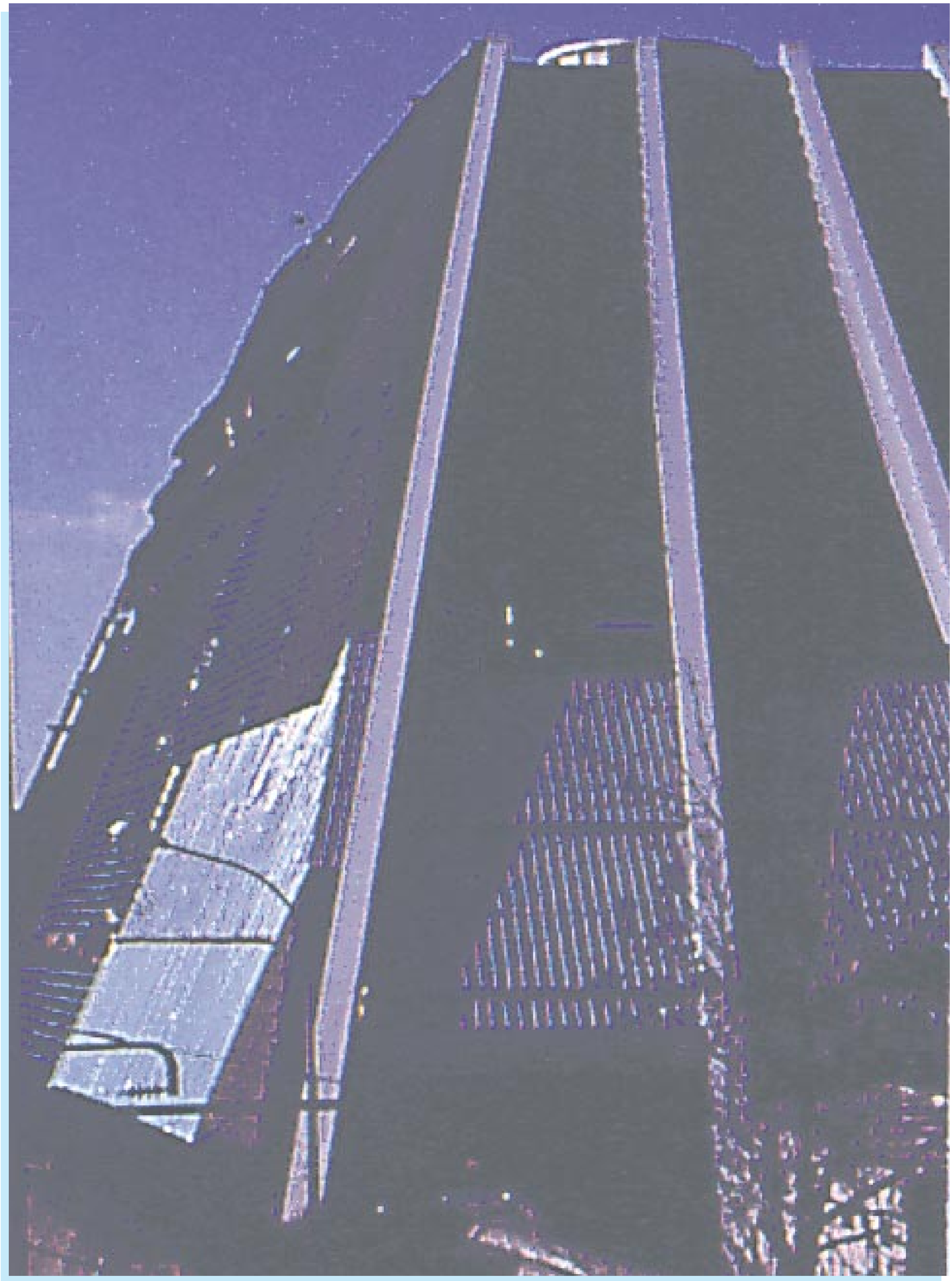

The use of environmentally sound technologies supports sustainable economic growth, benefiting business, industry and the environment.

Bringing tangible, measurable benefits 2

Environmentally sound technologies (ESTs) exist today to help industries and companies achieve significant improvements in their environmental performance by reducing pollution, waste, and the use of energy and raw materials. Most of the technologies provide end-of-pipe solutions, an interim but still important step. In addition, as industries and companies are demonstrating, the use of ESTs brings direct benefits to the bottom line.

Environmentally sound technologies (ESTs) support sustainable economic growth by reducing and cleaning up pollution, cutting down on the use of energy and other material resources, and increasingly by preventing pollution and waste through cleaner production and recycling. In addition, by providing proven, workable solutions to air and water pollution, waste management and other urgent problems, they are helping to make cities and communities cleaner and healthier. End-of-pipe technologies reduce pollution, but can divert financial resources away from more efficient cleaner production solutions. The focus is more and more on cleaner production and pollution prevention, not on end-of-pipe pollution control.

The benefits of using ESTs will become increasingly important. Already, those benefits are tangible and measurable. They are felt most directly by business, both large companies and small and medium-sized enterprises (SMEs) – which, while they do not individually pollute a great deal, collectively contribute substantially to the pollution problem. After all, it is industry, in both developed and developing countries, which accounts for the lion’s share of environmental pollution problems – although agriculture, transportation and the rapid growth in urban activity everywhere are also key contributors.

A fivefold approach

There are typically five ways for any company or industry to tackle its environmental problems:

- through simple operating and housekeeping processes (fixing leaks; separating waste streams to allow recovery);
- by redesigning and/or reformulating products (replacing chlorofluorocarbons (CFCs) with substitutes in aerosols; replacing mercury, cadmium and lead with other less toxic substances as components);
- by modifying processes (replacing single rinse practices with counter current processes; replacing single path processes with closed loop processes);
- through changing plant equipment (installing new technologies such as ion exchange; ultrafiltration; reverse osmosis to separate components in the waste stream and allow their recovery);
- by substituting less harmful raw materials (using oxygen instead of chlorine for bleaching in the pulp and paper industry; using halogenated solvents instead of non-halogenated compounds in the electronics industry).

These are, in fact, the five steps to cleaner production. However, the important point is that ESTs – both end-of-pipe and cleaner production technologies – make it possible to carry out all of them. Many of the technologies used are

THE ENVIRONMENT IS CENTRAL TO OUR BUSINESS

api, one of Italy's leading private industrial groups, active both in the oil business and in the field of alternative energy, was one of the first in the country to grasp the strategic importance of ensuring its business activities are compatible with the environment.

The api Group today has more than 20 companies, with a consolidated turnover of L6,000 billion a year. It has 65 years' experience and enthusiasm of facing up to new challenges – nowhere more so than in oil, its core business.

The environment is a major challenge – for business, and for every one of us. We intend to meet it not just by complying with legislation, but by working with other stakeholders to go even further in finding solutions.

That is why

- in 1991, we launched a L300 billion investment Energy, Security and Environment programme at our Falconara refinery, through which the whole cycle has been updated to provide more environmentally friendly and secure products, while achieving significant emission reductions and better site placement with respect to the external area
- we are developing a computerized environmental management system, based on internationally recognized certification standards like ISO 14000 and Emas, aimed at certifying any refinery activity in the context of a sound environmental management system
- from 1999, we will issue an annual environmental 'balance sheet' for the Falconara refinery
- we have signed three agreements with the Municipality of Falconara Marittima, Legambiente, Italy's biggest environmental organization, and the labour unions, committing the company to environmental protection measures far beyond those required legally. Together with Legambiente, we are committed to organizing and running an annual Forum on the Environment at the refinery to discuss and find solutions to major problems concerning industry-community relations.

These actions demonstrate api's determination to put the environment at the centre of our business philosophy.

With its two partners, ABB Sae Sadelmi and Texaco, api is also pioneering a new approach to energy production in Italy, building the country's first power station to use integrated gasification combined cycle technology at its Falconara refinery.

It is one of the most ambitious and important projects ever undertaken in the country – costing L1,300 billion and involving state-of-the-art gasification co-generation technology to produce 280MW of electricity a year from processing TAR, a bituminous production residue with a high sulphur content.

The new plant will

- lead to a reduction of all pollutants, especially SO_2 and NOx
- remove a significant quantity of fuel oil with high sulphur content from the market
- allow for an annual reduction of about 180,000 tonnes of CO_2
- allow the production of 280MW of clean electrical energy without any further emission to the atmosphere.

It symbolizes api's ambition to become an integrated energy group, capable of exploiting various technologies – including renewable sources – for energy production in a way that is compatible with protecting the environment.

This is our policy. It reflects our conviction that it is only through cooperation that we can relate general issues to the specific local situation and ensure that technological excellence, traditionally in the hands of the industrial sector, can also have a political and social value, and have a directly beneficial influence on the wider environment.

Clemente Napolitano
Managing Director
api raffineria di ancona

specific to a particular process or product, but many others can be adapted for wide use.

In adopting ESTs, companies need to consider where the technologies fit into the five phases of product life cycles (design, production, distribution, use and disposal), and to think about not just the impact of individual pollutants, but the effects of the whole production process – which means adopting an integrated approach to pollution prevention and control.

This approach includes:

- minimizing energy, materials and wastes used or created per unit of product;
- high process accuracy for the entire range of products;
- anticipating and preventing defects at each step in the process;
- system cut-off if defects are found;
- a workforce trained to ensure quality control at all stages.

Almost all these systems will incorporate ESTs. For instance, in automotive manufacturing, the use of more efficient assembly methods will cut steel waste, energy per vehicle, paint wastage and space to assemble the vehicle (through more efficient use of heating, lighting and land). The domino effect is important. For example, reducing one input, energy, will bring other environmental and economic gains, including less contamination and less materials use, while lean designs such as lighter cars which contain recyclable aluminium and plastics can lead to less mining waste, less hydrocarbon use, less solid waste and fewer emissions.

Technology solutions exist

There is, rightly, much debate over exactly how much progress has been achieved, and is being made, in tackling the world's environmental problems. But the key point is that the technological means to improve the environmental performance of most industrial activities exist already; there is available, today, a suite of ESTs that will produce significant environmental and economic gains – ranging from end-of-pipe pollution control solutions (which are not cleaner technologies from the purely technical standpoint, but which do help to reduce pollution) to technologies that prevent pollution through cleaner or eco-efficient production.

Three main categories

Existing ESTs fall into three broad, main categories.

- Processes and materials that reduce the environmentally harmful effects of a given operation, without necessarily making fundamental changes to the original process. Examples include flue gas desulphurization, catalytic converters for car exhausts, and water treatment and detoxification.
- Process modifications to existing operations to eliminate, or at least minimize, their negative environmental impact. Examples include fuel conservation, waste heat recovery and co-generation technologies in the energy sector, and advanced measurement, control and computerized technologies in other industries (for example, chemical) to cut undesirable by-products and achieve cleaner, more energy-efficient processes.
- Technologies that are inherently sound from an environmental standpoint. Examples include solar energy, several process technologies (for example, membrane separation) introduced into the chemical industry, and biotechnology applications.

Generally speaking, ESTs in the first two categories have been developed more rapidly and used more widely than those in the third. The reason is mainly economic. These ESTs, particularly in the first category – the classic end-of-pipe solutions – usually involve only incremental changes or additions to existing equipment, whereas switching to technologies in the third category can sometimes involve heavy investment and other costs.

However, technologies which are inherently environmentally sound do not always require radical transformation and, while retrofitting may be expensive, the costs can be less if the technologies are installed from the outset. The problem with some new cleaner technologies is that their up-front costs are higher than for traditional technologies – although these costs are frequently recovered over the long term.

Four generations of ESTs

The International Institute for Sustainable Development (IISD) classifies ESTs a different way: into four generations – remediation, abatement, pollution prevention and sustainable technologies.

Remediation technologies treat environmental problems after they have occurred. They include various soil clean-up methods, treatment of surface water or groundwater, and a variety of technologies to restore damaged or degraded landscapes.

Abatement or end-of-pipe technologies capture or treat pollutants before they escape into the environment, employing physical, chemical or biological means to reduce emissions. They include municipal sewage treatment systems, catalytic converters for cars, heavy metal treatment for the plating industry, electrostatic precipitators and flue gas desulphurization equipment for coal-fired power plants.

It is important to stress that these technologies do not prevent or eliminate pollutants. They are usually capital intensive, require significant amounts of energy and resources to use, and produce a waste disposal problem of their own. But they are effective and most regulatory activity and investment in ESTs is focused on abatement technologies.

Pollution prevention technologies are of two types. The first are improved or alternative industrial and agricultural processes that do not produce pollutants. Examples include paper making processes that eliminate chlorine bleaching, cleaning techniques that eliminate toxic solvents, reformulated manufacturing processes that eliminate heavy metals and toxic chemicals, and agricultural practices that eliminate chemical pesticides and fertilizers. The second type are alternative products whose use and disposal avoid or prevent pollutants. These include phosphate-free, biodegradable detergents, lead-free gasoline, mercury-free batteries, water-based paints and adhesives, and non-toxic cleansers.

Pollution prevention is being driven by regulation (with its new focus on performance rather than prescription), consumer pressure

BOX 2.1

Characteristics of sustainable technologies

Low environmental impact

- Very low or benign emissions to the environment in production, use and disposal.
- No toxic releases.
- Benefit environment indirectly through uses and/or inherent efficiency.

Resource efficiency

- Efficient utilization of material resources, often using recycled material.
- Based on renewable resources and energy (or minimal use of non-renewable energy).
- Efficient consumption of energy in production and use.
- Durable, re-usable and/or recyclable.

Economic advantages

- Economically cost-effective compared to conventional product or service.
- Incorporate externalities in market price.
- Can be financed by the user through various financial saving streams.
- Improve productivity or competitiveness of industry and commerce.

Social advantages

- Enhance or maintain living standards or quality of life.
- Readily available and easily accessible to all income groups and cultures.
- Consistent with themes of decentralization, individual control and democracy.

and, not least, the need to modernize industry. Industrial pollution is frequently caused by old, inefficient processes that are heavy users of materials and energy, and produce unwanted by-products. Improving and replacing these technologies with more eco-efficient processes generally reduces input costs, streamlines production, eliminates or reduces wastes, and saves money.

Sustainable technologies are resource efficient, provide economic and social advantages, and have a low environmental impact (see Box 2.1).

The IISD makes the point that technologies can be modified to move to the next step along the evolutionary path – and that there are "many existing technologies, products and services to which the attributes of sustainability can be added". For instance, a product can be made more sustainable by making it more resource efficient or more renewable.

Cleaning up industry

The major users of ESTs are the manufacturing industries. They are particularly heavy polluters, accounting for 25 per cent of nitrogen oxide emissions, 40-50 per cent of sulphur oxide emissions, 60 per cent of water pollution, 75 per cent of non-hazardous waste, 90 per cent of toxic discharges to water, and virtually all potentially hazardous releases and wastes in the Organisation for Economic Co-operation and Development (OECD) countries. The picture is similar worldwide.

A few industries, which are mainly dominated by large plants, are responsible for most industrial pollution – about 75 per cent of potentially toxic emissions, for instance. They are energy supply, ferrous and non-ferrous metallurgy, industrial chemicals, pulp and paper, cement and mining. These industries provide basic feedstocks to many other productive operations, as well as products for the consumer market – and are also heavy users of energy, contributing considerably to greenhouse gas emissions and global climate change.

One difficult problem is that many of the basic processes used by many of these industries – for instance, to produce steel, aluminium, pulp and paper, and chemicals – are fundamentally the same as they were 50, even 100 years ago. The most effective approach to reducing their pollution and energy use would be to rethink the processes from scratch. ESTs are the key to improving their performance and mitigating the pollution they cause.

In fact, every major industry in the industrialized world has invested heavily in measures to combat environmental pollution, largely as a result of stringent environmental regulations since the late 1960s. Consumer products and chemical industries reportedly spend the equivalent of 38 per cent of net income after taxes on environmental management, while the automotive industry spends about two-thirds of its net income on this. Industry leaders expect their environmental spending to increase more rapidly than profits. Progress and problems within some of the key industries are examined below.

Chemicals

The chemical industry is one of the most serious global polluters and, recognizing this, the industry spends twice as much on research and development a year as all manufacturing industries do on average – with a sizeable share of this spending going on finding ways to reduce the level of pollution caused by its activities and to save energy. Worldwide, the industry's investments in environmental protection in recent years have averaged 5 per cent of all its investments: in some countries, notably in Germany, environmental investments have exceeded 10 per cent. Indeed, the German chemical industry is a good benchmark, since 98 per cent of its environmental investments have been spent on cleaner air, water protection and waste disposal and, in

BOX 2.2

Saving energy and raw materials in the chemical industry

One Chinese chemical company identified a total of 20 cleaner production options when it reviewed its operations at a penta-erythritol plant in Beijing, which accounted for more than 40 per cent of the chemical oxygen demand in the wastewater discharged by the entire factory. The plant operations included synthesis, first and second evaporation, crystallization, washing and drying.

The company implemented nine of the options within six months and established the feasibility of another six. They included installing a microcomputer to control the quantity and speed of addition of one of the raw materials; improving and expanding the refrigeration system; fitting new centrifuges with better separation characteristics; installing vacuum pumps to recover product previously lost with wastewater during the crystallization process; and installing an end-of-pipe wastewater facility to meet higher discharge standards.

As a result of introducing the technologies, the plant has increased production, reduced operating costs for treatment, and saved on raw materials and energy use.

return, the industry has reduced air and water emissions by 70 per cent and 90 per cent in the last 25 years, while achieving a 200 per cent increase in production.

In the 1970s, the response of most chemical companies to legislation was to invest mainly in end-of-pipe technologies – such as effluent treatment equipment and flue gas scrubbing units. Since then, the industry has introduced ESTs on a huge scale worldwide, making considerable strides in identifying and reducing major pollutants. Some companies have made substantial changes to process technology: by optimizing operations to reduce emissions and waste generation at source or by replacing mercury-based techniques with membrane separation (in the chlor-alkali industry, for example), and some have substituted dangerous organic solvents such as benzene and trichloroethylene with a number of less hazardous alternatives. Generally speaking, however, the industry has not made these kinds of fundamental changes.

One factor is that most ESTs introduced into the chemical industry have been designed for large-scale production plants and operations. The industry is now moving towards producing small-scale speciality chemicals, and introducing automation and batch-processing concepts – a shift which should lead to the development of new ESTs compatible with medium- and small-scale operations.

The industry uses enormous amounts of energy to produce more than 70,000 distinct products through organic and inorganic processes. An encouraging feature of its progress has been the substantial gains in energy efficiency, for example a 43 per cent improvement in the United States between 1974 and 1990, and similar gains in other countries. This has been achieved through new technologies such as:

- the LP-OXO low-pressure oxidation process for producing industrial solvents and plasticizer, which uses 40 per cent less energy than conventional methods;
- the new Unipol process for making polyethylene;
- new ethylene oxide and ethylene glycol production technologies;
- state-of-the-art technologies for producing acrylic, nylon and polyester fibres, which have been transferred from the United States to China, India, Indonesia and Turkey;
- ion-exchange membrane cells, which use less energy and eliminate the associated environmental hazards of using mercury and diaphragm cells for producing chlorine and sodium hydroxide.

The industry will need to make more radical changes in technology to achieve further significant reductions in the pollution it causes, and there are difficulties with this. Generally, the industry expects an integrated process to recover its development and installation costs in about 10-15 years; during that time, the process is usually operated according to its design specifications, regardless of inherent inefficiencies and/or environmental incompatibility. Meanwhile, retrofitting operations to incorporate radical process changes will invariably be expensive. However, environmental protection concepts are being increasingly incorporated into process designs from the beginning. At the same time, companies are moving to waste minimization in their production processes, through measures such as waste and wastewater treatment, recycling, catalysts, membranes, desulphurization plants and noise reduction. Polluting catalysts such as tin and mercury, for example, will probably be replaced by enzymatic catalysts that have been immobilized on suitable substrates. Several biotechnology-based applications are also expected to be adopted by the industry.

Pulp and paper

The pulp and paper industry is large and growing, reflecting the world's demand for paper. Pulp and paper mill operations cause significant air and water emissions, require enormous volumes of water every day (and therefore are often located near rivers, lakes or seas), are heavy users of energy, and contribute to emissions of nitrogen oxides and sulphur dioxide – almost all from burning fuels rather than from the production process. The production processes in large modern mills are more efficient than those in the older, smaller ones, so they use energy, water and raw materials much more efficiently, and pollute much less. Some major pulp mills now have 'closed processes' to recycle effluent water, and their emissions of known pollutants are virtually non-detectable.

Even so, total energy consumption is increasing continuously, even in the most modern mills and, in 1992, the United States paper industry was the third largest user of energy after the petroleum and chemical sectors. However, the industry does generate a significant proportion of its own energy needs by burning by-products such as residues and bark. The United States industry, for instance, generates 55 per cent of its energy needs in this way. In recent years, a number of new technologies have reduced the water content in the sludge produced by paper mill operations sufficiently that it too can be incinerated and used for generating electricity on site. In the United States, the industry is a leader in co-generation, where high-pressure steam is used first to drive electric turbines, and then is used a second time for process applications demanding steam or heat, a dual use which is more efficient than using the energy just to produce electricity.

BOX 2.3

Reducing pollution in pulp and paper production

An Indonesian pulp and paper manufacturer invested US$42 million in a system to treat solid, liquid and gaseous wastes, and another US$1.8 million in a fibre recovery process, and achieved major reductions in pollution and the use of energy and raw materials.

The cleaner production technologies included:

- using oxygen rather than bleaching chemicals to reduce the lignin in the pulp;
- lowering the chemical and biological oxygen demand of the effluent;
- recycling the cooking chemical to provide power for cooking, pulp drying and paper-making, while reducing the chemical oxygen demand of the effluent;
- recycling the water from the pulp drying machine;
- using a cascade system that cut water consumption by 23 per cent per tonne of pulp;
- a fibre recovery system to recover good fibre from reject pulp, saving 40 tonnes of pulp a day;
- collecting and re-using all spills in the mill.

The mill produces 790,000 tonnes of short-fibre pulp a year, and 254,000 tonnes of writing and printing paper. As well as energy and raw material savings, the new technologies have reduced the use of clean water and there is also less effluent needing treatment.

Our Commitment:
as little environmental impact as possible

Companhia Siderúrgica Nacional (CSN) is Brazil's leading steelmaker. Our President Vargas mill – Latin America's largest integrated steelworks, located 145 kilometres from Rio de Janeiro – produces hot and cold rolled and galvanized sheet, non-coated sheet and tin-free sheet, and tin plate for major industries, and accounted for 17 percent of Brazil's total production of crude steel in 1996. We are the world's biggest one-site producer of tin mill products.

We know full well that our industry – like any other – will only remain competitive if it respects and generates benefits for the environment in which it operates.

Therefore, our environmental policy is clear: we have to be permanently watchful towards our processes to guarantee that our operations alter the environment as little as possible. And because the quality of life of our employees and the wider community is just as important as the quality of our products, we have committed ourselves to:

- incorporating environmental considerations into all our business decisions
- exceeding existing environmental legislation
- keeping open a permanent channel of communication with the community on all environmental questions
- developing environmental improvement programmes inside the company and for the community
- recognizing environmental problems for which we are responsible, and remedying them
- constantly improving our environmental performance.

CSN began investing in environmental improvements in the 1970s, well before the company was privatized in 1993. Up to 1996, we had invested more than US$230 million in technologies and equipment to reduce emissions – and we have already spent US$26.7 million of the US$100 million set aside for further environmental investments to 1999.

In addition to specific spending on environmental protection, we are also investing in projects which will substantially benefit the environment. One, budgeted at US$300 million, is the construction of a thermoelectric cogeneration power plant that will increase the re-use of steel mill gaseous emissions, while reducing the consumption of electrical energy.

Our environmental management programme includes: analysis of intake and discharge water of the Paraiba River; monitoring gas and particulate emissions into the atmosphere; labour force occupational hygiene and health programmes; development of mill risk analysis, and regular twice-a-year environmental audits.

Our future goals include obtaining certification based on the ISO 14000 and QS 9000 norms.

And we are carrying out technical studies on the production of blast furnace slag bricks, recycling of coke and sinter plant wastes, substitution of wooden railroad sleepers by steel sleepers, and the use of steel scaffolds instead of wooden ones – to conserve natural resources and foster the use of steel and steelmaking wastes.

At CSN we are determined to constantly improve our environmental performance in order to guarantee, for both present and future generations, that we make as little impact as possible on the environment.

One of six electrostatic precipitators – huge anti-pollution devices which filter the air at the sinter plants

President Vargas Steelworks – overall night view

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BOX 2.4

Waste reduction: an urgent priority for metal plating

Metal plating is a big, diverse business, covering products as varied as metal cans, machinery, household appliances, cars and trucks, aircraft and even jewellery, musical instruments and toys, and is dominated by small companies in both developed and developing countries. In the United States alone, there are an estimated 13,500 metal finishing operations, most located in highly industrialized areas, employing on average 65 people and discharging 140,000 litres of wastewater a day.

A feature of the industry in developed countries is the major technological shift it has experienced over the past 10-20 years. One reason is that because metal plating pollutes, the scope and stringency of environmental regulations have increased steadily, and something like 30-50 per cent of some country's plating industries have disappeared because of these stricter rules. In developing countries, however, there have been far fewer and less rapid technological advances – and businesses there rely much more on unskilled labour and less on automation.

Metal plating processes use many chemicals – cyanide, chromium, cadmium, nickel, aluminium, copper, iron, lead, tin and zinc – most of which end up as wastewater or solid waste. Air emissions include chromium and a cocktail of dangerous solvents. Wastewaters are usually treated on site, but this still leaves a hazardous sludge for disposal. Residual metals in wastewaters discharged to municipal sewerage systems are partially removed by the municipality's biological treatment process, but this also generates a sludge. Contaminated liquid solvents are either recovered by distillation, or sent for incineration, while wet scrubbers can control chromium emissions and other heavy metals.

In these circumstances, while pollution prevention is critical, waste minimization is a priority for the industry. During the past 10-15 years, the best companies have made significant strides in this area – in some cases reducing waste volumes by 90 per cent. However, the pace of change has been generally slow throughout the industry.

As the Washington Waste Minimization Workshop, organized by the Organisation for Economic Co-operation and Development (OECD) in 1995, was told, "cleaner technologies and products already exist" – air emission control; process solution maintenance (for example, microfiltration, ion exchange, membrane electrolysis); chemical recovery (for example, evaporation, ion exchange, electrodialysis, reverse osmosis); and off-site metals recovery (for example, filtration, ion exchange, electrolytic). Why then, as the report to the Washington meeting stated, are there still "barriers (which) limit the use of pollution prevention" in metal plating?

"In the developed countries, the industry is dominated by small companies. With fewer resources and personnel, they find it impossible to use the technologies used in larger companies. Consequently, these businesses have a disproportionate impact on the environment. The primary need of these companies is access to information on the relatively simple, but effective technologies that are now available."

The report also noted "a lack of access to new, cost-effective, cleaner technology" – and that "industrial managers often do not appreciate the financial and other benefits associated with waste minimization, and face significant psychological barriers when shifting to unknown but cleaner technologies".

The main focus in the 1970s and 1980s was on reducing the amount of fibre and oxygen-demanding compounds (or biological oxygen demand – BOD) discharged into water, and sulphur dioxide emitted into the air. There were major investments in new in-plant technologies, with the result that the Swedish pulp and paper industry – one of the world's largest – and the industry in Finland reduced both per unit BOD emissions and sulphur emissions by 90 per cent.

In the 1980s, the main environmental issue was the reduction of organically-bound chlorine and dioxins used in the bleaching process. The development and introduction of new bleaching technologies with low chlorine charges have led to virtually dioxin-free bleaching. Currently, at least 15 mills in Canada, Finland, South Africa, Sweden and the United States are trying to achieve closed-cycle bleaching. It is expected that some will have totally closed bleaching systems by the end of the century although this process only minimizes, and does not eliminate, environmental impact. A central challenge for the 1990s is to reduce nitrogen oxide emissions.

Steel

The iron and steel industry has a major impact on the environment because of the sheer scale of its operations, and its use of energy and raw materials. In the 1950s and 1960s, it was a major source of pollution, especially air pollution – a problem tackled initially by retrofitting gas and dust collection facilities to existing plants, which has cost the industry over 50 per cent of its expenditure on environmental control.

The industry has replaced older plants with newer facilities, incorporating the most up-to-date environmental practices in their design and operation, as commercial conditions dictate. One result has been a significant reduction in dust emissions in some countries. Producing a tonne of steel can use up to 50 tonnes of water. Steel plants have tackled the problem of discharges of contaminated water through treating and recycling it. The development of closed loop systems means that in many countries over 90 per cent of the water used is recycled. By some estimates, the industry spent US$20 billion on environmental control in the 1980s.

The industry also uses large quantities of energy to produce heat to run the furnaces which smelt the iron ore, and at several stages during the processing operations. Continuous casting – where the molten metal is poured continuously into slabs or other steel shapes, instead of into ingot moulds – has been increasing since the 1970s and now stands at 80 per cent of production. In some countries, almost 100 per cent of steel is continuously cast. It is far more energy efficient because it removes a complete process stage and significantly reduces the amount of crude steel needed for each tonne of finished steel supplied to customers. However, retrofitting existing plants is very capital intensive and can take years.

Another significant change has been to electric furnaces, which also consume much less energy, because they typically use 100 per cent scrap and avoid the energy needed to smelt iron ore. Electric furnace use has increased steadily in the past 20 years, but has stabilized at about 35-40 per cent. (Open hearth furnaces had disappeared entirely from United States steelmaking by 1992.)

Two new process technologies under development will revolutionize the industry: direct steelmaking and near-net-shape casting. Direct steelmaking uses existing post-combustion and heat-transfer technology to increase the scrap melting capability in basic oxygen furnaces, and to produce steel from iron ore in one operation, while achieving significant cuts in energy consumption. Near-net-shape casting applies several existing technologies to cast the steel close to the shape of the final product, thereby reducing the amount of down-stream processing. It will reduce energy use even more than direct steelmaking.

Construction

The construction industry is an important one. Its output represents 8-12 per cent of gross domestic product in most national economies and it certainly affects the environment directly, through its own operations. But as a major consumer for other industries, such as mining/quarrying, cement, steel and aluminium, it also has a major indirect impact.

Environmental impacts occur at every stage of the construction cycle: siting, production and supply of building materials and equipment, on-site construction, operation and demolition. New building development, together with the quarrying of sand and gravel, extraction of brick materials and clay, and exploitation of timber resources, destroy natural areas, forests and wetlands. Transporting building materials uses large amounts of energy, as does the production of cement, brick, glass, lime, steel and aluminium. Moreover, these processes generate greenhouse gases and emissions of dust, fibres, particulates and other air pollutants. Demolishing buildings creates massive amounts of waste, adding to the considerable quantities produced by quarrying and mining, and building maintenance and operations. Solutions to these problems do exist. They include the efficient use, re-use and recycling of building materials, and cleaner production and eco-efficient technologies.

Top priority is the efficient management of natural resources. This is possible, thanks to ESTs, at almost every stage of mineral use, from eliminating waste in manufacturing operations to the recovery of materials from products at the end of their useful lives. Using more mineral and agricultural wastes as inputs to the industry would reduce its impact on the natural environment. The recovery and use of mining and industrial wastes include blast furnace slag in cement production, gypsum from phosphate production and desulphurization units for panels and blocks, and red mud from aluminium processing for brick and ceramics production. The most significant results have been achieved in using fly ash, produced in large amounts by coal-fired power stations, as a raw material in cement, concrete, sand-lime bricks and ceramics, as well as for road building. Agricultural wastes such as rice husks, coffee shells and sawdust have long been used as alternative fuels for brick firing. A new approach is to use wastes as both raw material and fuel in the cement industry. The rotary kiln is a very efficient reactor for the thermal cracking of waste, including rubber tyres, paints and other toxic materials, and domestic waste.

The relationship with the cement industry is a specific one as it is used almost exclusively by the construction industry. Cement production causes local pollution from airborne dust particles. This can be controlled by using efficient filtering systems. In France, for example, dust emissions dropped from 200,000 tonnes a year in the 1950-1960s to very low levels in the 1990s, even though production doubled. But many cement plants worldwide do not use efficient filtering. Producers of cement, lime, bricks, ceramics and glass are high-energy users, operating at temperatures between 950 degrees and 1,450 degrees C. The cement industry is making efforts to address the problem of energy consumption, mainly through using alternative fuels and improved processes and kiln design. A major step has been the conversion from wet to dry production.

BOX 2.5

On-site 'green' building techniques in Japan

The Global Environment Centre carried out a survey of on-site 'green' techniques in the construction industry in Japan and found that companies had developed and adopted a range of measures, including improvements to equipment and processes, and simple new ways to control and re-use waste materials. Some examples are given below.

- The development of a construction method using panel concrete, which does not require moulds for pouring concrete, reducing the amount of waste and controlling the use of moulds made from tropical wood. Building components such as floors, walls, columns, stairs, girders and beams are manufactured as panel concrete and assembled into one structure using cast-in-place concrete.
- The use of a plastic mould to replace the typical veneer board mould, reducing the number of trees cut down. The plastic moulds can be recycled and re-used, reducing construction waste.
- The recycling of primary treatment soil using a slurry shield method, leading to fewer deliveries and cutting disposal costs of the surplus soil.
- The introduction of separate storage for general waste, industrial waste and corrugated cardboard boxes. Storing the waste in one place makes it difficult to identify the components, so disposal costs are high. Separating the waste into different containers makes identification easy, helps improve the site environment and cuts disposal costs.

Counting the costs of ESTs

One familiar argument deployed by companies against introducing ESTs is they cost too much and could impact on corporate profits and

TransCanada

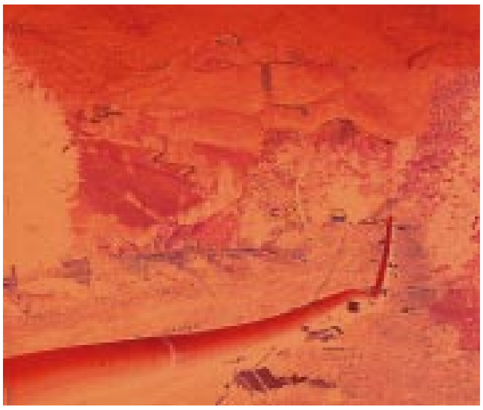
OUR COMMITMENT

TransCanada is an international energy company with its headquarters in Calgary, Alberta, Canada. We own and operate over 15,000 km of natural gas and oil pipelines, process and market energy products, have developed and operate some of the world's most modern, high-efficiency combined-cycle electric generation plants, operate the world's largest high-quality carbon black facility, and manufacture specialized chemicals for the agricultural and pharmaceutical industries.

Our **environmental management system** is based on visible commitment from employees, senior management and directors. Company employees and contractors are both responsible and accountable for environmental excellence. We set standards, monitor our activities, and evaluate our performance to ensure we continuously improve.

Our **environmental programme** minimizes the potential adverse effects of our activities through avoidance, mitigation or remediation, and restores any disturbed land to as close to its original condition as possible.

Our **project planning programmes** include: preparing environmental and socio-economic assessments; including environmental specifications in contracts; having independent environmental inspectors on site during construction; avoiding wetlands whenever possible, or using special construction practices to protect vulnerable areas; minimizing impacts on wildlife by avoiding construction in sensitive areas and during breeding periods; protecting rare or sensitive plant species. We also consult with community stakeholders before, during and after construction, and work with local authorities to evaluate heritage sites and excavate artefacts when necessary.



Construction of the TransGas de Occidente pipeline in Colombia. We have a 34% interest in and operate this natural gas pipeline – a 344 km pipeline with 400 km of laterals. The line crosses some of the most difficult mountain terrain in Colombia.

Two TransCanada employees inspecting an artificial nesting structure for ducks. The structures were set up in Manitoba as part of the Pipelines for Ducks Waterfowl Nesting Tunnel Program, a joint initiative of TransCanada and the Manitoba Habitat Heritage Corporation.

Our **management programmes** include: monitoring facilities, waste management, hazardous waste, noise management, vegetation control, training, energy conservation and air quality. We also audit environmental performance and report to senior management and TransCanada's board.

We fully support Canada's national **Climate Change Challenge** to reduce greenhouse gas emissions to 1990 levels by the year 2000. Our commitment to implementing cost-effective ways of reducing emissions includes: moving natural gas out of pipelines rather than releasing it into the atmosphere; improving compressor sealing systems; using high efficiency, low NOx turbines; operating three enhanced combined cycle power plants which generate electricity using natural gas and waste heat from our turbines. We have also planted over three million trees on urban and rural lands across Canada.

TransCanada supports many local projects. Wherever we are in the world, we work with stakeholders to address local concerns. In developing countries, a significant challenge is to meet local social and economic expectations while building and operating safe, profitable projects.

Public expectations for responsible environmental management are increasing. People demand to be involved in development activities affecting their quality of life. Scrutiny by governments and non-governmental organizations (NGOs) is also increasing.

The challenges are many. TransCanada has the people and the commitment to meet them.

G.W. Watson
President and Chief Executive Officer

workers' jobs. The same objections are raised by countries concerned that spending on the environment threatens their economic growth. Germany is well placed to address these issues. It has some of the toughest environmental rules in the world, requiring both the private and public sectors to make huge investments in clean air and water, waste disposal, noise abatement and other environmental protection measures.

A 1994 report from the German Federal Environmental Agency (FEA) – *Environmental Protection – an Economic Asset* – tackled head-on the question of what ESTs really cost. Between 1975 and 1991, manufacturing industry and the government (in the former West Germany) spent some US$250 billion on pollution abatement or prevention – half on investment, half on operating costs. At 1985 prices, this worked out at an annual average of about US$15 billion. In terms of the economy as a whole, environmental spending accounted for 1.6 per cent of gross national product – far less than that spent on defence, education and health. The FEA reported that in 1991 about 7,400 out of a total of 73,000 manufacturing companies invested in environmental measures, with an average per company of US$500,000. Air and water quality accounted for nearly 80 per cent of corporate environmental investment. In 1991 (in the unified Germany), the proportion of overall business investment dedicated to environmental protection ranged from 0.8 per cent to 24.9 per cent. Spending was well below the average in leather processing, the garment trade and manufacture of office equipment and well above in leather production, chemicals, non-ferrous metals, semi-finished products and oil refining.

The report said that "it is extremely rare for investments to be made simply for the sake of the environment. They are usually also intended to upgrade production technology. It would also be wrong to deduce that the sectors spending most on the environment tend to be those which are having to downscale. Some pollution-intensive sectors really are in decline (mining, oil refining, iron and steel, foundries), while others rank among the growth industries (energy and water supply, chemicals, pulp/paper/paperboard)."

Procurement and production "do not have to be expensive just because they satisfy environmental standards", said the FEA. "There are many instances where a lot of money can be saved on conventional feedstocks or production methods." The report pointed out that public subsidies have helped to ease the burden on companies, and to "ensure that urgent environmental investments are not put off till a finer day, and to speed up the development and introduction of cleaner technologies and environmentally friendlier products". Federal government assistance totalled some US$1.4 billion in 1991.

The FEA calculated the cost benefits to the economy – and, therefore, to industry – from protecting the environment. Specific measures such as diesel fuel desulphurization to reduce sulphur dioxide emissions, three-way catalytic converters for all new vehicles and those to force agriculture to comply with nitrate levels in drinking water had a cost-benefit ratio as much as 1:5. "This makes environmental action a highly lucrative proposition", it commented.

Tough environmental regulations and heavy spending on ESTs and other improvements can cost jobs by raising production costs and putting companies at a disadvantage in the international arena, the report acknowledged. But, it added, this ignores the new jobs created thanks to environmental protection. The FEA said that following present trends, more than 1.1 million people in Germany will owe their jobs to environmental protection and, conversely, some 185,000 more people would be out of work in 2000 if environmental policy were frozen at 1990 levels. "On balance, environmental protection does not destroy jobs, but actually

Determined to become clean and sustainable

Healthy industrial development is essential to generate resources to create jobs, as well as promote education – both of which are the basis of social well-being. And social well-being is a condition for achieving sustainable development.

But development will only be healthy if industry's practices, processes and products are clean. Government can encourage this transformation, and society must accept and support it too – but it is industry's responsibility to drive and implement the changes. Altos Hornos de Mexico S.A. de C.V. (AHMSA) is doing so.

Since privatization in 1991, the company has invested around US$150 million in environment-related programs.

Among the most important measures have been installing a hydrochloric acid plant and water treatment recycling facilities, as well as other equipment for preventing atmospheric pollution. This investment has paid off. AHMSA has reduced water consumption by 53 percent and atmospheric emissions by 60 percent, and increased its recycling rate to 74 percent.

In December 1996, the company was awarded ISO 14001 certification at its hot strip mill and blast furnace plants – the first steel plant in North America, and the first company in Mexico to receive this recognition.

AHMSA's commitment to a cleaner environment extends to helping neighbouring communities. In the last four years, for example, it has donated 3,550 waste containers and 21 refuse collection vehicles, constructed a landfill and waste water treatment plant, and provided support for the water supply system. The company has recently signed an agreement with the Federal Government to support five national parks covering one million hectares – and has also developed a deer breeding farm and many other activities.

AHMSA's management, shareholders and employees recognize that support for the environment is the key to the company's continuing success. We are all determined to continue the process until AHMSA is a truly sustainable business.

Alonso Ancira Elizondo
Executive Vice President and
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provides important new momentum for the labour market." The report also noted that environmental measures had created opportunities in manufacturing and other industries for higher-qualified people.

And what do the companies themselves think? The FEA also reported the results of a survey of 600 firms in the former West Germany:

- only 30 per cent felt that protecting the environment would hurt their profits;
- more than half believed it would improve their competitive position;
- two out of three companies had invested in environmental protection and other measures which had reduced costs or increased earnings; and
- 60 per cent said that improving environmental performance was *critical* to their survival (emphasis added).

Benefiting the bottom line

The World Business Council for Sustainable Development (WBCSD) reinforced the point in its *Signals of Change* report, timed for the 1997 United Nations General Assembly Special Session (UNGASS). Eco-efficiency, producing more with fewer resources and less pollution, "encourages business to become more competitive", it said, stressing that the introduction of ESTs, especially cleaner production technologies, brought major benefits to companies' bottom lines. It gave some examples.

- A leading United States company has saved at least US$750 million over the past 20 years by a continuous programme of pollution control and prevention.
- A copper smelting plant in the United States, the most advanced in the world, uses the Outokumpu Flash converting furnace to achieve high capacity and productivity, while capturing 99.9 per cent of the sulphur generated in the smelting process, and eliminating the open-air ladle transfer of molten metals, a major source of emissions.
- A sugar factory in Mexico, processing about 720,000 tonnes of sugar cane a year, has cut its water consumption by 94 per cent, reduced the amount of effluent it discharges, saved US$220,000 in the first year and repaid the investment within two years.
- China's biggest commercial enzyme producer worked with a United States company to improve its manufacturing systems and reduce waste. The results: a 20 per cent energy saving, a doubling of production and cost savings of US$240,000 a year.

The WBCSD makes the point that "a requirement for sustainable development is basic efficiency – getting as much added value as possible, with as little input as necessary of energy and natural resources, while producing little waste, especially in the form of pollution". ESTs make a central contribution to achieving these results.

Sources

Automotive Environmental Analyst, March 1997, Financial Times.

Cleaner Production in the Asia Pacific Economic Cooperation Region, 1994, UNEP IE.

Cleaner Production Worldwide, 1993, UNEP IE.

EarthEnterprise™ Tool Kit, 1994, International Institute for Sustainable Development.

Energy and Environmental Technologies to Respond to Global Climate Change Concerns, 1994, OECD.

Environmental Protection – an Economic Asset, 1994, Environmental Economics Section, Federal Environmental Agency, Germany.

Environmentally Sound Technology for Sustainable Development, 1992, ATLAS Bulletin.

Greener Management International, April 1993, Greenleaf Publishing.

Industry and Environment, various issues, UNEP IE.

Signals of Change: Business Progress Towards Sustainable Development, 1997, World Business Council for Sustainable Development.

Technologies for Cleaner Production and Products, 1995, OECD.

Towards a Sustainable Paper Cycle, 1996, WBCSD and the International Institute for Environment and Development.

Washington Waste Minimization Workshop, 1995, OECD.