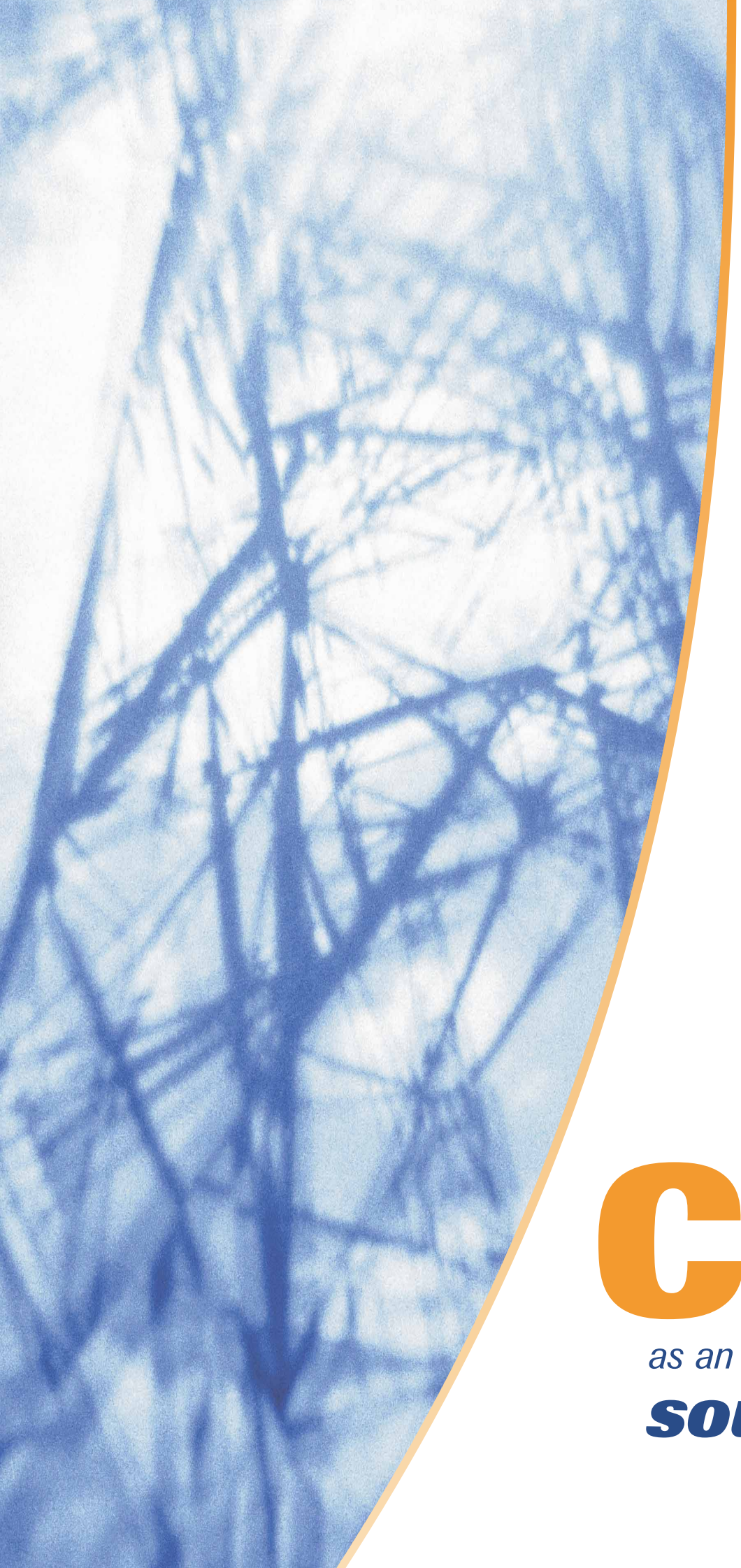


World Coal Institute

The role of Coal as an energy source

The role of coal as an energy source

Key Messages

- *Energy demand has grown strongly and will continue to increase, particularly in developing countries where energy is needed for economic growth and poverty alleviation.*
- *All energy sources will be needed to satisfy that demand by providing a diverse and balanced supply mix.*
- *Coal is vital for global energy security. It is abundantly available, affordable, reliable and easy and safe to transport.*
- *In an energy hungry world the challenge for coal, as for other fossil fuels, is to further substantially reduce its greenhouse gas and other emissions, while continuing to make a major contribution to economic and social development and energy security.*
- *Coal is part way down a technology pathway that has already delivered major environmental improvements. Further technical solutions include improved combustion efficiency and reduced emissions, coal gasification, new approaches to carbon capture and storage, and the production of hydrogen from coal, which will play a part in the transition to a hydrogen-based energy future. The ultimate goal is near complete elimination of emissions.*
- *The member companies of the World Coal Institute are committed to improving coal's sustainability by:*
  - *Supporting major research efforts to make cleaner technologies affordable and thereby accelerate their uptake;*
  - *Raising awareness within the industry;*
  - *Providing credible input to policy making; and*
  - *Demonstrating leadership in implementing the Guiding Principles for the Coal Industry, set out at the back of this document.*

The world needs coal

Advanced coal technologies will meet the challenges of the 21st century

The role of Coal as an energy source

Contents

Introduction

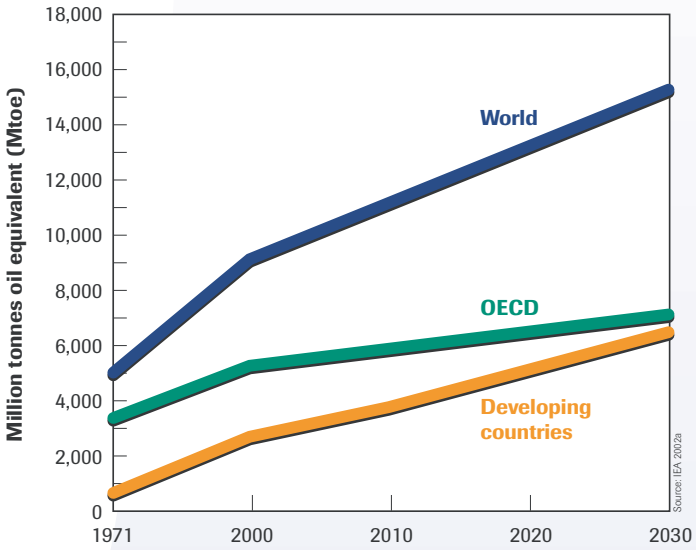
Energy is a fundamental driver of economic development and contributor to people's quality of life. It sustains the living standards of developed countries to a high level of comfort and convenience and in the developing world it leads people out of poverty. Access to electricity increases life expectancy, reduces infant mortality, facilitates education and improves productivity. It provides a window to the wider world.

However, the energy sector faces major challenges in the 21st century.

It will have to continue to supply secure and affordable energy in the face of growing demand. Even with energy conservation measures in developed countries, global energy consumption will continue to increase, driven by economic growth and the needs of developing countries. Overall demand is projected to increase by almost 70% over the next 30 years, with most of that growth coming from developing countries [IEA 2002a]. Even then 1.4 billion people in developing countries will still not have access to electricity in 2030 [IEA 2002a].

At the same time, society is demanding cleaner energy and less pollution. The desire for lower emissions has led to widespread questioning of the role of fossil fuels in general and of coal in particular.

Energy demand



The industry has accepted and is responding to the call for improved environmental performance from the use of coal.

This report explains how coal will continue to make a major contribution to global energy supply in the 21st century. Not only will the huge reserve base of coal be needed, but technological advancement can ensure coal is part of a cleaner energy future.

Definition of Sustainable Development *(Brundtland Commission)*

"…development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The World Bank on the role of energy in poverty alleviation

"Reliable energy is a key component of economic and social development…lack of energy is among the key forces slowing down poverty reduction and growth of the rural sector."

World Bank 2002

The IEA on the role of fossil fuels in sustainable development

"…renewables alone do not offer us a path to a sustainable future within our present span of vision. Economic development and poverty eradication depend on secure, affordable energy supplies … Fossil fuels, though environmentally-challenged, can meet the criteria of security and affordability. Technology, driven by the right incentives, offers possible answers to the environmental problems – clean coal technology, and technologies to safely capture and store carbon."

Statement to the World Summit on Sustainable Development, 2002, by Robert Priddle, the Executive Director of the International Energy Agency (IEA) at that time.

Growing Energy Demand

...the need for a balanced energy mix

The world faces major challenges – to meet the needs of a growing population, bring billions of people out of poverty and offer them a better standard of living, and sustain economic development for rich and poor countries alike.

Meeting these challenges will lead to growing demand for energy. The International Energy Agency (IEA), in its latest World Energy Outlook (2002), projects that world energy demand will grow by two-thirds over the next thirty years.

Most of this growth will take place in developing countries. A third of it will be in China and India alone. At present, the average citizen of these countries uses just one-seventh as much energy as the average OECD citizen [IEA 2002b]. Inevitably, development in these countries will narrow this gap, necessitating a significant increase in their reliance on electricity and transportation and requiring major new supplies of energy.

To meet this need, the world cannot ignore any of the sources of energy available – especially coal, being the most abundant and affordable of all the fossil fuels. All fuels will have to play their part and coal's role will be a vital one.

A balanced energy mix

All forms of energy production have their impacts – negative as well as positive. There is no truly risk-free way of producing energy, whether in terms of human physical safety, security of supply or environmental impact.

The most effective way of reducing these risks is for policies to encourage a portfolio of investments – a diverse energy mix, where the strengths of one source can help make up for the disadvantages of others.

The role of renewable sources of energy will increase in a world committed to sustainable development. However, there are practical and economic limits to the rate of growth of renewables – the IEA forecasts that they will still account for less than 5% of world electricity supply by 2030 [IEA 2002a].

Other fuels will have to provide the great bulk of the additional energy required over the period. As the most important fuel for electricity generation, coal will have a major and vital role to play, along with other fossil fuels.

Fuel	Positive points	Negative points
Coal	• Abundant, affordable, safe, secure. • Easy to transport and store. • Widely available.	• The most carbon intensive fuel for electricity. • Poses technological challenges as part of low global CO_2 growth.
Oil	• Convenient. • Easy to transport and store. • No effective substitute in transportation uses.	• Carbon intensive. • Price volatility. • Resource concentration. • Vulnerability to disruption or geopolitical instability. • Transport risks.
Gas	• Efficient and convenient. • Fuel of choice for many uses, such as residential heating.	• Carbon intensive. • Expensive and risky to transport and store. • Requires dedicated, inflexible infrastructure. • Price volatility. • Resource concentration.
Nuclear	• Carbon-free generation. • Few resource constraints.	• Public acceptability. • Waste disposal question marks. • Capital intensive – may be uneconomic in some markets.
Renewables	• Low emissions on a life cycle basis. • Sustainable.	• Generally high cost. • Intermittent sources. • Major expansion will take time. • Potential siting problems.

Energy Security

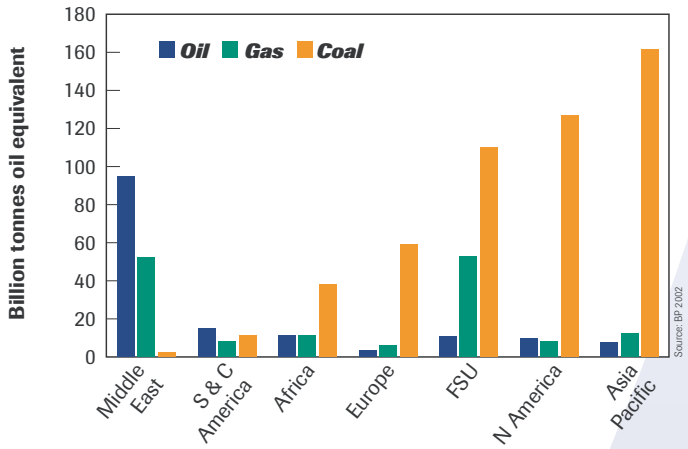
...coal's role

There is effectively no limit on the availability of coal into the future. This places coal in a unique position in a world where reliable supplies of affordable energy are essential for continuing global development.

Without fuel, humanity's basic needs for lighting, heating, cooking and mobility would not be met. This means having affordable sources of energy available in sufficient quantities to meet the demands of a growing world population.

Resource base

That coal can continue to supply the world's energy is not in doubt. The IEA has stated: "World reserves of coal are enormous and, compared with oil and natural gas, widely dispersed… The world's proven reserve base represents about 200 years of production at current rates… Proven coal reserves have increased by over 50% in the past 22 years. The correlation of strong growth of proven coal reserves with robust production growth suggests that additions to proven coal reserves will continue to occur in those regions with strong, competitive coal industries" [IEA 2001]. In other words, there is no resource constraint on the use of coal, as far into the future as we can reasonably look.

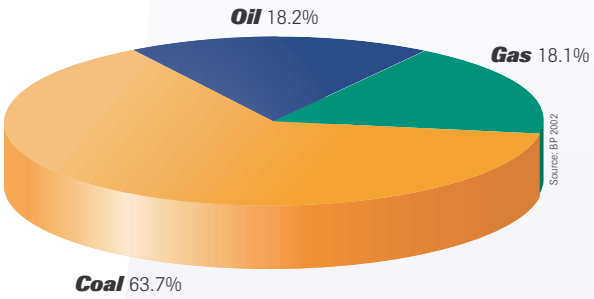


***Proven reserves** 2001*

Vulnerability to short-term disruption

There is also a short term dimension to energy security – minimising the risk of supply disruptions, whether by accident, political intervention, terrorism or industrial dispute – which is ever more important in our modern world. Developed countries are increasingly dependent on electricity-based

Proven reserves of fossil fuels worldwide



systems – it is difficult to imagine a world in which such systems ceased to function – while the needs of developing countries are even more direct and basic – access to energy is a route to a better life and its absence can mean, literally, darkness and discomfort.

Coal has an immensely valuable role in this respect, complementing other fuels and energy sources that are generally more vulnerable to disruption.

Coal contributes to security of the energy mix in a variety of ways:

- *Coal reserves are very large and will be available for the foreseeable future without raising geopolitical or safety issues.*
- *Coal is readily available from a wide variety of sources in a well-supplied worldwide market.*
- *Coal can be easily stored at power stations and stocks can be drawn on in emergencies.*
- *Coal-based power is not dependent on the weather and can be used as a backup for wind and hydropower.*
- *Coal does not need high pressure pipelines or dedicated supply routes.*
- *Coal supply routes do not need to be protected at enormous expense.*

These features help facilitate efficient and competitive energy markets and help stabilise energy prices through inter-fuel competition.

The Value of Flexibility in the Fuel System

When gas prices rose significantly in the United Kingdom at the end of the 1990s, the availability of coal and coal-burning capacity in the electricity system avoided any significant impact on consumers.

Sustainable Development

...the role of coal

Sustainable development is a broad goal, with three recognised pillars – economic, social and environmental. Coal has a major future role to play in all three pillars.

The importance of coal and other fossil fuels was acknowledged at the World Summit on Sustainable Development (WSSD) in Johannesburg in August/September 2002. While this called, rightly, for further progress on renewable energy, it also called on governments to:

"Diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective energy technologies, including fossil fuel technologies."

The three pillars of sustainable development are more intertwined than is often thought. Sometimes there is a tendency to focus solely on the environmental dimension and make it the only priority. This risks depriving the world of both economic growth and the benefits that energy provides in improving people's lives.

The overall ambition is to achieve "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This is the Brundtland Commission's definition. Another definition from the UK Government is: "A better quality of life for everyone, now and for generations to come".

Sustainability requires the present generation to address the three pillars of sustainable development together, so that they meet their own needs in ways that do not limit the options of generations to follow.

Coal plays a major role in all three pillars of sustainable development

Economic

- ***Coal produces 39% of the world's electricity (twice as much as the next largest source) and around 70% of the world's steel*** *[IEA 2002a and WCI 2003a]*.
- ***Coal use in power generation is projected to grow 60% by 2030*** *[IEA 2002a]*.
- ***The benefits amount to a gain of billions of dollars to developed and developing countries alike.***

Social

- ***1.6 billion people in developing countries do not have access to electricity; for many, coal will be the route to electrification and a better life*** *[IEA 2002a]*.
- ***Around 1 billion people have gained access to electricity via coal in the past two decades*** *[WCI 2003b]*.
- ***Coal provides 7 million jobs worldwide and coal production is the key economic activity in many communities*** *[WCI 2002a]*.

Environmental

- ***Emissions from coal burning have fallen substantially in recent decades even while consumption has increased.***
- ***Development of modern advanced technologies can combine the economic and social advantages of coal with the need for environmental improvement.***
- ***If coal-fired power stations across the world were brought up to current German levels of efficiency, the CO_2 reductions from this alone would be greater than from the Kyoto process*** *[WCI 2003b]*.
- ***In the long term, new coal-based generation technology options, such as gasification and carbon capture and storage by geological sequestration, offer the possibility of ultra-low or zero emissions, at an acceptable cost.***

Economic Development

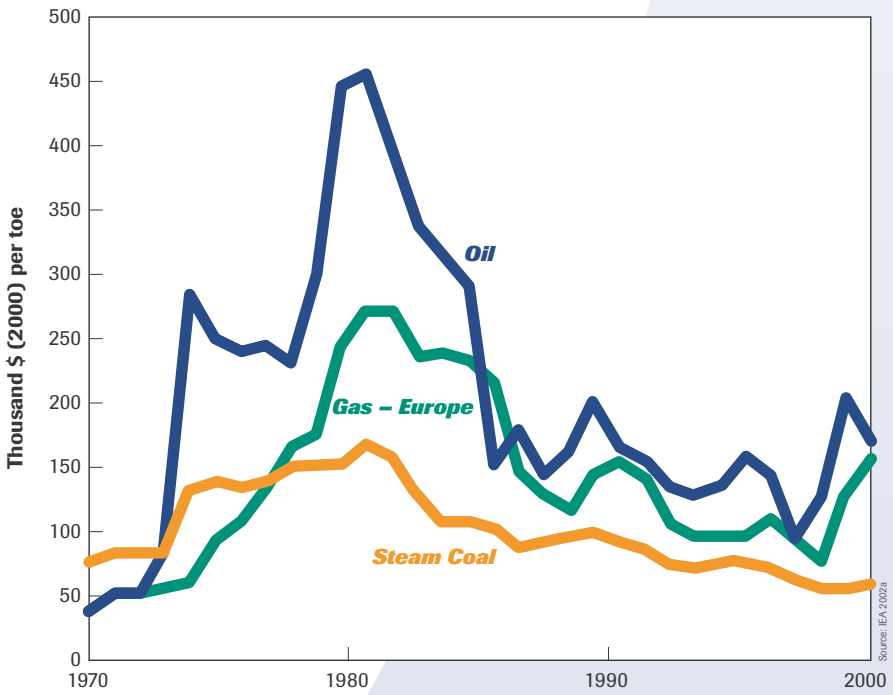
Coal makes a significant economic contribution to the global economy. For consumers, coal offers excellent value. In most circumstances, it is cheaper per energy unit than other fuels, and as a result it has remained the fuel of choice for electricity generation on a global basis. Coal produces 39% of the world's electricity [IEA 2002a], which is double the share of its nearest competitors – gas and hydro – and is also an essential element in 70% of the world's steel production [WCI 2003a].

The IEA projects that the key role provided by coal will continue, with coal use in power generation projected to rise by around 60% in the next three decades [IEA 2002a]. If the relentless increase in global electricity demand continues as predicted, the contribution of coal cannot be ignored.

One of coal's main virtues – its affordability – arises from the intensely competitive nature of its market. Coal prices have declined steadily in real terms over a long period of time as a result of competition in a free market, in which:

- *international trade has increased;*
- *electricity markets have been deregulated;*
- *mining productivity has increased greatly; and*
- *shipping costs have been reduced.*

Real oil, gas and coal prices *2000 $/toe*




Courtesy of Eskom

Coal prices are consistently more stable than oil and gas prices, reflecting coal's diverse and competitive markets.

The benefits to consumers, principally through lower power generation costs, have been enormous. In South Africa, for example, coal underpins the electricity system and electricity prices are among the lowest in the world. Just as the expansion of cheap electricity into the townships played a significant role in social development, so it continues to play an essential role in keeping South African industries competitive, with obvious advantages to this growing economy.

Since coal reserves are widely distributed, substantial economic benefits flow to many coal producing countries. Coal is currently mined in over 50 countries, and worldwide the industry employs some seven million people, 90% of them in the developing world [WCI 2002a]. The earnings from the industry are therefore widely distributed.

Much of the coal industry in developing countries is export oriented. It is a major source of foreign hard currency earnings, as well as saving import costs. Overall, coal generates around $7 billion per annum in export revenues for developing countries and saves them $60 billion or more in energy import costs every year [WCI 2003c].

Coal mining can and does provide a significant direct contribution to economic development at a local level, particularly in the poorer parts of the world. Large-scale mines are often the biggest source of income for rural communities. In addition to providing wages for local people, they are also the source of much local economic and social infrastructure – roads, transport, education, water and communications.

Social Development

The use of coal as a low-cost energy source also makes a significant contribution to social development. Dependable and affordable access to modern energy, particularly electricity, is essential for improving public health, providing modern information and education services, and saving people from subsistence tasks, such as gathering fuel, allowing them to pursue other more rewarding activities.

The global challenge to provide adequate access to energy is daunting. According to a recent IEA study [IEA 2002a], 1.6 billion people in developing countries, or 27% of the world's population, do not have access to electricity, and around 2.4 billion people rely on primitive biomass fuels for cooking and heating. In the absence of radical new policies, 1.4 billion people will still lack access to electricity in 30 years time and the number of people relying on biomass for cooking and heating will actually rise to 2.6 billion.

The need for affordable energy is particularly acute for the poorest groups who spend a high proportion of their meagre incomes on heat and light.

As the then IEA Executive Director, Robert Priddle, commented at the World Summit on Sustainable Development in 2002, renewables alone will not provide a solution to these development dilemmas.

Or, as the World Bank puts it: "Reliable energy is a key component of economic and social development…lack of energy is among the key forces slowing down poverty reduction and growth of the rural sector" [World Bank 2002].

Electricity is one of the most effective and environmentally responsible ways of delivering the modern energy needed for social development. A lack of electricity is strongly correlated with poverty. If poor people are to wait for the development of renewable substitutes for coal, they may have to wait a very long time. Coal provides an affordable, safe and increasingly clean fuel for power generation, where there is often no alternative route to achieving widespread access to electricity in a reasonable time frame.

The role of coal in social development extends beyond its role as a mainstay of electrification. Coal production benefits local populations and coal companies are involved in the local communities in which they operate and their workforces live. Education and skill development programmes

Poverty and Electrification in sub-Saharan Africa

Sub-Saharan Africa suffers from acute energy poverty, with an average electrification rate of little over 10% (excluding South Africa). Around 575 million people rely on biomass for their energy. The extensive use of biomass is incompatible with sustainable development.

- ***The energy needs of a growing population can lead to a scarcity of supplies, forcing people – usually women and children – to spend much of the day gathering fuel wood and other forms of biomass from further afield, reducing the time that people can dedicate to more productive activities. In rural areas, many women carry 20kg of fuel wood an average of 5km every day.***
- ***Collecting wood for fuel leads to deforestation and ecological damage.***
- ***The inefficient use of biomass can lead to respiratory diseases and other serious health effects from indoor smoke pollution.***
- ***The use of biomass energy reduces agricultural productivity because agricultural residues and dung are also widely used as fertiliser.***

Securing access to modern energy services is therefore one of the most significant milestones towards sustainable development in sub-Saharan Africa.

South Africa presents a striking contrast with the rest of the region. South Africa has raised its electrification rate from 35% to 66.1% in the past decade, with rural electrification increasing from 15% to 55%. This has dramatically improved the quality of life for South Africans, stimulating the creation of new businesses, creating jobs and making South Africa more competitive internationally.

South Africa's significant indigenous coal supplies have been vital to this electrification programme. In 2001, coal-fired generation accounted for nearly 90% (175TWh) of the power produced by South Africa's national electricity utility, Eskom; all of it fuelled by low-cost, locally sourced coal.

Sources: IEA 2002a and WCI 2002b

are an essential component in most major coal operations and the cost of schools is often paid in whole or in part by the local mine. Management programmes are frequently designed to help local administrators in their work. Improving the education and skill levels of the local community helps to attract further investment and thereby sustains the community after mine closure.

Electrification in China

China offers a striking example of coal-based electrification. Over the past 15 years, China has connected up some 700 million people to the electricity system. The country is now 98% electrified, or a similar level to most developed countries. Electrification was a vital component to its poverty alleviation campaign in the mid-1980s, which built up the basic infrastructure and created local enterprises. As a result, from 1985 to 2000, electricity production in China rose by nearly 1,000 TWh, 84% of which is coal-fired. China's economy grew by an annual rate of 9.1% during this period.

Source: IEA 2002a

Anglo Coal makes use of Industrial Theatre presentations in its AIDS education and awareness programmes.

Coal Mining Responding to HIV/AIDS

Coal producers in South Africa actively engage in the fight against HIV/AIDS. In South Africa, 4.7 million people are living with HIV/AIDS - a massive development crisis. The companies have not only launched projects amongst their employees but also acknowledged the importance of addressing the community as a whole.

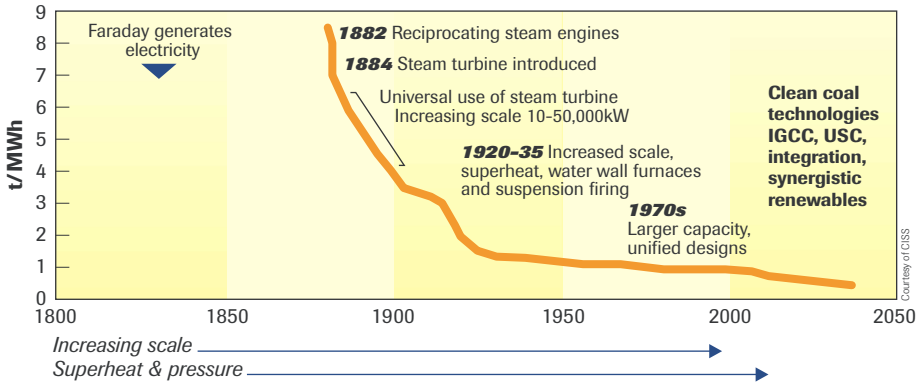
For example, in 1997 Anglo Coal launched its first project – the Peer Education Project – in the area surrounding its Kriel Colliery. The project used workshops and meetings to develop structures and capacity to successfully change sexual behaviour in the region. The company launched its second project in December 2000 – the Witbank Powerbelt HIV/AIDS project – a long-term collaborative initiative to minimise the prevalence of the disease and to assist in social regeneration within the defined high-risk areas in the Powerbelt region. Anglo Coal and its parent company, Anglo American, also make anti-retroviral therapies (ART) available at company expense to HIV positive employees who have progressed to a stage of infection where ART is clinically indicated. The company continues to work with governments, international donors and NGOs so that public sector capacity is created to extend ART beyond the workplace and to the broader community.

Source: WCI 2002c

Improving
Environmental Performance
...the potential of coal

The coal industry accepts that it must substantially improve the environmental performance of its products. This is necessary if coal is to have any claim to sustainability and realise its full potential contribution to economic and social development. The industry acknowledges that there have been, and continue to be, real problems in this regard. However, it can respond to and meet these challenges by working to ensure that coal is produced and used efficiently, and that the opportunities for technological advancement – on which a major improvement in coal's environmental performance hinges – are fully and vigorously pursued.

Greenhouse gas emissions: historical perspective



The crucial issue is how coal is used, not the fuel itself. Technologies have already been developed that are capable of almost entirely eliminating local and regional pollutants from coal-fired power generation – particulates, oxides of nitrogen and sulphur dioxide – the challenge with these technologies being to increase the extent of their global use. New, more efficient power plants reduce emissions of carbon dioxide, and research and development into CO_2 capture and storage is paving the way for a low emissions future. Coal no longer needs to equate to smoke and smog, and indeed can provide a route away from these problems with major attendant public health benefits. For example, one large coal-fired power station has a fraction of the impact on local pollution compared with the thousands or millions of home fires that it can replace, and which otherwise would continue to contribute to ill-health and premature death in the families that must rely on them. It is estimated that, in China alone, more than 100,000 people die each year from indoor air pollution caused by open fires [World Bank 1997].

Coal-fired power generation is becoming increasingly efficient, resulting in less and less coal being used per unit of electricity generated. The thermal efficiency of coal-fired electricity underwent an eight-fold improvement during the 20th century. This alone made a major contribution to reducing greenhouse gas emissions.

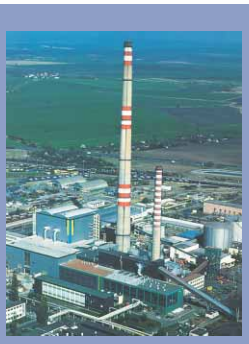
Yet if coal is to keep and expand its place in the energy mix, the development and deployment of improved coal technologies has to continue. This is a multifaceted goal, involving:

- ***The wider deployment of current best practice and technology:*** *It has been calculated that if the thermal efficiency of existing coal-fired power plant worldwide were brought up to current German levels of efficiency, the resulting reductions in global CO_2 emissions would exceed that represented by the Kyoto Protocol's first targets [WCI 2003b]. There are very large potential benefits from the transfer of modern combustion techniques from developed to developing countries.*
- ***Further development of advanced coal technology:*** *Power plant builders have already pushed efficiency levels up beyond 40%, but the process is continuing and 50% and better is in prospect. This would lead to a reduction in greenhouse gas emissions to 10-20% lower than the best conventional plants that exist today.*

Coal Use can be Compatible with Environmental Improvements

- ***Sulphur emissions in the US have fallen 3% a year since 1980, despite rising coal use.***
- ***Germany has reduced NO_x and particulate emissions by over 80% since the early 1980s, despite retaining a significant proportion of coal in its energy mix***
- ***The UK and Germany, both still major coal users, have met their Rio targets for stabilisation of CO_2 emissions and are on track to meet their Kyoto reduction commitments.***

Mladá Boleslav's Coal-Fired Cogeneration Plant Upgrade



Source: WCI 2000

Mladá Boleslav's Coal-Fired Cogeneration Plant in the Czech Republic underwent a major upgrade at the end of the 1990s. The plant is now one of the most advanced coal-fired cogeneration district heating plants, providing 70 MW of electricity to the Skoda automobilova sa car factory and 140 MW of district heat for VW-owned Skoda and about 10,000 homes in the town of Mladá Boleslav.

The new plant utilises two base load circulating fluidised bed boilers. Through the introduction of state-of-the-art energy efficient technology, both NO_x and SO_2 emissions have been significantly reduced, achieving levels below 200 mg/m^3. Carbon dioxide emissions have been reduced by over 60% compared with the old plant. The whole modernisation of the plant is estimated to have reduced greenhouse gas emissions by some 280,000 t CO_2 per annum.

- ***Enhancing the synergies between coal and renewables:*** *Synergies between coal, biomass and solar thermal can significantly increase the efficiency of these renewable energy technologies and may be the most cost-effective way of increasing the use of renewables.*

  The economics and efficiency of biomass renewable fuels can be greatly improved by co-firing the materials with fossil fuels, notably coal. Co-combustion with fuel crops – such as sugar-cane bagasse – already happens. The process enhances the cost-effectiveness of biomass and would encourage an increase in the use of this renewable resource. Up to 10% biomass could be utilised in existing conventional power stations with no need for modification, reducing greenhouse gas emissions by up to 10%.

  Also, linking steam from solar thermal technology with the steam cycle of coal-fired power plants offers the potential to convert 40% of solar energy into electricity. This compares to 13% for large-scale photovoltaic systems, which also have much higher capital costs.

- ***Ultra-low emissions technology:*** *Extensive research and development is under way into low and zero emissions technologies. While these are not yet commercial, they hold out great promise as potentially viable longer-term options. They are likely to be among the most economical and environmentally acceptable routes to a low carbon future.*

Courtesy of SIDEC

Dual fuel bagasse-coal electric power plants, such as Belle Vue in Mauritius, shown above, enhance the synergies between coal and renewables.

The overall picture is one of continuing progress towards reduced emissions from coal-fired electricity generation. As older power stations are replaced, the emissions produced by the new capacity are much lower.

Ongoing supercritical developments of conventional coal combustion techniques are targeted to greatly increase the thermal efficiency of coal-burning to over 50%. Another major technology stream – the gasification of coal in integrated combined cycle (IGCC) systems – is becoming increasingly well understood and commercially practical. Some 1,800 MW of this type of plant is now operating and another 3,150 MW is planned for the future [IEA CCC 2003]. Near zero emissions can be realised if such IGCC systems are combined with emerging carbon capture and storage technology.

Our understanding of this carbon capture and storage technology is also developing rapidly. Safely and permanently storing CO_2 underground – whether in natural geological structures or depleted oil and gas wells or unmineable coal seams – is not a pipe dream. The technology is already proven and has been widely used in commercial applications, involving enhanced oil recovery.

Courtesy of ELCOGAS SA

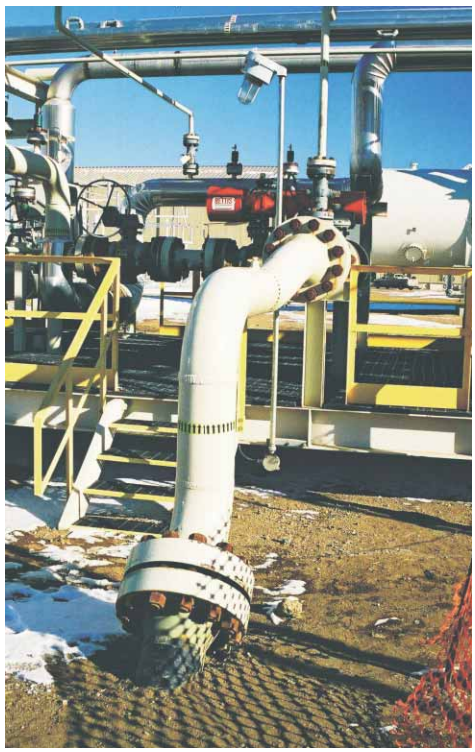
ELCOGAS IGCC Plant is a 350MW power plant located in Puertollano, Spain. Coal gasification and extensive gas cleaning prior to combustion means that atmospheric pollutant emissions at IGCC plant are as low as those of natural gas combined cycle plant.

While uncertainties surround the costs of large-scale CO_2 capture and storage, these will be much better understood as a result of projects such as the recently announced FutureGen project in the United States. At the core of FutureGen is a proposal to build a US$1 billion IGCC and CO_2 capture and storage demonstration plant, capable of producing electricity at no more than 10% above the cost of high-tech conventional coal plant. If this can be delivered, it will put affordable ultra-low emissions coal-based power within reach.

Numerous other governments are also initiating programmes of work in the area of carbon capture and sequestration, with the aim of lowering its costs. In effect, the fact that fossil fuel combustion produces CO_2 need not mean in the future that it always contributes to greenhouse gas emissions.

Indeed coal, via gasification technology, has the potential to become a mainstay of a future 'hydrogen economy'. It is an abundant potential source of the huge quantities of manufactured hydrogen that would be required for the widespread application of emissions-free hydrogen-based energy systems.

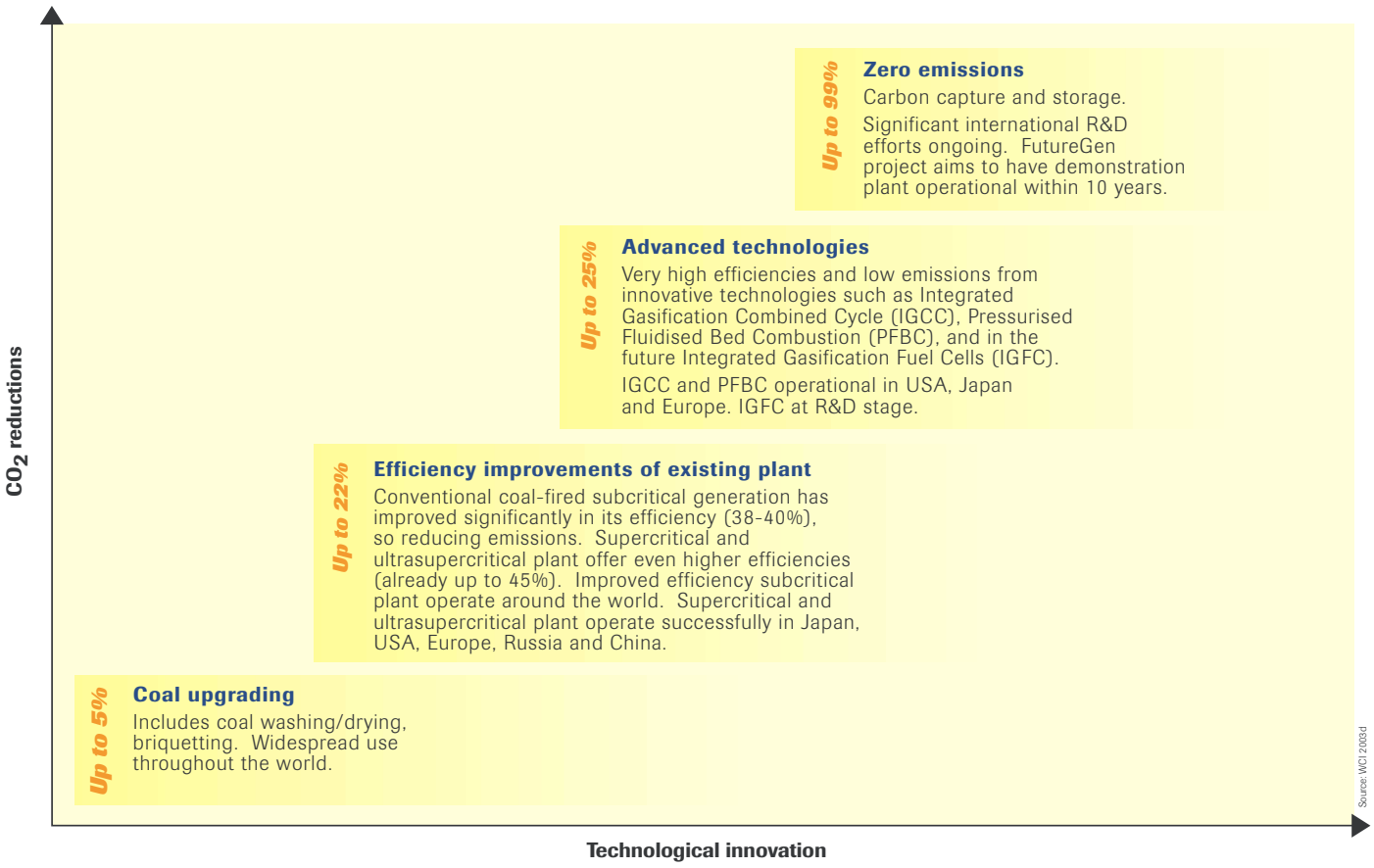
The members of the World Coal Institute see FutureGen and similar projects as especially important in helping to show that near zero emissions power generation from coal is not just a distant vision, but something that can actually be demonstrated in the foreseeable future. Building on the innovations in coal technology that have already delivered significant environmental improvements, FutureGen



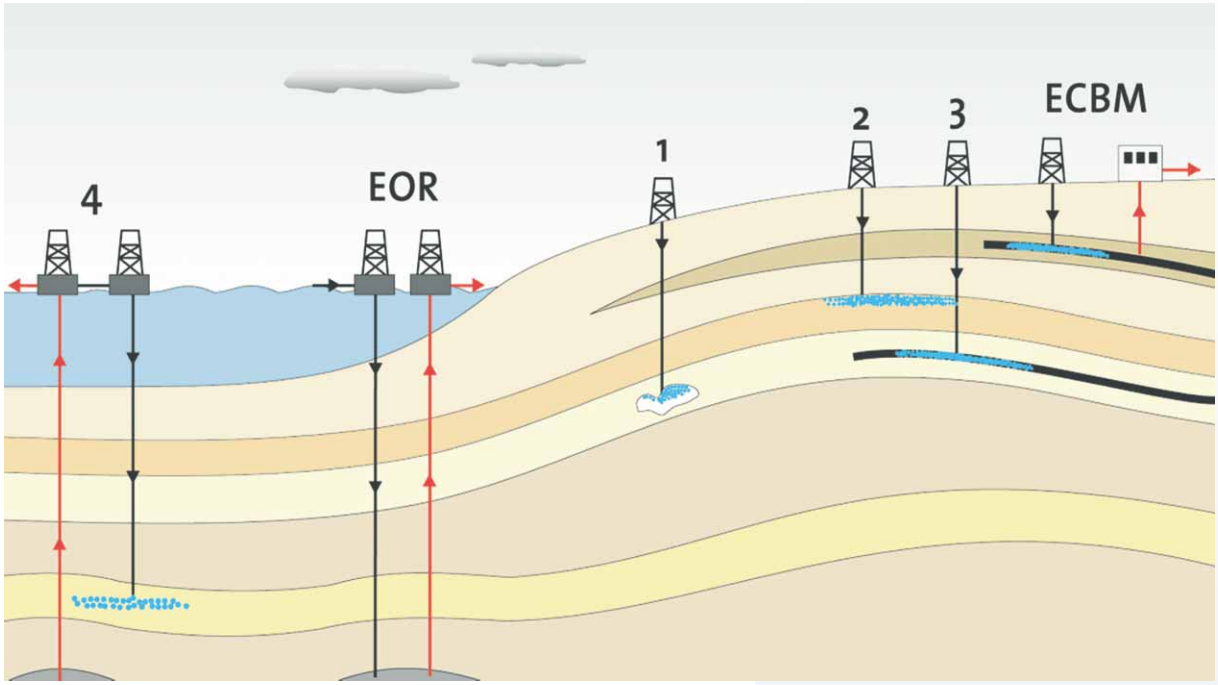
Courtesy of Brian Ricketts, UK Coal.

Pipeline carrying CO_2 from North Dakota, USA, emerges from the ground at Weyburn, Canada.

The CO_2 from the Great Plains Synfuels Plant in North Dakota, USA, is pumped 205 miles through a 16" pipeline across the border into Saskatchewan, Canada, where it is used by EnCana to recover tertiary oil from the Weyburn field.



The coal-fired route to CO_2 reduction



There is a range of options for geological storage. Enhanced oil recovery (EOR) and enhanced coal bed methane recovery (ECBM); saline aquifers – water-saturated reservoir rocks (4); large voids and cavities (1); depleted oil and gas reservoirs (2); and deep unmineable coal seams (3).

represents a further major step forward towards meeting the challenge of environmental acceptability that faces coal and the communities that rely on coal now and into the future.

Life cycle issues

In quantifying greenhouse gas emissions associated with a power station or factory, it is important to consider the entire process chain, rather than concentrating solely on emissions at the 'burner tip'. The complete life cycle, encompassing emissions from fuel production, processing, storage, transportation and distribution, as well as fuel combustion, needs to be accounted for.

For example, over 90% of the life cycle greenhouse gas emissions from coal generally occur at the point of combustion. In contrast, as little as 60% of the greenhouse emissions from natural gas may occur at the point of combustion. The remaining 40% of greenhouse emissions in the natural gas production chain may result from gas venting/flaring at the wellhead, stripping and venting during processing, gas leaks in pipeline compression, transmission and distribution, and gas consumed in processing and compression. The leakage of natural gas is significant in environmental terms as methane, the main component of natural gas, is itself a greenhouse gas with a global warming potential of 23 times that of CO_2. With ever increasing transmission distances, increases in such emissions are inevitable. Equally, the liquefaction of natural gas (as LNG), to make it transportable by sea, requires large amounts of energy.

When all these factors are taken into account, the total environmental impact of burning coal can be comparable with other fossil fuels, depending on local circumstances. The conclusions of one life cycle analysis are shown in the 'Coal in a Sustainable Society' box below.

Coal in a Sustainable Society (CISS)

Key Findings – Electricity Generation

- *On a full life cycle basis, greenhouse gas emissions from coal-based generation may not be significantly different from those of gas-based electricity generation measured on the same life cycle basis.*
- *Emerging clean coal technologies will significantly reduce the difference in greenhouse gas emissions between the best gas technologies and coal, at the point of combustion.*
- *Synergies between coal, biomass and solar thermal can significantly increase the efficiency of these renewable energy technologies and may be the most cost-effective way to increase the use of renewable energy.*
- *By-products can be utilised to further lower life cycle greenhouse emissions from coal-based generation by approximately 9%.*
- *Utilising coal seam methane is a relatively easy way to reduce total greenhouse gas emissions.*
- *Although non-hydro renewables (including solar, wind and biomass) have low greenhouse gas emissions, emissions from hydro-electricity are often significant (as a result of emissions from submerged vegetation).*

For more information and to see the full reports, visit the CISS website: www.ciss.com.au

Technology Pathway

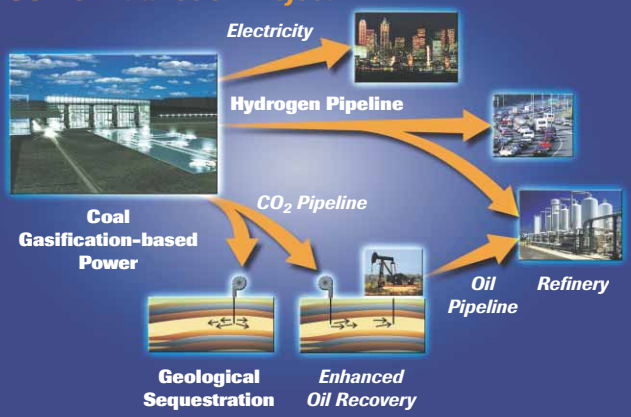
Coal is a major provider of the energy that is needed for development and is not going to disappear. It is therefore important that clean coal technology continues to improve, as will happen in the right policy environment.

The challenge is to ensure that advanced coal technology, along with other promising options including renewables, can be fully explored as part of a more sustainable energy future. The pathway to lower emissions through coal can be identified and the importance of coal makes it vital that this path be followed.

Technology deployment	Maximum emission reduction	Developed countries	Developing countries
Conventional			
Thermal efficiency up to 40%			
Particulates			
Bag filters	>99%	✓✓	Some
Electrostatic precipitators	>99%	✓✓	Some
SO_x			
FGD	90-97%	✓✓	Some
NO_x			
Low NO_x burners	70%	✓✓	Some
SCR	80-90%	✓✓	Some
Advanced combustion systems			
Thermal efficiency up to 60%			
Supercritical/ Ultrasupercritical	*	✓✓	Some
PFBC	*	✓	Some
IGCC	*	✓	Some
Zero emission technologies			
IGCC + Carbon capture & storage	Near 100%	R&D	Not at present

* = reductions achieved through efficiency gains.
✓ = indication of market penetration.

Source: WCI 2003c



Towards a Hydrogen Economy?

It is not clear how far and how fast the world will need to go on the path towards lower emissions; there are many uncertainties as to the costs and benefits of alternative courses. However, one significant longer-term scenario is a global move towards hydrogen-based energy systems, in which hydrogen is used to produce electricity from fuel cells, both for stationary power production and for use in electric vehicles.

A key uncertainty surrounding the widespread uptake of fuel cells relates to the availability of hydrogen, which does not naturally occur in usable quantities. It would therefore have to be manufactured and fossil fuels are one possible source. Coal, with the biggest and most widespread reserves of any fossil fuel, is a prime candidate to provide the hydrogen necessary for the widespread and sustainable deployment of such energy systems. However, if the longer-term aim is to reduce emissions to near zero, the CO_2 produced in the process would need to be kept from entering the atmosphere.

A number of technical routes are possible to achieve the 'zero emissions from coal' concept. One is the use of coal gasification, combined with carbon sequestration. The basic gasification technology is proven and demonstrated, providing a gas stream from which highly concentrated hydrogen (H_2) and CO_2 can be readily extracted.

Major research and development programmes are targeting the commercialisation of CO_2 capture, storage and utilisation technologies. These hold out the promise of radically reduced greenhouse gas emissions per unit of energy produced from coal and, in the longer term, a low carbon, hydrogen-based economy, in which coal complements renewable energies and other non-fossil sources. The US DOE FutureGen project aims to demonstrate such technologies, so that by 2020 low carbon electricity costs are no more than 10% above current coal-fired generation options.

In Conclusion

Coal is an essential part of the energy mix and is vital for the continued secure supply of affordable electricity.

The coal industry recognises the need to improve the environmental acceptability of its product. Furthering the development and deployment of new coal utilisation technology is a key priority area, and has an important policy dimension. Coal producers are ready to work with others – customers, suppliers, governments, international agencies, and civil society – in pursuit of the common goal of sustainable development. Given the growing demand for coal arising from the economic and social needs of developing and developed countries alike, a multistakeholder approach is needed.

The coal industry's commitment to maximising its contribution to sustainable development has been outlined in a report, prepared by the World Coal Institute for the United Nations Environment Programme (UNEP). In that report – *Sustainable Entrepreneurship – the Way Forward for the Coal Industry* – the industry expresses its goal to maximise its contribution to all three of the pillars of sustainable development – economic, social and environmental – and identifies the areas that need to be addressed as a priority.

The goal of sustainable development challenges coal producers and users, governments and others to help to meet the world's growing energy needs, while making an effective response to the imperative of reducing greenhouse emissions. This requires policies that actively pursue the opportunities presented by low emissions coal technologies, along with other worthwhile fossil fuel based and renewable energy options.

The challenge of sustainable development is complex and multidimensional. It requires a positive, multifaceted approach that employs all available means and explores all promising options. Coal has an essential role now and into the future in meeting this challenge.

Courtesy of EDF Energy

Cottam Power Station, UK.

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Guiding Principles
for the Coal Industry

- work to increase understanding of the principles of sustainable development within the industry and among mining communities, and demonstrate leadership in implementing the principles;
- minimise any adverse impacts from its activities on the biosphere, on the health and safety of its employees, and on local communities;
- improve the technical and economic efficiency of energy conversion, thereby minimising resource use;
- significantly reduce 'per unit' emissions from the production and use of coal;
- contribute to the efficient and beneficial transfer of new and advanced clean coal technologies to enhance their global uptake and to assist in meeting the needs of developing countries (recognising their legitimate development aspirations and the low energy efficiency of older thermal plant); and
- support by individual coal companies for community development initiatives to address local sustainability issues, providing enhanced economic and social opportunities relevant to the location and scale of their operations.

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