The demand for energy is
expected to double as living
standards rise throughout
the developing world.

ESTs for energy 8

People need energy for most of their everyday tasks: heating, lighting, cooking and transport and, of course, it is also essential for industry. But producing and using energy causes serious, and in some areas worsening, environmental damage. Current patterns of production and use "are unsustainable, and have become more so since Rio", according to the United Nations Development Programme (UNDP). There is a pressing need to implement available environmentally sound technologies (ESTs) more widely in the energy sector, and to develop new technologies. One priority is to use ESTs to achieve major energy efficiency improvements.

World energy demand has doubled since 1973 and is predicted to double again by the year 2020. UNEP predicts a 100 per cent increase in energy use in Asia and the Pacific, and growth of 50-77 per cent in Latin America for the period 1990-2010. UNDP projects that the present annual level of worldwide investment in the energy supply sector, US$450 billion, will increase to perhaps US$750 billion by the year 2020. The World Energy Council forecasts that demand for oil, coal and gas will soar to unprecedented levels. As industrialization speeds ahead in the developing countries their energy use will continue to climb rapidly. Electricity use is expected to grow especially fast: developing countries are undertaking a massive number of large-scale electrification projects. The World Energy Council predicts that more electrical generating capacity will be built worldwide in the next 20-25 years than was built in the previous century.

This enormous surge in demand for energy brings with it the risk of adding greatly to pollution locally (air pollution); regionally (the long-range transport of acid precipitation, or 'acid rain'); and globally (greenhouse gas emissions). It reinforces the importance of introducing more pollution control and prevention measures, applying more rigorous demand-side management, and achieving energy and energy-intensive materials efficiency improvements.

However, the picture is not all black on the pollution side. Industrialized countries have made considerable progress in the past 20 years in curbing a range of pollutants from power plants and refineries, using well-established technologies (see Chapter 6). For example, flue gas desulphurization technology, or 'scrubbers', can remove up to 95 per cent of sulphur dioxide emissions from coal-burning power plants, while various modifications can reduce nitrogen dioxide releases by at least 50 per cent. Even so, much more needs to be done, particularly with retrofitting existing power plants. This is especially the case in Central and Eastern Europe, and the former USSR, where not only is the combustion efficiency of old plants poor, but modern, emissions control technologies are still not widely used, and air pollution and acid rain problems are acute.

A major concern in both industrialized and developing countries is the world's current reliance on fossil fuels, which is causing continuing problems with greenhouse gas emissions in particular. Transport is one energy area requiring urgent action (see Chapter 11).

Railways – a technology meeting the needs of the environment

RENFE – the Spanish national rail network – is making a significant contribution to the environment by providing a proven environmentally sound technology solution to the transportation problems of pollution, noise, congestion and accidents.

With its national network of 12,280 kms of tracks, the company is serving an increasing number of communities spread over a wide area, through its local, regional and long distance high-speed, intermodal and freight services.

RENFE's contribution to Spain's environment can be measured by counting the external costs – those costs borne by society as a whole and not those met by the market – of global climate change, local and regional atmospheric pollution, noise, accident rates and traffic levels against the expenditure of replacing the railways with other forms of transportation.

If the different impacts of each form of transport are evaluated on a per unit basis, RENFE's net contribution to society amounts to 123,098 million pesetas. With the continuing growth of the transportation system in Spain and the cost-cutting strategies embarked upon by RENFE under the 1994 Contract Programme made between the company and the State, rail transportation will save Spanish society a net 151,000 million pesetas in 1998 – almost 30,000 million more than in 1995.

As support for the rail system increases, more units of transportation will be available, they will make greater financial and economic savings and, most significantly, they will lower the environmental damage from transportation. Increased business for the railways is a step forward to the ultimate objective – sustainable mobility.

Savings generated by trains compared with other means of transport

Factor	Cost differential for volume of traffic in 1995
	Million Ptas
Urban traffic congestion	37,928
Accidents	139,756
Noise	195
Atmospheric pollution	15,038
Climate change	6,625
TOTAL	199,542

RENFE

Environment Office/Gerencia de Medio Ambiente
Central Office/Oficinas Centrales
Avenida de Pío XII, 110, 28036-Madrid, Spain

But an equally important challenge is the area of electric power supply and use. The Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA) call for a three-pronged approach:

- improve the efficiency of fossil fuel generation technologies;
- increase the share of power generation by non-fossil fuel sources;
- develop end-of-pipe technologies to capture and dispose of greenhouse gas emissions from fossil fuel power plants.

Coal

Coal is the single most important fossil fuel because it dominates the generation of electricity, accounting for 44 per cent worldwide in 1993. Cleaner methods of mining coal are needed, particularly to address associated methane emissions, which account for between 4 and 7 per cent of all global methane releases. Methane is naturally present in coal seams and is released when the coal is extracted. The trend towards deeper-seam mining is likely to lead to greater methane releases. Technologies to address this problem include those discussed briefly below.

- Pre-extraction of coal bed methane – draining the gas, for example through horizontal bore holes inside the mine and vertical boreholes from the surface. The extraction of coal bed methane, in widespread use in the United States, has attracted considerable interest in Australia, and also in many Eastern and Central European countries.
- Underground coal gasification – an alternative to conventional extraction which, if successful, offers the potential to exploit deep reserves that are uneconomic to open up by traditional techniques. The technology involves igniting and reacting the coal underground with a mixture of oxygen (or air) and water (or steam), to convert the coal into a low or medium calorific gas which is brought to the surface through a production well.
- Biotechnology – to convert coal to cleaner fuels (see Chapter 12).

Pre-combustion technologies can upgrade the quality of the coal, which helps combustion efficiency. The most widely used is coal-washing, which removes the coal ash and also reduces the amount of inorganic sulphur: 30 per cent in the case of conventional processes and 60 per cent using more advanced techniques. In the future, biotechnologies may remove up to 90 per cent of the sulphur.

Advanced technologies

With electricity satisfying an increasing share of worldwide energy demand, it is vital to improve the efficiency of electricity generation from coal and other fossil fuels. Advanced fossil fuel technologies are widely available in the OECD countries. But the extent to which they are being used depends on the age of the existing plant and the relative prices of fossil fuels. The efficiency of generating systems is typically between 32 and 35 per cent. The more conventional technologies dominate present electricity production. The most widely used is pulverized firing, where the coal is ground to a very fine powder, then blown in a cloud with combustion air into a large boiler. The hot combustion products pass through several banks of tubes, producing high pressure superheated steam for use in a turbo-generator. Current pulverized fuel boilers, fitted with emission control equipment, have an overall efficiency of 35-37 per cent. The aim is to improve this to more than 45 per cent. More modern coal and other combustion technologies are now available, or being developed, that can outperform pulverized firing on both efficiency and environmental grounds.

- Fluidized bed combustion involves fluidizing crushed coal with sand, its own ash or limestone by supporting the particles on a strong rising current of air. Contact between the sulphur compounds and the limestone removes the sulphur directly from the

BOX 8.1

Cleaner coal technology in China

China presents a particular energy challenge, specifically with its coal industry. The country is rich in coal deposits and coal accounts for 70 per cent of the energy used. This usage of coal will prevail in the next century. The electricity-generating industry uses 25 per cent of total coal consumption. Some 300,000 heating boilers, industrial furnaces and household stoves consume almost 500 million tonnes of coal a year. The global implications of this are dramatic, and so developing clean coal technology is crucial and has therefore been the focus of China's environmental control measures.

The United Nations Industrial Development Organization (UNIDO) has been working with China to develop its capacity to design and manufacture boilers using circulating fluidized bed combustion. The project involves transferring this technology to a major company to replace inefficient, polluting coal and oil-fired boilers. UNIDO is also helping the Institute of Engineering Thermophysics at the Chinese Academy of Sciences to design, install and produce operating manuals for these boilers, and to promote their use at other energy generating plants in the country.

The circulating fluidized bed combustion technology will reduce greenhouse gas emissions and help to remove sulphur, a particular problem in China because of the variable quality of the coal. It will also boost efficiency in plants. Most industrial boilers in China operate at 60-65 per cent efficiency, compared with a worldwide average of 80-85 per cent. Circulating fluidized bed combustion boilers typically achieve 90 per cent efficiency. This means less coal is needed and less carbon dioxide is produced for each unit of energy generated.

furnace. There is no need to use flue gas desulphurization, and sulphur dioxide can be reduced by as much as 90 per cent. Nitrogen oxide emissions are also reduced significantly thanks to better control of furnace temperatures. Fluidized bed combustion can burn a large variety of fuels, including low grade fuels and wastes. It is a widely used commercial technique. Total thermal capacity installed worldwide increased from 1,000 megawatts (thermal) in 1980 to about 30,000 megawatts (thermal) in 1990, when there were almost 1,000 units in operation.

- Pressurized fluidized bed combustion takes fluidized bed combustion technology a stage further. It offers the potential for coal to be used in a combined cycle power generating plant, increasing efficiency significantly. Three plants are currently in operation in Japan, Spain and Sweden. Retrofitting existing coal-fired power plants with pressurized fluidized bed combustion technology is regarded as an attractive and competitive option because it can improve performance, provide increased fuel flexibility and increase output by up to 25 per cent. Today's plants use bubbling-bed technology. Future ones are expected to use circulating-bed technology, achieving even more efficiency.
- Integrated gasification combined cycle technology blows oxygen through the coal to convert it to a clean gas stream of carbon monoxide and hydrogen. This removes more than 99 per cent of sulphur and reduces nitrogen oxide emissions too. Coal-based plants can already achieve efficiencies of 43 per cent, more than is achieved with most pulverized fuel plants. The development of better gas turbines, using different materials and aircraft technology, and new hot gas cleaning techniques will increase efficiencies to 50 per cent in the future.
- The hybrid cycle combines fluidized bed and gasification technologies to give a higher generation efficiency than either by itself. Designs combining a pressurized fluidized bed gasifier and a fluidized bed char combustion chamber have been proposed in Germany, Finland, the United Kingdom and the United States.
- The ultra-supercritical steam cycle is based on the modern conventional steam cycle which operates with subcritical steam at a certain pressure. Increasing the pressure to a supercritical level in the high pressure turbine sections improves generation efficiency. Increasing it further to ultra-supercritical levels through developments in

materials technology would theoretically boost efficiency significantly. This technology is still in the design stages.

- The Kalina cycle works by using two or more working fluids, instead of just one as used in the standard Rankine cycle. The cycle involves raising high pressure steam in a boiler, which is then expanded through a steam turbine to generate electricity before it is condensed and returned to the boiler. With the Kalina method, the ratio of one fluid to another is varied in different parts of the cycle, and increases in efficiency of 10 per cent or more are claimed by tailoring the cycle to suit the specific system.
- The humid air turbine (HAT) cycle employs a single gas turbine, in place of the gas and steam turbines used in a combined cycle plant, to generate electricity with increased efficiency. It can be used with both natural gas and coal-fuelled plants.
- A new clean coal technology, developed through a project funded by the European Union's Joint Opportunities for Unconventional or Long-Term Energy Supply (JOULE) programme, involves mixing coal with waste (household, industrial or agricultural) so that carbon dioxide and other emissions are significantly reduced. There are plans to use the technology to build a pilot 5-megawatt power station in Germany, able to produce enough 'clean' electricity for a town of 30,000 people by burning all the waste the town produces.

Efficiency in industry

Energy efficiency or conservation, in industry, commercial buildings and homes, is an essential strategy for reducing greenhouse gas and other emissions from power plants. By some calculations, countries could reduce their energy consumption by at least 10-20 per cent simply by adopting the most efficient technologies currently on the market. As the heaviest user, industry is clearly the prime target for improving energy efficiency. Energy use in industry can be divided into five main categories: steam generation, process heating, motor drives for plant equipment, air handling and lighting. Improvements can be achieved in each group through one or more of the following changes:

- improved energy management, for example advanced control systems;
- equipment changes, for example motor or lighting replacement;
- process refinements, for example recycling, waste minimization;
- process change, for example new process technologies;
- product change, for example new or substitute products.

UNDP, while making the point that "significant potential to improve energy efficiency exists in all industries", singles out five major energy users: iron and steel, chemicals, petroleum refining, pulp and paper, and cement. "The introduction of advanced technology to

BOX 8.2

Energy saving in the glass industry

Glass production is an energy-intensive activity, with up to 80-90 per cent of energy use in the furnaces where glass is melted before forming. Energy savings can be achieved by: reducing heat carried off with flue gas by recovering the waste heat and using it to regenerate steam and power; reducing conduction with better insulation in the furnace; and improving process control to optimize furnace temperature and pressure.

A programme of furnace insulation and energy management was introduced by the China Glass Development Centre, set up in cooperation with the United Nations Industrial Development Organization (UNIDO) in 1982, in six furnaces in Shandong, Henan, Jiangsu and Anhui.

Energy savings in the plants range from 22 to 36 per cent, decreasing production costs and reducing greenhouse gas emissions. At the same time, the improved process efficiency has increased output from the plants by 12 to 26 per cent, leading to increased sales.

SAirGroup

environmental care – the best guarantee of long-term business success

Philippe Bruggisser
Chief Operating Officer
and Deputy President
of the Swissair Group

Air transport places a strain on the environment – consuming energy, and producing pollutant emissions which take considerable effort to reduce. Air travel also brings together people, places and markets – promoting business and trade, generating prosperity and pleasure.

The SAirGroup and its member airlines – well aware of the conflicts and contradictions inherent in their activities – are firmly resolved to meet their responsibility to the environment in which they operate.

It is right, and it makes business sense to do so. Environmental care is one of the best guarantees of long-term economic success. By ensuring that our activities place as little strain as possible on the world around us, we will enhance the acceptability of our operations among customers, suppliers, investors, the authorities and other key partners, improve our competitiveness and help secure the long-term future of the air transport sector.

We have made ecological considerations a firm fixture in our overall management activities, and ecological criteria an integral element in our strategic and decision-making process.

Our ecological principles

- We will abide by all relevant laws and regulations.
- We will continually improve our ecological efficiency and use of natural resources through the available economic and technological possibilities.
- We abide by the principles of the International Chamber of Commerce Business Charter on sustainable long-term development.
- We periodically audit the impact of our activities on the environment, and publish the results in line with our policy of open and transparent communications, inside and outside the Group.

What we are doing

- With its investment of CHF 2.5 billion, Swissair has become the first airline in the world to introduce a new 'family' of Airbus aircraft, using state-of-the-art engines that reduce NOx emissions by 40 percent, burn much less fuel, and cut down on noise.
- Swissair is introducing a new heating system for its head office complex, which uses a low-temperature carbonization process to generate heat from waste paper, cardboard and waste wood. The system will save 800 tonnes of heating oil a year and halve NOx pollutants.
- New stationary energy supply units at Zurich Airport terminals are reducing pollutants from kerosene-powered auxiliary power supply units by 90 percent, saving 12.3 million litres of kerosene annually.
- Swissair's own facilities treat industrial wastewater so it can be reused in technical operations. Pretreating the wastewater saves on both water and energy use.
- Separating rubbish on Swissair aircraft, introduced in 1990, has considerably reduced the amount of waste needing burning. Aluminium, glass, tin and plastic are recycled.

Swissair's latest environmental report *Flying the Globe with the World in Mind*, (also available on CD Rom), can be obtained from

Swissair Corporate Communications, CH-8058 Zurich Airport, Zurich, Switzerland
Tel. 41 1 812 4452   Fax. 41 1 812 9000

reduce costs, improve product quality and/or facilitate environmental protection will usually reduce energy requirements as well. The promotion of technological innovation in these industries will typically lead to substantial gains in energy efficiency."

Fundamental changes

Many of the basic processes in the steel, aluminium, pulp and paper, and chemical industries are fundamentally the same as they were 50 or 100 years ago. Many of these processes, however, need to be rethought and reshaped. For example, biotechnology, electrochemical processing, laser processing, microelectronic control and new materials can all contribute to improving energy and materials use. Often, replacing energy-intensive materials with others that use less energy, a core element in cleaner production and eco-efficiency, leads to very large savings.

A key approach is to focus on process integration, reducing the overall consumption of energy rather than concentrating only on the energy requirements of individual processes. One method integrates production processes with electricity generation by combining the Corex process for iron-making with co-generation using gas turbines. According to the OECD and the IEA, approaches to improving process efficiency "parallel life cycle and fuel cycle analyses. They rely on the application of several key concepts – particularly the avoidance of heat and power losses (through the application of heat recovery and energy cascading technologies); process substitution; and the closure of energy-intensive material cycles. The technology development challenge is to find ways to effectively apply the concepts, and to adapt available and emerging technologies so these concepts are cost-competitive for a wider range of applications, particularly smaller scale ones." Examples of this approach include those below.

- Better use of available energy from combustion of fossil fuels through the utilization of gas turbines for conventional power generation, as well as the provision of higher temperature process, drying or distillation heat in refineries, the chemical, pulp and paper, textile and food industries, together with combustion engines or fuel cells to provide power and lower temperature heat for hot water, drying and space heating.

BOX 8.3

Efficient office lighting in the United States

A project in California provides a good demonstration of the potential to reduce not only electricity use overall, but peak demand as well.

Part of an existing building was re-equipped with low-energy lights and an electronically ballasted lighting control system. This combination provides considerable flexibility: illumination levels can be set manually or adjusted automatically, while light intensity can be adjusted with dimmable lamps.

In one year, the strategy saved 68 kilowatt-hours of electricity for every square metre in the buildings. Savings are most impressive at weekends, when electricity use is down by 70-80 per cent.

BOX 8.4

Co-generation in the United Kingdom

Small-scale, gas-driven combined heat and power units can have conversion efficiencies of up to 85 per cent if there are reliable outlets for all of the heat and power produced. As well as achieving savings, companies can also control their own energy supply, reducing the risk of costly shut downs.

A subsidiary of a major United Kingdom sugar company cut its annual energy bill at one plant by 10 per cent thanks to co-generation. The company installed a co-generation plant with an hourly capacity of 15 megawatts of electricity and 50 tonnes of hot steam. Surplus electricity is exported to the local utility company.

BOX 8.5

District heating schemes in Europe

A number of cities and towns in Europe are using co-generation for district heating schemes, with encouraging results.

- Amsterdam, the Netherlands, has a number of community heating and power plants, typically serving large apartment blocks, public buildings and hospitals. They work at an average efficiency of 82 per cent (compared to 36 per cent in large power plants), and have reduced sulphur dioxide emissions by 1,213 tonnes a year.

- Brescia, Italy, meets 50 per cent of its heating needs from district heating systems, and has cut emissions of sulphur dioxide and particulates dramatically from 1972, when 25 per cent of the city was heated by natural gas and 75 per cent by gas oil or fuel oil.

- Helsinki, Finland, has a district heating network covering 950 kilometres and supplying 90 per cent of the energy for heating purposes. The city has received the United Nations Sasakawa Environment Prize for its achievements in improving urban air quality.

- Rheinsberg, Germany, established a district heating system in 1992, then installed a new community heating and power plant in 1993, based on three natural gas fired engines, and peak load boilers fired with wood chips and oil. More than 60 per cent of consumers are connected to the system, and local air pollution has been reduced thanks to their switching over from burning brown coal in individual stoves.

- Avoiding heat losses by using heat exchangers and vapour compressors to capture available heat from industrial or commercial processes and use it for other purposes.
- Recovering and upgrading waste heat, using heat pumps and heat transformers.
- Reducing heat demand in buildings, and heating and cooling demands of production machinery, by using advanced thermal insulation methods.
- Less energy-intensive processes such as thin strip casting of metals and membrane separation technology.
- Increased recycling of energy-intensive materials.
- Substituting energy-intensive materials with new materials, such as ceramics.

Residential and commercial use

There is also a great need to use energy more efficiently in residential and commercial buildings. Every year, people in the OECD countries use the equivalent of 1,500 million tonnes of oil to run the heating, air conditioning and lighting in their shops, offices and homes. UNDP calculates there are potential savings in energy use of 30 to 50 per cent in residential buildings in industrialized countries, while in commercial buildings potential savings range from 25-55 per cent in industrial countries to 50-60 per cent in developing countries. For heating, energy-efficient technologies include:

- improvements in traditional heating systems;
- integrating renewable energy systems directly into building components;
- large underground systems to store hot water for months, providing heat in the winter;
- advanced, cost-competitive heat pumps to provide both heating and cooling.

However, most of these developments involve a high standard of technology not available everywhere, especially in the non-industrialized countries. Moreover, some are simply not relevant to certain regions. Therefore, the aim should be to improve technologies that offset energy consumption in the most significant end uses for each specific area, taking into account local social factors, which may be as important as technical or financial considerations. For example, wood stoves for heating or cooking are widely used in developing countries. As some stoves have efficiencies as low as a few per cent the aim should be to replace them with higher efficiency models that are appropriate for local fuels and available financial resources.

Co-generation

The OECD says that co-generation – the simultaneous generation of heat and power from the same source – is “one of the most effective technologies for the rational use of energy”. In thermal power plants, generally one-third of the energy is converted to electricity and the other two-thirds produces low-grade heat. If this is not usable, it means that 60-65 per cent of the primary energy is wasted. Using technologies like supercritical steam cycles and combined cycles can increase efficiency to 45 per cent in steam plants. But co-generation plants achieve an efficiency of at least 80-85 per cent when they are sited close to the users of the energy, and the ‘waste’ heat is put to use, not discarded.

Co-generation is nothing new: it can be found in industry throughout the OECD countries. Small-scale, gas-driven combined heat and power units are attractive to companies (for example, in the chemical, primary metals, food, and paper and pulp industries) wanting to cut their energy bills. A joint European/United States study has concluded that co-generation is the cheapest form of thermal power generation. But the same study found that co-generation is being “neglected” in most national energy plans. Overall, it provides only about 7 per cent of the European Union’s total electricity demand, though the figure rises to more than 30 per cent for the Netherlands, Denmark and Finland. The OECD says there is considerable scope for expanding co-generation into large office buildings, commercial centres, hotels, hospitals and sports centres.

Why, with its environmental and economic benefits, is co-generation being “neglected”? According to COGEN Europe, it is because the players in the power industry are often centralized and “characterized by vertical integration, lack of competition and the development of over-capacity”, and because “for the wider development of high efficiency co-generation systems, reform is necessary”. The OECD also points out that many co-generation projects fail because of economic miscalculations, for instance “mismatching heat and power loads, disparate energy price evolution of fossil fuels and of heat and electricity, and insufficient scales of utilization times”.

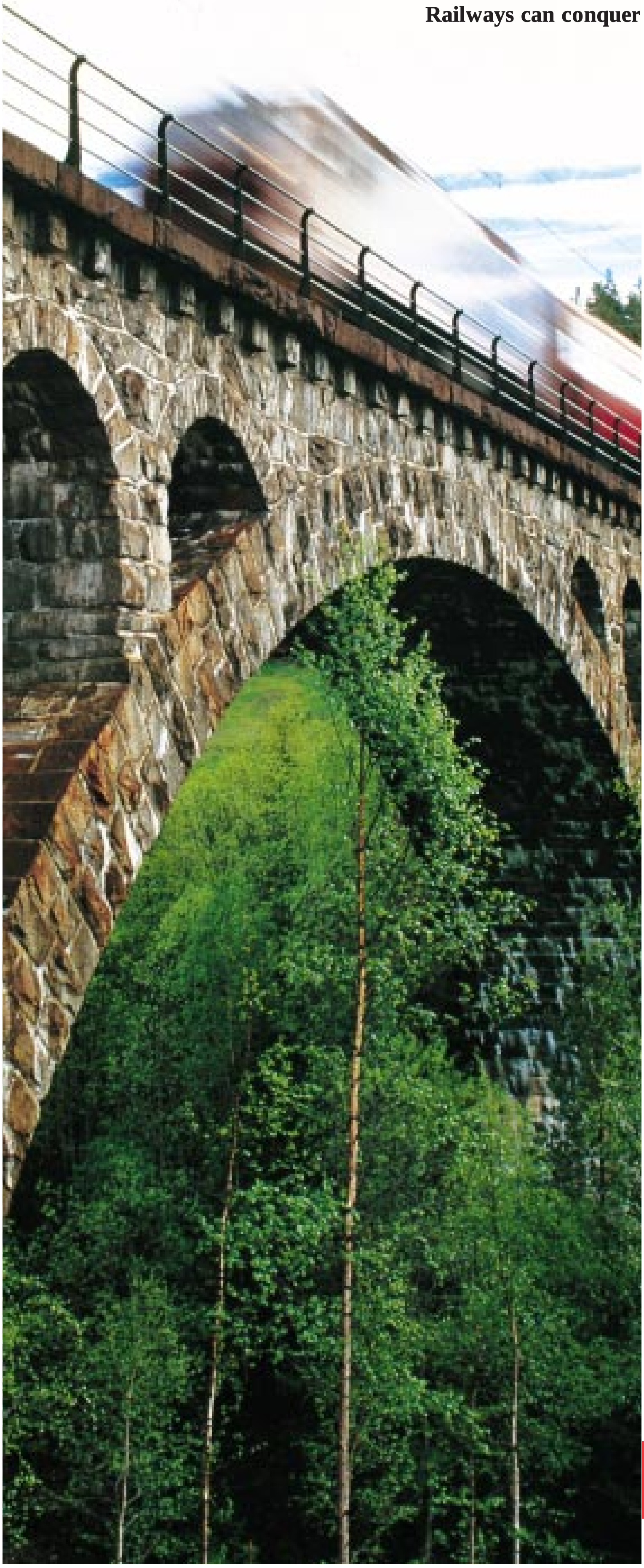
> The international community, particularly the industrialized countries, have an obligation to provide access to environmentally sound technologies and corresponding know-how to developing countries on favourable terms
>
> Stephen Kalonzo Musyoka,
> Minister for Foreign Affairs, Kenya

According to COGEN, a powerful argument in favour of co-generation is that “new technologies, especially engines and turbines, now provide a vast range of opportunities for smaller-scale and localized high efficiency systems providing heating/cooling/electricity where consumers want them”. This factor explains the growing interest in using co-generation with district heating schemes: a “very robust and flexible system”, says the OECD. However, such schemes are limited to only a few countries in the OECD: Austria, Denmark, Finland, Germany, Sweden and Switzerland. For the OECD as a whole, district heating contributes only 1-2 per cent towards energy consumption in the residential sector.

Fuel flexibility is an important factor in the development of district heating systems. For example, a system that can use cheap fuels, such as wood, peat and straw, provides a cushion against price rises of other fuels. On the other hand, setting up district heating networks requires considerable investment, with a 20-30 year wait

Journey to the Future

Railways conquered yesterday's frontiers.
Today's challenge is not geographical conquest, but environmental survival.
Railways can conquer tomorrow as well.



In Norway – a country of vast distances and sparsely populated areas – railways have been bringing people and business together for nearly 150 years. Norwegian State Railways (NSB) has played a major role in building a modern society, and still intends to be a leader in meeting today's historic challenges.

By using less energy and causing less pollution than other means of transportation, railways offer unrivalled environmental and social friendliness, as well as personal safety. By constantly investing in modernizing the railway network, NSB aims to provide an environmentally sustainable form of transportation.

NSB also intends to maintain its leading role as a major transport company committed to the Norwegian environment, by constantly striving to improve its performance in key areas such as energy consumption, waste, noise pollution/vibration, air and soil pollution, vegetation control, biological diversity, responsible land use, and the correction of previous environmental negligence.

Saving the environment is imperative for our planet's very survival. The transportation sector must respond to the challenge of Rio by contributing to the implementation of Agenda 21. Developing efficient railways – and integrating them with networking growth points in local communities – is an important part of that contribution.

In NSB, we have committed ourselves to Agenda 21 – on our **Journey to the Future**.

«NSB's vision is to ensure the company's position as a clear environmental winner in the transport industry.»

O. Ueland
Executive Director

for a return, financially unattractive to investors. Another problem is that many consumers have had bad experiences with poorly designed and built systems. This, says the OECD, has given district heating a "bad reputation" in some countries and can "present a major barrier to the implementation of further schemes".

Nonetheless, the OECD is optimistic that co-generation and district heating schemes will play an increasingly important role as urban authorities move to tackle the "growing environmental impact related to the handling and conversion of energy" in cities and towns. COGEN believes, for example, that there are considerable long- and medium-term opportunities in Central and Eastern Europe, where the scope for refurbishing and adding electricity generation capacity to existing community heating systems (currently inefficient, polluting and in a very poor state of repair) is enormous. The European Commission has confirmed its support for the wider use of co-generation as a means of reducing Europe-wide carbon dioxide emissions.

A key role for technologies

A priority is improving end-use energy efficiency. UNDP is in no doubt that using the most efficient technologies available today is the key to achieving energy efficiency improvements in both the industrialized and developing countries, and that "the potential for further improvements through continued research and development is high, as the performance of current technologies is far from their fundamental physical limits". But while high rates of innovation in the energy sector are needed to bring about a sustainable future, many promising technologies for reducing emissions, such as fuel cells and most renewable energy technologies, require relatively modest investments in research and development and commercial incentives.

The new technological opportunities will be taken up much more with new investments than with retrofitting existing equipment, a point of particular importance for developing countries as they aim for more investments in new infrastructure and equipment. Thus, says UNDP, "if they were to have these opportunities, they would be able to leapfrog to the new generation of cleaner energy technologies, without going through the same unsustainable path that the industrialized countries have followed". UNDP adds: "Energy can become an instrument for sustainable development. The point is, while the future may be difficult, a continuation of present trends cannot be sustained."

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