen NO_X, primarily as nitrogen oxide (NO) and nitrogen dioxide (NO_2), are visible in the air as a brown haze. NO_X is produced primarily by oxidation of atmospheric nitrogen (N_2) at high temperature (power plants and internal combustion engines). NO_X is an important air pollutant due not only to its own negative health effects, but also due to its role in pho-

tochemical reactions with organic compounds, formation of $O_{3,}$ and its contribution to the formation of nitrate aerosols which are fine particles. They have adverse health effects and contribute to reduced visibility.

PM-10 refers to particulate matter of less than 10-micron diameter, while PM–2.5 refers to particles of diameter less than 2.5 micron. Mass is proportional to the cube of the diameter, therefore one 10-micron particle has a thousand times the mass of one 1-micron particle. Consequently, a low mass loading of small particles may actually represent a very high number of particles—and opportunities to enter and be trapped in the deep lung, causing long-term health problems.

Far more serious are PM–10 levels (particles of a diameter of less than 10 microns) measured at all sampling sites. PM–10 levels measured exceeded the Chilean (and U.S. EPA) 24-hour average standard of 150 micrograms per normal cubic meter from 8 to 51 days during 1998. Values exceeded the more stringent California state standard from 324 to 340 days of the year. The formation and transport of fine particles is a complex process. Based on ammonia and sulfate analyses it is believed that roughly 25 to 50 percent of the fine particles in the air of Santiago are a result of copper smelting south (and upwind) of Santiago. The fine sulfate particles result from the oxidation of SO_2 and subsequent reaction with ammonium to form ammonium sulfate aerosol.

Average air quality data does not always reveal the true potential for adverse health effects. The 8- or 24-hour average standard may be met but short term, and acute pollutant loadings may have adverse effects on human health, particularly on the young, old, and those with respiratory or cardiovascular problems. In particular, young children in Santiago have a much higher rate of acute respiratory illness than those outside the metro area.

Water Quality

Industrial water pollution impacts are even harder to assess as regulations deal almost exclusively with discharge standards, not resultant water quality. The wastewater treatment companies that assess fees regulate industrial sewage loadings and fines based on discharge loadings and exceedance of allowable limits. Their concern with wastewater quality is the fact that they want to avoid an upset of their wastewater treatment plant.

No baseline effluent or water quality data was available for this study and probably does not exist. It is estimated that 95 percent of all drinking water in the metropolitan area is treated. The real problem is sewage. There is very little treatment of municipal effluent (stated to be 5 to 15 percent nationwide), as is evidenced by the open drainage canals running through Santiago. As a result, fecal coliform levels downstream of discharge points are quite high. This is very important as coliform is a major cause of diarrheal disease (particularly dangerous to infants and children).

A second issue is industrial wastewater, which is typically mixed and discharged along with municipal wastewater. Industrial wastewater includes a wide range of pollutants, including organics, heavy metals such as mercury and chrome, nickel, lead, cadmium, and many others. This is an important factor in excess morbidity and mortality, as heavy metals are known to cause a wide range of cancers and neurological disorders.

Health Impacts

Air and water quality standards are set primarily to protect human health. EP3 helped firms reduce their pollution discharges, meet discharge standards, and thereby improve human health. Primary and secondary (spin-

off) effects of EP3 contributed to improved health of the general population. Proper disposal of industrial waste, including hazardous and toxic compounds, will reduce population exposures to air pollution, runoff to surface waters, and introduction of leachates to surface water, groundwater, and aquifers. Improvements in worker health and safety have also occurred.

Examples of air pollutants resulting from industrial operations audited by EP3, known health effects, and measures taken to reduce emissions and exposures are shown in table 3.2. As regards particulate matter (PM), note that it occurs in a range of diameters. Diameter varies as a function of source. Primarily grinding processes and breakdown of larger particles produces larger particles. These particles are trapped and removed in the nose, throat and upper respiratory tract. And fumes, such as condensation of Volatile Organic Compounds (VOC) form fine particles or metal fumes, or reaction of ammonia and sulfate or nitrate in the gas phase to form ammonium sulfate or ammonium nitrate. The later predominate in the open atmosphere while the former are more common in the industrial setting. In either case, smaller particles (less than one micron diameter) enter the deep lung and remain there or are absorbed into the blood in the alveolar sacs. The smaller particulate matter creates the greatest health threat.

Table 3.2. Air-Pollutant Effects and Measures Taken Under EP3

Industry	Pollutants	Health Effects	Measures
Tannery	● PM ● VOCs ● Chromium	● Respiratory ● Respiratory, cancers ● Cancers	● Baghouses ● Evaporation barriers, water-based dispersants ● Recovery
Printing press	● PM ● VOCs	● Respiratory ● Respiratory, cancers	● Change to natural gas firing ● Reduced use of oil-based inks
Hospital	● Pathogenic particles from incomplete incineration of wastes	● Spread of disease	● Offsite incineration and disposal
Electroplating	● PM from grinding and buffing ● VOCs ● Chromium	● Respiratory ● Respiratory, cancers ● Cancers	● Cyclones and baghouses ● Evaporation barriers, water-based dispersants ● Recovery
Fish products	● PM ● Odors	● Respiratory ● Nuisance	● Venturi scrubbers and cyclones ● Venturi scrubbers
Textiles	● PM	● Respiratory	● Baghouses and change to natural gas for boilers

PM = Particulate Matter VOC = Volatile Organic Compounds

Examples of water pollutants resulting from industrial operations audited by EP3, known health effects, and measures taken to reduce emissions and exposures are shown in table 3.3.

Going by the assessment team's onsite visits, it is clear that most firms are reducing air and water pollution emissions. Unfortunately, baseline and post-EP3 air and water quality data, and baseline emissions and effluent data necessary to estimate or quantify impacts are not available. It is therefore not possible to quantify specific benefits for these factories or to estimate the overall impact on health of pollution-prevention measures in Chile.

Table 3.3. Water-Pollutant Effects and Measures Taken Under EP3

Industry	Pollutants	Health Effects	Measures
Tannery	• Chromium	• Cancers	• Metals recovery
Printing press	• Organics	• Cancers and nuisance odors	• Venturi scrubbers and incineration
Electroplating	• Chromium, nickel and zinc	• Cancers	• Metals recovery
Fish products	• Oily wastes • Organic matter • Ammonia compounds	• Increased BOD in receiving waters • Increased BOD • Nuisance odor	• Water use reduction, recovery of oils • Recovery of solids • Venturi scrubbers
Textiles	• Organic fibers • Dyes	• Increased BOD • Cancers	• Filtration and recovery of fibers • Nontoxic dyes, reduced use
Dairy and cheese	• Organic matter	• Increased BOD	• Reduced water use, sale of whey
Slaughterhouse	• Organic matter	• Increased BOD • Odors	• Unresolved • Wet scrubbers

BOD = biological oxygen demand

4. Program Performance

TO BE JUDGED EFFECTIVE, the program and its pollution-prevention concepts should gain sustained support from government and industrial groups. Benefits would be sustained after USAID funding ends, and benefits should be replicated beyond the project. Lastly, effective use of USAID assistance should generate a measurable impact on environmental quality.

Effectiveness

Effectiveness attempts to assess how appropriate the intervention was in meeting program objectives. Was the program directed to the right group to meet program objectives? Were the tools adopted relevant to the context in which they were implemented? Was implementation consistent in its approach, and was the approach the best way to use USAID resources to get the job done?

The host country implementing institution first chosen to implement EP3 was the American–Chilean Chamber of Commerce (AmCham). It was selected because of its private sector orientation, its understanding of the local economy, its political sensitivities, and its ability to provided a forum to disseminate pollution-prevention success stories. As often happens, the choice of AmCham was based on individuals at AmCham who were very interested in pollution prevention. When they left the country, the program suffered. Those that took over did not have the same enthusiasm, and the project stalled.

In the second year, implementation was shifted from AmCham to a local environmental consulting firm, Qualitek, associated with ERM, a U.S.–based environmental firm. Both implementing institutions—AmCham and Qualitek—were careful to disassociate their technical pollution-prevention activities from debates underway about how to establish and organize governmental institutions to develop and enforce environmental standards and regulations. The failure to engage Chilean authorities in a policy dialog during EP3's early years is noted by some people as one of its most significant weaknesses.

The quality of technical assistance was generally highly regarded. Also, the technical approach of having one or two international experts working closely with Chilean environmental engineers on pollution audit teams was effective in identifying appropriate solutions for factories and providing a transfer of technology to local environmental firms. The weakness in the approach was that only a few industrial firms were reached. Of roughly 17,000 small and medium enterprises in the Santiago area, 26 were chosen for environmental audits.

Effectiveness of technology transfer could have been improved if more attention had been given to up-front assessment of small and medium industry requirements in the Chilean context. While the Chilean owners, engineers and plant managers gave high praise to the U.S technical experts who assisted in the environmental audits, their recommendations sometimes exceeded the technical capacity of small firms. Also, technical choices were based on engineering principles that assumed much higher levels of automated processing than was the case in Chile where manual labor is still cost effective. This proved to be the case in a milk-processing plant where advice from an EP3 industrial engineer from India, familiar with LDC operations, was more relevant than higher tech solutions. The pollution audit for the

slaughterhouse had similar problems. Lastly, many of the technical manuals on clean production and pollution-prevention documentation from the EPA were in English. These were of little value to participating firms, particularly their operations personnel.

During project implementation, enforcement of environmental regulations was negligible. Thus, avoided costs from fines or higher costs of waste disposal were probably not important motivating factors. More realistic is the possibility that participants expected to get free technical advice and perhaps other goods from the USAID program. The difficulty in measuring program effectiveness lies in linking the economic gains to the EP3 approach. The firms that appear to have benefited most—such as a leather tannery, a dairy, a fish meal plant, a printing company, and a textile factory—are those that were dynamic and capable of modifying their industrial processes to take advantage of changing local and global markets. It can be argued that those firms would have adopted (possibly several years later) many of the pollution-prevention processes anyway. In fact, most introduced new technologies and clean production practices beyond those recommended by EP3.

Other small, less dynamic firms did not fare as well. Due to a downturn in the local economy during 1998–99, many held back on the implementation of clean production recommendations. This finding flies in the face of the potential financial returns and suggests that technologies may not have generated as large savings as expected by EP3. It is likely that smaller firms have different priorities, less capital, and are unsure of the financial merits of pollution prevention.

In sum, the effectiveness of EP3's approach was technically sound, but weak in both the scope of coverage and its follow-up. Technology transfer might have been improved by a more thorough investigation of the industries prior to initiation of technical audits. This would have enabled establishment of an industrial baseline, so that improvements, both environmental and financial, could be quantified and valued. Also, it might have been useful to focus on a group of companies in a single industrial sector, such as food processing or metal finishing. This would allow the project to demonstrate the merits of clean production and make sure it was adopted by a large number of firms producing similar products in one industry. The "wholesale" rather than "retail" approach would have enhanced replication. It might also have been more effective to start with companies that had greater potential for success or with owners who were more influential within their trade associations.

To be balanced in this assessment, there were external factors that limited effectiveness. The termination of USAID's presence in Chile at the same time as the completion of EP3 meant there was little residual institutional support beyond the life of the project. By mid-1995, the concept of pollution prevention was picked up and given financial support by several international and bilateral donors in Chile. In some instances the projects of those agencies were the direct institutional benefactors of the initial awareness building started by EP3.

Sustainability

Sustainability of benefits is a key measure of success for a pilot project like EP3. Program sustainability can be measured in part by whether or not people can recall after several years the program and its objectives. The evaluation team was often surprised at how few environmental professionals, outside of those directly involved in project implementation, knew about EP3, its objectives, or its impacts. Lack of follow-up with industry, the absence of policy dialog or establishment of a strong relationship with government agencies, and the failure to link lessons learned to dis-

semination and training efforts means that the program had little long-term impact.

The philosophy of pollution prevention has been incorporated within the regulatory framework and environmental standards adopted by CONOMA. The chief of CONOMA's Pollution Control Department noted that the agency had adopted its own approach and policy tools for clean production based on universal models, but acknowledged the important influence of EP3 early in the policymaking process. Often it was the personal role of key EP3 individuals who were cited as influential rather than the project as a whole. While strong and competent individuals are important, if institutional relationships are not well developed sustainability of benefits suffers.

The future of pollution prevention and clean production looks bright. Chile's Ministry of Economy has adopted a wide-ranging pollution-prevention program. The initial stage of its Public–Private Partnership for Clean Production is to run from 1999–2001. The aims of EP3 have been institutionalized, and commitments have been made to ensure that the pollution-prevention concepts are sustained in Chile. Can these very positive results be attributed to the EP3 program? Again, the importance of individuals that participated in the program were cited as being influential in convincing the Ministry of Economy to adopt its clean production program. Chilean environmental engineers who participated in EP3 were also influential in promoting the expansion of a government-initiated clean production program. On the other hand, pollution prevention is a universal concept, and can hardly be said to be "owned" by a project or program. Many other international and bilateral donors were active in providing pollution-prevention services to Chile in the interim. They could also surely claim credit for "sustaining" a program of clean production in Chile.

Project planners and USAID can be given much credit for recognizing an important developmental need in Chile and responding early in an effective way. More attention to follow-up and formulation of a plan for sustaining the program after its termination might have resulted in greater sustainability of EP3 benefits. As one respondent noted, EP3 planted the seed for pollution-prevention programs, but was not around to see the positive results from its efforts.

EP3 had an important role in helping to establish a viable local consulting services industry. As designed, the typical pollution-prevention audit consisted of a U.S. industry expert, a Chilean pollution-prevention expert, and two or three Chilean consultants who received on-the-job training in the assessment process. Local consultants were given additional training at the Environmental Research and Training Center (CIPMA). Complementing this was a "training the trainers" approach which included short-term U.S.–based training for three individuals and industrial engineering expertise from EPA experts brought to Chile for training sessions, also at CIPMA. Nearly 2,500 persons received training.

In part through EP3's training efforts, Chile now has a cadre of trained industrial environmental engineers working principally in the private sector and universities. Many have progressed professionally to become managers and heads of environmental agencies that have important roles in pollution prevention. Several have established their own environmental consulting firms. The environmental services business started off with a burst in the mid-1990s but has been slow during the past few years due to a downturn in the economy.

Early in the program CIPMA's training functions proved successful and useful. As a result, CIPMA was selected by EP3 to serve as a clearinghouse for pollution-prevention tech-

nical information, for postproject training and dissemination of information intended to sustain the project's work following termination. However, for various reasons its effort to sustain the activities of EP3 through establishment of a clearinghouse function failed to meet expectations. Some of the reasons for failure include

- CIPMA is primarily an environmental policy think tank and research organization. Institutionally, it had little credibility in the area of technical dissemination. Consequently, its role in training for technical aspects of pollution prevention was often overlooked by government and other agencies.

- The clearinghouse function was perhaps too early. At the time of EP3's termination the environmental regulatory structure had barely been established. As a result, there was little demand for documentation and case studies on pollution-prevention technologies. As demand for technical input built up later on, technologies were outdated, and industry was no longer linked to CIPMA on pollution prevention.

- Other donor agencies with slightly different pollution-prevention approaches subsumed the EP3 approach with new ideas and their own slightly different approaches. Industry groups generally gave more credence to the donor group in the country at the time, and not to older project approaches.

- It was difficult for CIPMA to interact with the former host country manager after the project because his personal business interests could present potential conflicts of interest.

- CIPMA had difficulty managing the training functions and documentation. Much of the documentation was not in Spanish. Also, because of their proprietary nature, environmental audits containing critical technical information generated by the project were never turned over to CIPMA.

All of these problems generated serious obstacles to building awareness of the program, and failed to establish the foundation for outreach and replication of EP3's technical approaches.

Prospects for Replication

Replication is used in a narrow sense and refers to the difficult process of extending project benefits beyond the original participating companies to other companies within Chile.

EP3's program management recognized that in order to be effective industrial audits had to be customized to the needs of participating firms. To overcome the reluctance of firms to divulge industrial secrets, agreements were made with each participating firm to protect proprietary information about that firm's industrial process and productivity. Information and outreach about the pollution-prevention processes adopted by firms faced two barriers: (1) the audits themselves were considered proprietary information and could not be shared; and (2) owners and plant managers were reluctant to share information about pollution-prevention changes that resulted in cost savings. They wanted to protect their competitive positions.

The evaluation team found, however, that the more influential the person involved in the PPDA (and also to some extent the more prosperous and established the company), the more likely the broad, nonspecific benefits were disseminated to others in the industry. For example, the president of the Chilean Tanneries Association was a participant in an EP3 audit. He continued to praise the results of EP3's technical assistance to other members

of the association and pushed the lessons learned at industry meetings. Similarly, a prosperous and well-established textile manufacturer, who participated in an EP3 audit, became a strong advocate of pollution-prevention audits within his industry, without divulging specific competitive benefits his company received. In these instances the reputation of participants enhanced replication of program benefits.

An example of significant replication was the Valparaíso Hospital. As a public hospital, medical staff had little concern with the profitability of pollution-prevention measures. They were concerned, however, with the impact of pollution-prevention measures on the health of patients and staff, and the maintenance of environmental health and safety in the workplace. The audit led to greater management coordination of medical services in general. As a result, medical staff used EP3's audit procedures to develop a training and outreach program for other medical services at the hospital and for workshops in university settings. The outreach had two purposes: first, to highlight improved measures to handle medical and toxic wastes, and second, to share systematic measures to assess and improve hospital administrative procedures for greater coordination of services among medical staff.

There are many reasons why replication and outreach were limited. The focus on specific problems of individual firms meant that an environmental audit of one firm was not easily transferred to other firms. Replication could have been enhanced if firms knew not only what technologies to use, but also how and where to install them, where to buy the equipment, and possible sources of financing. Many recommendations were generic, and (except in the case of no- or low-cost in-house process improvements) did not include specifics of how, where, and when to acquire the recommended technologies. Promotion of U.S. goods and services was an explicit objective of EP3. However, few sales were generated.

A more integrated approach would have examined the total waste stream from prior to the time it reaches the firm through the production process to end-of-pipe waste treatment alternatives. This approach might have focused on firms within an industrial sector or within a geographic area. Such an approach might have led to greater outreach and more expansive coverage for industrial sectors, and integrated solutions to waste management.

Looking at replication from the firm's perspective yields some interesting insights. In several instances, ownership or management had changed hands. Still, in most cases clean production techniques were still in place or had been expanded. This was the case at both the paint factory and the printing company. Both appeared to be successful, competitive enterprises. For example, the printing company manager noted that he provided incentives to plant workers to call attention to waste and to provide suggestions for pollution prevention. In general, successful pollution prevention was associated with good plant management. Good factory managers are those who understand costs, product development, and marketing. They did well with pollution prevention.

On the other hand, industries and firms with severe pollution problems often had financial problems due to weak management. They were producing the wrong product mix with inefficient machinery. In contrast, good managers saw pollution prevention as an integral part of efficient production. They adopted pollution reduction and waste minimization as a way to save money and improve product quality. There is a tendency for pollution-prevention programs to focus on those firms with the worst pollution. That may be the way to

clean up the greatest amount of pollution, but it is probably not the best approach if the goal is to achieve a sustained impact. Pollution-prevention efforts stand a better chance of success if they identify and work with the more progressive and better managed firms.

5. Lessons Learned

THE CHILE ENVIRONMENTAL POLLUTION prevention project (EP3) was a $1.3 million, three-year demonstration effort. It successfully introduced the concepts of pollution prevention and clean production to Chile's industrial sector. Twenty-six Pollution Prevention Diagnostic Assessments were completed at individual factories. The firms invested a total of $1.4 million, which generated annual savings of $1.9 million. They reduced their pollution emission load by 32 percent. Compared to "end of pipe" pollution treatment, firms found that with EP3 pollution prevention they could save money while also reducing environmental pollution. Pollution prevention is now fully accepted throughout Chile's industrial sector. While EP3 was successful at selling the pollution-prevention message and having 26 factory demonstration efforts, there were some missed opportunities. The lessons that emerge from this assessment are summarized below.

1. Institutionalization. *A pilot effort is an excellent way to experiment and test ideas and methods, but it should include a plan to scale up, disseminate, and sustain successful approaches.*

EP3 assumed that pollution-prevention techniques, once adopted, would generate substantial benefits and that firms would recognize the value of the EP3 approach and it would be adopted throughout the economy. EP3 was successful in creating a cadre of pollution engineers and working with the private sector. But it did not extend its message throughout the industrial sector and failed to develop close ties with the government or NGOs. There was no institutional arrangement to carry on the effort after USAID assistance ended. Designers and implementers of pilot projects need to develop a sustainability plan to ensure that benefits continue once the project ends. That usually requires an institutional structure with adequate funding and skills to maintain project benefits.

2. Replication. *EP3 helped firms reduce pollution, increase profits and improve their competitive position. But participating firms were reluctant to share the newly learned techniques with their competitors.*

EP3 recognized that Pollution Prevention Diagnostic Assessments had to be customized to the unique production process of participating firms. But each firm closely guards its production techniques, not wanting to help its competitors. Agreements were made to protect this proprietary information. As a result there was limited dissemination to other firms in the same industry. The exceptions took place when the audit was done at a firm where the owner was an influential leader in the industry trade association. Replication will not take place if it is a trade secret. A project needs to develop ways to replicate generic pollution-prevention approaches.

3. Which types of firms to focus on. *Good factory managers are those who understand costs, product development and marketing. They also did well with pollution prevention.*

In Chile, firms with severe pollution problems often had financial problems due to weak management. They were producing the wrong product mix with inefficient machinery. They were the losers. In contrast, good managers saw pollution prevention as an integral part of efficient production. They adopted pollution reduction and waste minimization as a way to save money and improve product quality. There is a tendency for pollution-prevention programs to focus on the firms with the worst pollution problems. That may not

be the best approach to achieve a sustained impact. Pollution-prevention efforts stand a better chance of success if they identify and work with the more progressive and better managed firms.

4. Timing. *It is important to be "ahead of the wave," but if a pollution-prevention program is too far ahead of a country's environmental consciousness, benefits will be limited.*

When EP3 was launched, environmental awareness and interest by the government and industry had just begun to grow. Chile had almost no environmental regulations in place. The law requiring Environmental Impact Assessments, the start of enforcement of pollution regulations and the establishment of the government environmental agency (CONOMA) all took place as the project was coming to an end. Without regulations, or enforcement, the project focused on selling pollution prevention directly to industry as a cost-saving measure. That proved to be a difficult task. If pollution laws are not in place, a pollution-prevention program may need to work with a country to develop its environmental policies and regulations, before trying to convince industry to adopt pollution-prevention measures.

5. Regulation. *Cost savings alone may be an insufficient incentive to convince firms to adopt waste minimization and pollution-prevention programs.*

Until the early 1990s, pollution laws were few and enforcement was rare. In addition, Chile had a history of a strong central government with the military in control until 1990. Business leaders and the government still had an ingrained command and control mentality. With little concern about pollution and the absence of regulations, the project had difficulty convincing a large number of firms to adopt clean production measures. Many firms viewed pollution prevention as a cost that might not generate any return on investment. Several years later, firms became interested in clean production and pollution prevention when they faced the threat of pollution fines, government sanctions, and penalties charged by the wastewater authority. While both the carrot and stick (cost savings and regulations) are important in motivating firms to take action, regulations and fines clearly focus the attention of factory managers and create demand for pollution-prevention measures.

6. Wholesale versus retail. *A project cannot hope to reach all firms directly but needs an intermediary to spread the message.*

There are 17,000 small and medium-sized industrial firms in the Santiago metro area. EP3 realized it couldn't reach all directly, so it worked with industry groups and trade associations. In some cases the associations were quite active and involved all members. However, such efforts had limited success. The EP3 approach of providing general public training sessions and dealing with one factory at a time did not succeed in reaching very many firms. A project cannot hope to succeed with a retail approach. Impact will be greatest when an institutional structure (such as an industrial trade association or a clean-production center) exists to actively disseminate pollution-prevention findings throughout an industry.

7. An integrated approach. *All pollution problems cannot be solved solely by clean production and pollution prevention.*

Many industries have already made capital investment for pollution control equipment. These systems must be considered and optimized as part of an integrated approach to pollution reduction. Cross-media effects must also be considered. Solving a water pollution problem may result in the creation of air quality or solid waste disposal problem. One problem may simply be traded for another. Such problems will not be identified if the program

focus is pollution prevention exclusively in one area. A life cycle analysis should also be performed on the input materials, as well as the products. Change in input materials may reduce process wastes but may also increase or decrease environmental impacts associated with production and delivery of input materials, or may shift the environmental burden to another sector of the economy. A balanced approach that considers integration of the industrial process, from start to finish , must be employed. The approach must consider inputs and their origin, cost effective clean production and pollution-prevention measures, and sometimes end-of-pipe applications, and a reasonably complete life cycle analysis.

Annex A. Assessment Methodology

DURING THE PERIOD FROM SEPTEMBER 1993 through October 1996 the USAID Chile Environmental Pollution Prevention Project (EP3) trained 2,497 people, provided technical assistance to industry, completed 26 Pollution Prevention Diagnostic Audits (PPDAs), and disseminated findings within Chile.

A three-person assessment team completed an in-country assessment during the period 15 March through 9 April 2000. The team members included an economist (the team leader), an environmental engineer, and an environmental economist. The team used two carefully tailored interview protocols: one for data collection at factories and a different protocol for data collection from industry, trade associations, government, NGOs, and other donors. It interviewed more than 65 people and collected data in Santiago, Valparaiso, Conception, Coronel, and Talcahuano.

To assess the impact of *training*, the assessment team identified 25 trainees and interviewed 12 of them. The team assessed the value of their training based on how they had used it during the period of EP3 implementation and how they had applied their skills since project completion. To assess the quality of training from the perspective of those who use environmental engineers, the team interviewed 30 factory managers and government officials to obtain their judgement of the value of the training, the quality of environmental consultants in Chile, and their experiences using EP3 trained consultants.

To assess *dissemination* of EP3 findings throughout Chile, the assessment team used its 18 factory site visits along with visits to government agencies, NGOs, trade associations, and other donors to determine the sustainability and replication of EP3 efforts.

To assess the impact of *PPDA audits*, the team made site visits to 10 of the 26 firms that were audited. The team analyzed whether the factories had used the audit recommendations, what their experience had been, whether they continued to maintain PPDA recommendations, and whether they instituted new pollution-prevention measures after EP3 ended. As a control, the assessment team visited 8 factories that did not receive EP3 audits. This provided a comparison and contrast of those who were in the program and those who were not.

Table A.1. Assessment Team Visits to Factories That Had a PPDA and Factories That Did Not

Sectors	Number of PPDAs	PPDA Site Visits	Non-PPDA Site Visits
Chemicals	6	3	4
Food Processing	4	3	2
Hospitals	2	1	—
Mining	4	—	1
Printing	4	1	—
Tannery	3	1	1
Textiles	3	1	—
Total	**26**	**10**	**8**

Annex B. Persons and Firms Contacted

USAID Project Personnel

Gilbert Jackson, LAC/RSD–E
Environmental Officer for Latin America
Responsible for EP3 activities

James Gallup
Previously USAID EP3 Project Manager
Currently with U.S. EPA

Keith Forbes
PPC/CDIE/R&RS
Environment and Pollution Analyst

Deborah Hanlon
Formerly USAID EP3 Project Manager
Managed EP3 Knowledge and Awareness Programs

Marlou Thompkinson–Church
Former USAID EP3 Project Manager, WEC Training. Presently with the Nature Conservancy

David Gerber
USAID EP3. Responsible for linkage of Chilean firms to U.S. environmental technology. Presently with EPA Global Technology Network

Betsy Marcotte
Hagler Bailly Services, Inc.
Hagler Bailly EP3 Contract Director.

Diana Page
Economics Officer
American Embassy; Santiago, Chile

Isabel Margarita Valenzuela R.
Commercial Advisor
American Embassy, Santiago, Chile

Industrial Firms

Eduardo Brenner G, 3/21
Manager, Galvanoplastia
Soc. Crom – Niq LTDA.
Electroplating company that received a PPDA

Gonzalo de Camino Ferrario, 3/23
Manager, Jorge de Camino Ferario
A leather tannery that received a PPDA

Jorge de Camino Gili, 3/23
Ownerr, Jorge de Camino Ferario
A leather tannery that received a PPDA

Rodrigo Maturana Correa, 3/23
Manager, Metal Bras LTDA
A waste recyling firm that received a PPDA

Fuad Garib, 3/24
Manager, Hitega S.A, Hilados Y Tejidos Garib
A textile firm that received a PPDA

Jose Miguel Perez de Castro Z, 3/27
Director of Administration and Finance
Soquina Paints
A paint firm that received a PPDA

Pedro Gac Vega, 3/27
Chief Engineer, Soquina Paints
A paint firm that received a PPDA

Jose Linj Navarin, 3/27
Manager,Curtiembre Etalfa
A tannery that did not participate in EP3

Andres Valenzuela Del Valle, 3/27
Owner, Curtiembre Etalfa
A tannery that did not participate in EP3

Carmen Gloria Araya R., 3/28
Director, Mineral Environmental Commission
Sociedad Nacional de Mineria
A mining firm that did not participate in EP3

Pedro Moral Lopez, 3/28
Director of Operations, Morgan Impressions
A printing firm that received a PPDA

Carlos Fuentes B., 3/29
Chief of Maintenance, AASA
Agricola Industrial Lo Valledor AASASA
A slaughterhouse that received a PPDA

Francisco Javier Urrutia H., 3/29
Director of Administration and Finance
Aguas Manquehue
A private water and sewage company that did not receive EP3 assistance

Alvaro Sola Alcazar, 3/29
Chief Engineer
Aguas Manquehue
A private water and sewage company that did not receive EP3 assistance

Jorge Urrutia, 3/31
General Manager
Del Cabo SA, Cornel
Fish Mean Processing Factory that did not receive EP3 assistance

Ruben Andrade Toro, 3/31
Chief Engineer
San Jose Fish Factory, Talcahuano
Received a PPDA

Edurado Hillerns Larranaga, 3/31
Chief of Environmental Matters
Compania Siderurgica Hachipato, SA
A steel mill that did not receive EP3 assistance

Victor Aranciba Burr, 3/31
Director of Environment
PETROX SA. A petroleum refinery
Did not receive EP3 assistance

Marco Antonio Leiva A.,4/3
Director, Los Fundos
A dairy and cheese factory that received a PPDA

Pollution Engineering Consultants

Jose Luis Kofman, Director General, 3/15
Bechtel Chile, Ltda.
Bechtel Andean Region

Jorge Castillo, 3/16
General Manager, AQUA Laboratories
Chairman of the Pollution Prevention Group of the Association of Sanitary Engineers
Environmental engineer trained under EP3

Dolores Rodriguez, 3/16
Environmental Pollution Consultant
Environmental engineer trained under EP3

Francisco Acuna Carter, 3/17
Director of Development
AMG Bioingenieria, Ltda.
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Guillermo Garcia Cornejo, 3/28
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The trade association for mining companies

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Chairman AmCham Environmental Committee
AmCham managed EP3 during the first year

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Macarena Ortega Granella, 3/29
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Annex C. Chilean Environmental Institutions That Support Clean Production and Pollution Prevention

INCLUDED IN THIS ANNEX are summary descriptions of several institutions that have as central objectives the support of pollution-prevention technologies, methods, and tools. New institutions have emerged over the past few years following the enactment of Chile's Framework Law on the Environment (Law 19.300) which took effect on March 9, 1994. These institutions complement others, both public and private, that have been instrumental in promoting sound environmental management in Chile for more than 20 years. The institutions fall into two groups: governmental and nongovernmental. However, with the growth of privatization in areas such as water supply and sanitation, governmental entities such as the Production Development Corporation (*Corporación de Fomento de la Producción, CORFO)* have begun to assume important roles in the interface between public entities and the private sector. The major Chilean environmental institutions summarized in this appendix include:

Governmental

National Commission on the Environment (*Commissión Nacional del Medio Ambiente, CONOMA)*

Environmental Health Services for the Metropolitan Area (*Servicio de Salud Metropolitano del Ambiente, SESMA)*

Ministry of Economy, Environment Unit (*Ministerio de Economía, Unidad Ambiental*)

Executive Secretariate for Clean Production (*Secretaría Ejecutiva de Producción Limpia*)

Production Development Corporation (*Corporación de Fomento de la Producción, CORFO)*

- CORFO–FAT, Fund for Technical Assistance (*Fondo de Asistencia Tecnica*)
- CORFO–PREMEX, Program to Support Management of Export Industries (*Programa de Apoyo a la Gestion de Empresas Exportdoras*)
- CORFO–PROFO, Project Promotion (*Proyecto de Fomento*)
- CORFO– FONTEC, National Fund for Development of Technology and Innovation (*Fondo Nacional de Desarrollo Tecnologíco y Productivo*)
- CORFO–CREDITOS, Financial Intermediation

Chilean Corporation for Technical Research (Corporación de Investigación Tecnologíca, INTEC–CHILE)

Nongovernmental

Chilean Environmental Association (*Asociación de Empresas y Profesionales par el Medio Ambiente, AEPA)*

Environmental Planning and Research Center (*Centro de Investigación y Planificación del Medio Ambiente, CIPMA)*

National Commission On the Environment *(Commissión Nacional del Medio Ambiente)*

The National Commission on the Environment (CONOMA) is a stand alone government agency that was given a permanent organiza-

tional framework under Chile's Basic Law on the Environment, approved in early 1994. CONOMA is directed by a Board of Governors composed of 13 cabinet ministers. The Board is chaired by the Secretary General to the President, an official of cabinet rank. CONOMA is expected to play a catalytic role in helping to define the broad policy framework and to provide selected service functions (such as environmental data collection, analysis, and training in environmental impact assessments) to the rest of the public sector. CONOMA has a coordinating role. It does not develop or enforce environmental laws or regulations. The organizational framework is in line with the overall strategy of strengthening key institutional functions and appropriate units in the line ministries and not the replacement of their functions.

CONOMA is now emerging as an effective organization for coordinating the nation effort on environmental policies and issues. It has four technical departments: Environmental Impact Evaluation; Decontamination Planning and Norms; Natural Resources; and Environmental Economics. Consistent with its legal mandate, its major functions are to

- Propose environmental policy to the president
- Operate the Environmental Impact Assessment Review system
- Coordinate the issuing of new environmental standards
- Formulate pollution prevention and clean production programs
- Coordinate environmental tasks among government ministries, bodies and agencies
- Operate the National Environmental Information System, now open to the public
- Fund environmental protection activities
- Assist authorities in formulating and implementing programs designed to educate the public on environmental protection, nature preservation, and environmental asset conservation issues

An Advisory Council provides consultation and support to the Board of Directors and the Executive Office of CONOMA. It is composed of two university scientists, two academicians from independent organizations, two business representatives, two representatives from nongovernmental organizations, and one representative of the president of the republic. It is presided over by the minister president of CONOMA. This council is also established in a similar manner at the regional level, but is presided over by the regional superintendent.

CONOMA is decentralized territorially through Regional Commissions for the Environment (COREMA). Each COREMA has a Regional Superintendent and five ex-officio members from within the region. A Technical Committee has also been established to assist each COREMA.

Environmental Health Services for the Metropolitan Area
(Servicio de Salud Metropolitano del Ambiente)

The fundamental aim of SESMA is to protect the health in Santiago of all persons currently at risk due to the environment. This objective is achieved through the following efforts:

Preventative Enforcement

Through requirements placed on the owners of productive activities that are subject to health requirements, by means of authorizations and resolutions that impact on the operation and/or expansion of their

establishments, in order to safeguard in this way the health and security of workers, the neighboring community, the environment and the population in general.

Command and Control Measures

To be accomplished by regular inspections in accordance with technical priorities or as requested by the community, in accordance with SESMA's responsibility under the Sanitary Code, that allows it to function as the Primary Health Tribunal.

Environmental Awareness and Prevention

To promote an increased awareness concerning sanitation and healthier living conditions in the community, through education, empowerment of community organizations, and increased social participation.

Interagency Coordination

Through the formation of strategic alliances between public and private agencies, that would be united in order to establish priorities for the protection of individual and community health.

Risk Assessment

Efforts will be taken to inform and educate the community, in order to warn, prevent or instruct them concerning the best practices to undertake in order to avoid health risks.

Ministry of Economy, Environment Unit

(Ministerio de Economía, Unidad Ambiental)

The Environmental Unit of the Ministry of Economy was created in 1995, shortly after the establishment of CONOMA with the aim of dealing with the development of a national institutional framework for environment within the industrial sector. Initially, its actions were directed toward studies aimed at the formulation of policies for the control of industrial contamination and assessment of the contribution of the industrial sector to overall environmental contamination in Chile. At the end of 1996, the Environmental Unit was subsumed within the Ministry's Division for the Development of Production and its principal activities are now directed toward formulation of new initiatives in the promotion of clean production.

At present, its principal objectives are

- To establish and coordinate strategies and policies that contribute to sustainable development by bringing together public and private sectors in order to stimulate the introduction of technics and technologies that simultaneously increase efficiencies within companies and minimize environmental harm.
- To support public and private sector initiatives oriented toward promotion of efficient and effective environmental management, consistent with the industrial development policies of the Ministry of Economy
- To oversee technical support and to coordinate the activities of the Ministry of Economy with respect to environmental issues
- To support the activities of the Division for the Development of Production with studies and technical analysis, specifically with reference to productive development and its relationship with environmental issues

Ministry of Economy, Executive Secretariat for Clean Production

(Secretaría Ejecutiva de Producción Limpia)

The Executive Secretariat for Clean Production was created in March 1998 as the executing arm of the Ministry's Policy for the Promotion of Clean Production. Its main goal is to provide secretariat functions in support of the Public–Private Committee for Clean Production. The Committee is composed of both public and private agencies directly involved in the production, management, oversight and regulation of industrial waste. Working together, the members of the Committee have mutually agreed upon a document—the Clean Production Agreement—which outlines the common environmental aims between industry and the public agencies responsible for regulation of the environment, and commits both to achieving concrete environmental objectives through the implementation of clean production processes.

In addition, the Ministry of Economy has launched together with support from CORFU, a National Center for Clean Production. The initial stage, which is to run from 1999-2001 calls for the establishment of a network of Cleaner Production Technology Centers, which will be directed toward the establishment of a national system of technical certification of clean technology and environmental services. In a second stage which is to be supported by foreign donor assistance, the Cleaner Production Centres are to expand their services to regions outside Santiago and help both public and private organizations build their clean technology skills. The ultimate aim of the centers is to build a philosophy of industrial self-monitoring whereby enforcement agencies will take up new roles in counseling and advising business in the search for environmental solutions.

Production Development Corporation

(Corporación de Fomento de la Producción)

CORFO was created in 1939, as an entity of the Chilean state charged with promoting national productive activities. Initially, it approached this mission by creating industries considered essential for Chile's economic development. Today, it has assumed a broader role of giving support for the modernization of private companies by assisting them in obtaining those key elements needed to increase their productivity, thereby strengthening the capacity of the country to confront on an equal footing the challenges of a global market and accelerated technological change.

At present, CORFO's activities are directed toward the following activities:

- Innovation and technological development;
- Modernization of companies to increase their competitiveness;
- Improvements in company management;
- Financing and the development of financial instruments in order to meet company requirements for growth and investment
- The promotion of private investments in special zones

Although CORFO's role in providing incentives for industrial development has not been directed specifically toward a solution for environmental problems, many of its financial instruments can be adapted to applications in this field. Consequently, these are of great utility to small and medium industries that want to increase their capacity to comply with environmental regulations, but lack sufficient

resources. Summarized below are the main financial instruments of CORFO that can be used in support of improved environmental management, their principal characteristics and common applications in Chile.

Fund for Technical Assistance (*Fondo de Asistencia Tecnica, FAT*)—The FAT provides companies with funds to enable them to cofinance the hiring of technical consultants who can assist in the introduction and integration of modern technologies. Technical assistance can be made available either for a single company or for a group of companies. Technical areas covered under the assistance can include: quality assessment, design, finance, production, marketing, strategic planning and organizational development, environmental management, or other specialized sectoral inputs. The aim is to optimize the company's managerial and productive capacity to enable it to compete on a global basis.

The terms and requirements for using the FAT are circumscribed to ensure that the firms accessing the Fund are firmly committed to modernizing their productive processes, are willing to make a significant personal commitment to the modernization effort, and are aware of the risks associated with the proposed investment. While much of the investments are directed toward new plant and equipment to facilitate exports, it can also be directed toward environmental improvements. FAT has been used for the following environmental applications:

- Diagnosis and Environmental Audit for Clean Production
- Technical and Economic Studies to Design Solutions for Environmental Problems
- Preparation of Environmental Impact Statements
- Planning Studies for Retrofitting, Conversion and/or Relocation of Industries
- Consolidation of Waste Management among Similar Industries or in Common Areas.

Program to Support Management of Export Industries (*Programa de Apoyo a la Gestion de Empresas Exportadoras, PREMEX*)—The PREMEX is focused on improving the competitive position of export industries, by introducing management changes in order to improve both productivity and product quality through "one shot" management consulting aimed at diagnosing managerial deficiencies and proposing short-term interventions. The consulting intervention is usually less than two months. PREMEX supports 60 percent of the cost of the consultancy up to a fixed level. Environmental applications include:

The introduction of environmental management systems (EMS), in anticipation of future requirements for exporting of goods requiring "green labeling". Support can also be provided to carry out the diagnosis and then outlining steps required for planning and implementing an EMS in order to achieve certification under the ISO 14000, if this is required by the company's overseas clients; other applications include the certification of food processing plants according to Hazard Analysis Critical Control Point criteria required in various export markets, especially in Europe and North America. This application is aimed specifically at ensuring the health and safety of food products, since this is so closely linked with the high quality environmental management.

Another important application is the conduct of life cycle analysis of a given product in order to identify new, and cleaner products and processes. Life-cycle analysis may be required by some countries in order to ensure that the overall process of design, extraction, transport, processing, use and disposal of a product or material is carried out in an environmentally sustainable manner.

Project Promotion (*Proyecto de Fomento, PROFO*)—PROFO is aimed at the promotion of associations among companies that produce similar or complementary products or are located in the same area. The objective is to assist them in the search for common solutions that can be achieved by working together as associations to increase their participation and competitiveness in the market. The instrument is especially geared to potential beneficiaries in the small and medium enterprise sector. Activities and results from this instrument of CORFO include supporting payments to managers of PROFO associations; seminars for technology transfer; consultations; trips; acquisition of books and specialized magazines; studies; and acquisition of minor equipment, among others. This program has had several environmental applications. Some examples include

- Group programs for training and implementation of environmental management systems and certification of ISO 14000 (and also ISO 9000)
- Group programs for waste minimization, including the identification of waste recycling and the use of waste by-products by others in the group
- Establishment of common sites for the collection and treatment of wastes. This has proved especially useful given the limited economies of scale of some small industries. Common treatment facilities have lowered costs significantly
- Collective programs for conversion and retrofitting industrial processes. Groups often work together to identify viable technical solutions to adapt their processes to meet environmental requirements in order to avoid relocation
- Group programs for the consolidation and relocation of industries. Groups often associate to look for new sites and to introduce new process changes at these sites
- Group associations also look for and test the efficiency of new environmental technologies, and work together to identify the best providers of technical inputs

National Fund for the Development of Technology and Innovation (*Fondo Nacional de Desarrollo Tecnologíco y Productivo,* FONTEC)—This agency of CORFO has as its objective to promote, direct, finance and underwrite the execution of technically innovative projects, the transfer of associated technologies, implementation of technical infrastructure, and in general, promotion of all of the developmental steps required to increase the scale of productivity and marketing of projects linked to innovative processes.

It is envisioned that new industries, new product lines and new technologies for a global economy will generate new types of environmental problems. FONTEC recognizes that the solutions to environmental problems from these new industries have to be covered by a line of finance from FONTEC in order that the environmental solution is linked to the technological innovation. Some examples of how such investments might be used to address environmental issues include

- Process changes in order to reduce the generation of wastes through the introduction of new technologies, automation, and the like
- Development of innovative systems for the recovery and treatment of effluents and waste streams
- Creation of a new product by internal recycling wastes from the process
- Creation of new, more environmentally friendly products, based on life-cycle analysis

- Creation of third-party services for recycling and reuse of the waste stream

Financial Intermediation (*Creditos*)—To achieve its commercial and environmental objectives, CORFO has established a program to provide medium and long term credit through commercial banks. These credit lines are oriented especially to small and medium enterprises and to nontraditional exports. Financing is available for investments of all type: for machinery and equipment, installation, construction, civil works, plantations, cattle, engineering, and accounting services, including working capital. The credit line is available for investments in waste remediation and improvement of the environment.

Major characteristics of CORFO credits are

- They are multisectoral, and can be used for investments in industry, agriculture, ranching, silviculture, fishing, minerals exploitation, tourism, education and health

- There is great flexibility in the loan conditions: with payback period from 2 to 10 years, and grace periods of up to 24 months, thus allowing the structuring of repayment to meet the needs of each type of investment

- There is the option to repay in either *Unidades de Fomento* (UF)—a Chilean currency unit—or in U.S. dollars at a fixed or floating rate

- The credit line is oriented to companies with annual sales up to US$30 million.

- The amount of the loan can be up to US$5 million, with no more than 30 percent intended for use as working capital.

Chilean Corporation for Technical Research
(Corporación de Investigación Tecnologíca)

INTEC–CHILE is a not-for-profit, private corporation that performs a public role in facilitating, motivating and increasing the level of technology transfer among public and private companies and organizations. It was created by the Production Development Corporation (CORFO) in 1968.

The objectives of INTEC–CHILE are to transfer technology to those productive sectors that are involved in managing technical projects that have a significant national impact. It provides training to improve technical management of industrial sectors that are producing goods and services. This is achieved through technology transfer by means of the following activities:

- Introducing new technologies, including the identification and realization of demand to meet new technical requirements, as well as evaluation, adaptation and diffusion of emerging technologies and best practices;

- Managing technically innovative projects that have significant national impact;

- Promotion of consultants and training of companies and consultants working with small and medium enterprises (SMEs);

- Creation of strategic alliances among national and international companies;

- Support to governmental organizations in the formulation of policies and the setting of standards along lines that are consistent with INTEC–CHILE.

INTEC–CHILE's Division of Environmental Technology has as its principal objective the transfer of environmental technologies to national companies in order to fulfill its public role as the principal arbitrator in the supply and demand of technologies. Its actions are centered around the following issues: environmental management; clean production; recycling and reduction of wastes; control and treatment of liquid and solid wastes; atmospheric emissions; strategic alliances between Chilean companies and foreign companies providing environmental technologies and services, among others.

Chilean Environmental Association

(Asociación de Empresas y Profesionales par el Medio Ambiente)

AEPA was founded in February 1999, by a group of companies offering environmental goods and services whose major aim was to respond to the government's new policies that would tend to bring about cleaner production processes. The Association's stated objective is "To promote application of the concept of sustainable development in the governmental, corporate and social spheres as a whole, in order to strengthen prevention, control and decontamination of productive activities."

Activities and services of AEPA are geared toward the development of partnerships among industrialists and those authorities and agencies involved with the environment in order to achieve progress consistent with environmental policies. AEPA aims to create a membership registry as a means of promoting environmental services and bringing groups together through meetings of national interest. AEPA offers an environmental database comprising

- Companies offering environmental services and equipment
- Professional consultants
- Chilean environmental authorities
- Relevant environmental and eco–economic studies carried out in Chile

Several of the environmental services offered by AEPA include

- Bimonthly publications pertaining to current environmental questions
- Organization of round table presentations, seminars, and so forth
- Market research concerning the demand for environmental services
- Market studies on the supply and demand for clean technology in Chile
- Promotion of technical tours and business missions
- Organization of a permanent training facility for the organization's members
- Dissemination of technical, market and environmental information

A working committee of AEPA has established ProChile–AEPA which aims to promote the export of Latin American environmental products and services originating from Chilean environmental companies. The same group also intends to obtain new technologies from abroad in order to induce technology transfers and the promotion of "green marketing" in Chile.

Environmental Planning and Research Center

(Centro de Investigación y Planificación del Medio Ambiente)

CIPMA is a nonprofit organization for research, information, dissemination, and dialog in the area of environmental policy. It was founded in 1979 and accredited as an "independent academic institution" by the Chilean National Council for Science and Technology. CIPMA's funding derives from national and international organizations, and from public and private corporations who provide grant support for research. Its main objectives are

- To contribute to national dialog on formulation of national environmental policy integrated with economic, social and cultural development of the country
- To undertake research that provides the technical foundation for dialog and contributes to design and improvement of policy instruments for sustainable development
- To facilitate collaboration among the various social actors in the search for improved environmental management through consensus and for processes for resolving environmental conflicts

CIPMA's activities include research, training, seminars, and working groups on various environmental topics. More recent research has focused on the interrelationship between development and the environment, and the formulation of government policy and environmental management in the various sectors of society with an emphasis on participatory approaches. Research themes have included international trade and the environment, the use of economic instruments in environmental policy, public–private collaboration in environmental policy, and participation by citizen groups, and resolution of environmental conflicts.

The courses offered by CIPMA have been attended by staff of government agencies, entrepreneurs, academic and research staff, and other professionals. Typical training topics have included clean production, pollution control, and environmental management. Most courses have been undertaken through contracts with international or bilateral organizations such as the Inter-American Development Bank and the U.S. Environmental Protection Agency. Training sessions are complemented by Seminars and Workshops aimed at disseminating research results and to obtain feedback from the diverse sectors concerned with the environment. Themes addressed by these groups have included: Mercosur and the environment, economic instruments in environmental policy, and improving the quality of life.

CIPMA publishes a range of publications and occasional papers on topics related to its research and training programs, primarily in the areas of environmental management, sustainable development and pollution control, as well as books, reports and proceedings from seminars and scientific symposiums. Under an agreement signed in 1997, the Association's database—which comprises over 14,000 national and international publications on environment—was recently transferred to the Document Center of CONOMA, and is available to the public.