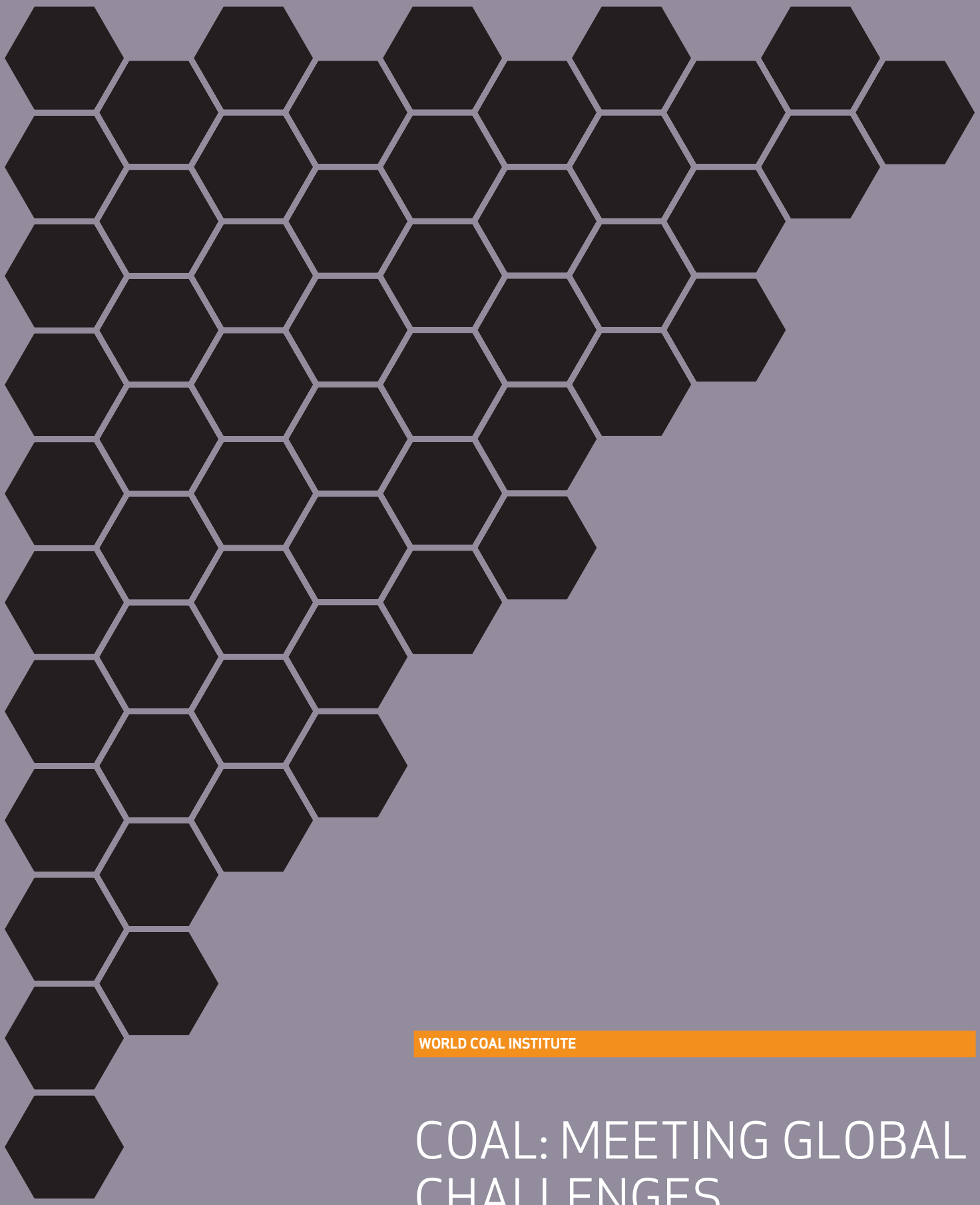


WORLD COAL INSTITUTE

COAL: MEETING GLOBAL CHALLENGES

COAL: MEETING GLOBAL CHALLENGES

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.
- As the most important fuel for electricity generation and a vital input into steel production and other industrial processes, coal will have a major role to play in meeting future energy needs.
- Coal liquefaction allows coal to act as a substitute for crude oil; synthetic gas can also be produced from coal.
- In most circumstances coal is cheaper per energy unit than other fuels. As a result, it has remained the fuel of choice for electricity generation and steel production on a global basis and is likely to remain so for several decades.
- Coal prices are consistently more stable than oil and gas prices, reflecting coal's widespread availability and diverse and competitive markets.
- Coal has a unique role to play in meeting the demand for a secure energy supply. It is abundantly available, affordable, reliable, geographically and politically well-distributed, and easy and safe to transport.
- Environmental effects of electricity production are a concern for us all. The challenge for coal – as for all fossil fuels – is to reduce its greenhouse gas and other emissions, while continuing to make a major contribution to global development and energy security.
- Coal is on a technology pathway that has already delivered major environmental improvements. Further technical solutions include improved combustion efficiency and reduced emissions, coal gasification, carbon capture and storage, and the production of hydrogen from coal.
- Carbon dioxide capture and storage offers the potential for major reductions in CO_2 emissions from coal consumption, approaching zero emissions.
- Constructive partnerships between energy producers, energy consumers and governments are essential to ensure demand for affordable and reliable energy is met, while managing sustainable development and energy security.

Copies of all World Coal Institute publications and further information on the coal industry are available on our website: www.worldcoal.org

World Coal Institute

Contents

INTRODUCTION

COAL: MEETING GLOBAL CHALLENGES

>> Coal has a vital role to play in meeting the global challenges of the 21st century. >>

In 2003, the World Coal Institute (WCI) published *The Role of Coal as an Energy Source* examining the important contribution of coal to the global energy mix. The report specifically focused on the use of coal in electricity generation and was shaped by the energy context at that time, most notably the outcomes of the World Summit on Sustainable Development, held in Johannesburg in September 2002. 'Sustainable development' dominated the energy agenda.

While sustainable development has not diminished in importance, the global energy scene faces fresh challenges and new developments. The World Coal Institute has taken the opportunity to reappraise coal's role as an energy source in light of these challenges in *Coal: Meeting Global Challenges.*

One of the most notable issues to have emerged since 2003 is energy security. Ensuring secure, reliable, affordable supplies of energy is a serious concern in the world today and coal has a vital role to play. *Coal: Meeting Global Challenges* looks in more detail at energy security concerns, while the WCI report *Coal: Secure Energy (2005)* specifically focuses on this issue.

The world faces challenges associated with poverty. Over 1.6 billion people worldwide do not have access to electricity. Access to energy is essential to alleviating poverty – it is a fundamental driver of economic development and contributor to people's quality of life. *Coal: Meeting Global Challenges* looks at the contribution of coal to social and economic development worldwide.

Environmental challenges have also evolved. The entry into force of the Kyoto Protocol in February 2005 was a significant step in moving the environmental agenda forward, with increasing attention being paid to future action. In *Coal: Meeting Global Challenges,* the World Coal Institute renews its call for increased awareness and acceptance of the significant role played by clean coal technologies in reducing environmental impacts associated with coal consumption. *Coal: Meeting Global Challenges* looks at progress made and what more needs to be done to allow coal to continue to play its vital role worldwide without a negative impact on the environment. Carbon capture and storage in particular offers the potential to reduce carbon dioxide emissions from coal use to near zero levels.

With global energy demand expected to rise by 52% over the next 30 years and fossil fuel consumption projected to increase, calling for a cut in energy consumption is not a sufficient solution to the challenges we face. *Coal: Meeting Global Challenges* reviews all of these issues against the evolving energy context and highlights that coal has an important role to play in meeting global energy demand in the 21st century.

INTRODUCTION END

SECTION ONE

ENERGY IN THE 21ST CENTURY

>> The 21st century global energy context is dominated by demand growth. >>

"Tackling climate change and promoting clean technologies, while pursuing energy security and sustainable development will require a global concerted effort over a sustained period," G8 Communiqué 2005.

Global economic growth, the primary driver of energy demand, is conservatively forecast to average 3.2% per annum between 2002 and 2030. Population growth will continue, with the world population expected to reach over 8 billion by 2030, from its current level of 6.4 billion [UN 2004].

Over the last ten years, world primary energy demand has risen by 25%, an upward trend that is set to continue [BP 2005]. International Energy Agency (IEA) projections indicate that demand for energy will increase by half again between now and 2030, with more than two-thirds of this increase coming from developing countries.

Fossil fuels will continue to dominate energy consumption – accounting for around 85% of the increase in world primary energy demand over the next 30 years. While nuclear energy provides a significant proportion of energy in some economies, it can face very long permitting and construction cycles and private financing is difficult to find. Renewable energies are growing fast but from a small base and by 2030 they are still only expected to meet 14% of total energy demand [IEA 2005a].

The forecast growth in demand will not alleviate the major concerns around energy poverty. In 2000, only one in six people worldwide had the access to energy required to provide the high living standards enjoyed in the developed world. These one billion people consumed over 50% of the world's energy supply, while the one billion poorest used only 4% [WBCSD 2004]. As UN-Energy has stated: "This situation entrenches poverty, constrains the delivery of social services, limits opportunities for women, and erodes environmental sustainability at the local, national and global levels".

Energy is essential to poverty alleviation. All fuel sources will be needed – but as the most abundant and affordable of all the fossil fuels, the role of coal will be vital.

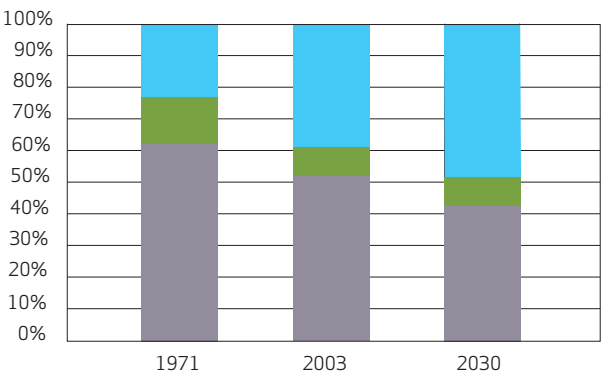
Coal will continue to play a significant role in meeting energy demand worldwide. The world currently relies on coal for 40% of its electricity and 66% of steel production is dependent on coal. Many countries rely on coal for much greater proportions of their electricity – South Africa, China, and India, for example, use their large, indigenous supplies of coal to generate most of their electricity. In the future, coal conversion technologies will make synthetic gas and liquid transportation fuels derived from coal an attractive alternative. Coal also plays an important role in cement manufacturing and other industrial processes.

The abundance, affordability, and geographical and political diversity of coal are important in a world ever more concerned with energy security. At the same time, environmental impacts associated with our energy consumption must be addressed. Society is demanding cleaner energy and less pollution. The coal industry is looking ahead and responding to the call for improved environmental performance through the use and continued development of clean coal technologies.

All forms of energy have positive and negative attributes. But given that energy demand is going to continue to rise and many challenges have to be met, we have to review our energy options and balance these responsibly and reliably. Constructive partnerships between energy producers, energy consumers and governments will be essential to meeting global energy demand and achieving sustainable development, energy security and improved environmental performances this century.

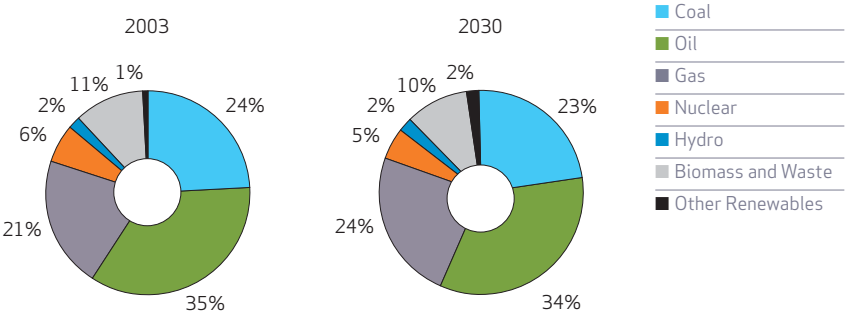
SECTION ONE END

Regional Shares in World Primary Energy Demand



Source: IEA 2005a

Total World Primary Energy Consumption (% by Fuel)



Source: IEA 2005a

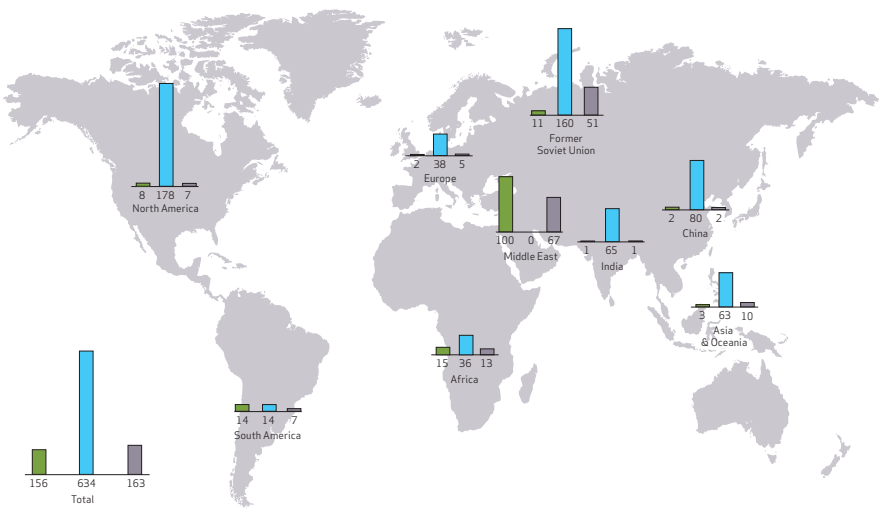
SECTION TWO

COAL – PROVIDING ENHANCED SECURITY

>> As global demand for energy continues to rise, energy security concerns will become ever more important. >>

Energy security: "…the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices…" UNDP 2004.

Location of the World's Main Fossil Fuel Reserves (Gigatonnes of oil equivalent)



* Values below 0.5 Gtoe have been rounded down to 0

Sources: BP and World Energy Council

To provide solid economic growth and to maintain levels of economic performance, energy must be readily available, affordable and able to provide a reliable source of power without vulnerability to long-term or short-term disruptions.

Different sources of energy meet different needs – some are best suited to baseload generation, others to peak load, and others to meeting environmental considerations. A diverse mix of energy sources – each with different advantages – provides security to an energy system by allowing flexibility in meeting each country's needs.

Coal has particular attributes that make a positive contribution to energy security as part of a balanced energy mix.

Abundant Resources

Coal reserves are significantly more abundant and much more widely and evenly dispersed than other fossil fuels – oil and gas reserves are tightly concentrated in the Middle East and the Former Soviet Union (see map). There is no doubt that there are sizeable worldwide reserves of coal – at current production and consumption rates over 160 years' worth is available [BP 2005].

This is in contrast to 'conventional' oil and gas with various forecasts indicating a depletion of supplies as early as the middle of this century.

While renewable energies cannot be considered by the same measure of resource availability, there are issues of concern regarding their availability – in particular their reliability and intermittency. Nuclear energy also faces availability concerns, although these revolve around political acceptability rather than resource availability.

Coal is a truly global industry – it is mined commercially in over 50 countries and is used in over 70 via a well-supplied, competitive international market.

Coal markets are well-functioning and responsive to changes in supply and demand.

Coal can be transported to demand centres quickly, safely and easily by ship and rail. The world currently consumes over 5.5 billion tonnes of coal for use in power generation, steel production, cement manufacture, as a chemical feedstock and as a liquid fuel [IEA 2005b]. The largest coal producing countries are not confined to one region (see table on page 9).

Coal can be transformed to liquid and gaseous fuels to guard against oil import dependence and price shocks – South Africa has a well-established coal-to-liquids industry and China is currently adopting this technology.

Energy Security

Coal has long been and will remain one of society's most secure forms of energy, offering many advantages.

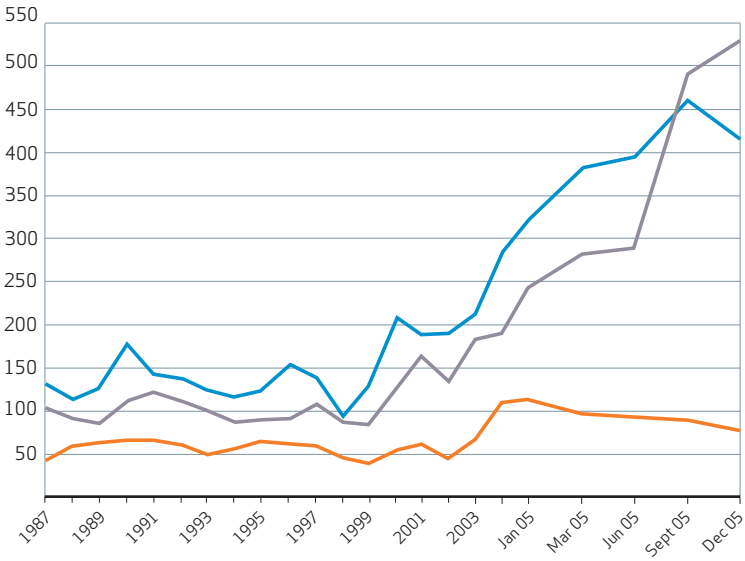
- **Coal is abundant and widespread.**
- **Major developed and developing economies have large indigenous coal reserves.**
- **Coal is readily available from a wide variety of sources in a well-supplied worldwide market.**
- **Coal is affordable.**
- **Coal is safe to transport and store.**
- **Coal-based synthetic gas and liquid transportation fuels will be available in greater quantities in the future.**
- **Coal can be stockpiled at mines, power stations, or intermediate locations.**
- **Coal-based electricity is well-established and highly reliable.**
- **Coal is not dependent on weather or rainfall.**

"...if we do not do something to prevent it, the EU will import 90% of its oil and 80% of its gas by 2030," Andris Piebalgs, EU Energy Commissioner.

Energy Price Trends (US$ per tonne of oil equivalent)

Oil
Gas
Coal

Sources: BP 2005; NYMEX; IEA 2006a; MCR 2005



China is building a commercial scale direct liquefaction plant in Inner Mongolia, which will produce around 160,000 barrels a day of finished gasoline and diesel fuel.

These technologies are also being strongly considered in the USA and in other countries. Coal gasification is a further example where indigenous (or imported) fuels can be transformed to address environmental concerns while enhancing energy security.

Affordability

Coal is an affordable source of energy. Coal prices have historically been lower and more stable than oil and gas prices on an equivalent energy basis, and despite the growth of index and derivative based sales in recent years, this is likely to remain the case (see graph). In addition, overall costs for coal power stations are usually lower than for alternative power generation. Coal will remain one of the key choices for baseload electricity generation.

In countries with energy intensive industries, the impact of any fuel and electricity price increases will be compounded. High prices can lead to a loss of competitive advantage and in prolonged cases, loss of the industry altogether. Countries with access to indigenous energy supplies, or to affordable

fuels from a well-supplied world market, can avoid many of these negative impacts, enabling further economic development and growth.

As a truly global industry, coal will have an important role to play in helping to meet the challenge of energy security.

SECTION TWO END

Top Ten Coal Exporters

Australia	219 Mt
Indonesia	107 Mt
PR China	86 Mt
South Africa	67 Mt
Russia	65 Mt
Colombia	52 Mt
USA	43 Mt
Canada	27 Mt
Kazakhstan	22 Mt
Poland	20 Mt

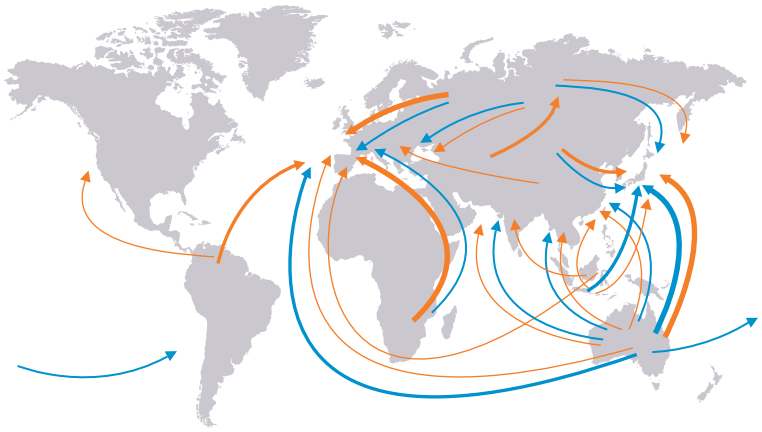
Source: IEA 2005b

Top Ten Hard Coal Producers

PR China	1956 Mt
USA	933 Mt
India	373 Mt
Australia	285 Mt
South Africa	238 Mt
Russia	210 Mt
Indonesia	129 Mt
Poland	100 Mt
Kazakhstan	83 Mt
Ukraine	62 Mt

Source: IEA 2005b

Main World Coal Trade Flows 2004



Coking
Steam

Source: IEA 2004

SECTION THREE

COAL – TACKLING POVERTY

>> The number of people living on less than $1 a day has been estimated at 1.1 billion. >>

"…growth is the best antidote to poverty."
Palaniappan Chidambaram, Minister of Finance, India, 2006.

Almost half of the population of Africa lives in this state of extreme poverty – a proportion that has actually grown worse over the past two decades [Sachs 2005].

There are currently 1.6 billion people – or 25% of the global population – without any access to electricity. A further 2.4 billion people rely on primitive biomass 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 [IEA 2004].

This is a huge challenge. IEA studies have projected that a total of US$200 billion of investment in electricity will be needed to help halve the proportion of people living on less than US$1 a day by 2015. This is in addition to the US$5.8 trillion needed just to meet existing projections in electricity demand [IEA 2004].

At the United Nations Millennium Summit in September 2000, world leaders agreed to a set of time-bound targets for tackling poverty, hunger, illiteracy, gender inequality, disease, and environmental degradation – the eight 'Millennium Development Goals' (MDGs). While there is no MDG specifically on energy, access to energy services is vital to the achievement of all these goals [UNDP 2005]. This link was also recognised at the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, where the priority was placed on sustainable development, incorporating economic, social and environmental sustainability.

While energy services themselves are not sufficient to eradicate extreme poverty, they are necessary to create the conditions for economic growth and improved social equality.

Coal has a critical role to play in extending access to energy worldwide. Coal underpins the economic and social development of many countries, as well as providing the support infrastructure for such development to occur.

Coal and Electrification

Coal plays an important role in providing affordable electricity worldwide – 40% of global electricity is coal-based. In many countries, the use of coal in electricity generation is even more significant (see table on page 12). The availability of affordable, abundant supplies of coal has been significant in the social and economic development of many countries. The IEA projects that the key role provided by coal will continue, with coal use in power generation projected to almost double in the next three decades [IEA 2004].

The situation in sub-Saharan Africa gives an example of how coal-based electricity can make a valuable contribution to raising electrification levels and aiding development. Access to the electricity grid in sub-Saharan

Alleviating Poverty – the Importance of Coal

- **Coal produces 40% of the world's electricity (twice as much as the next largest source) and around 66% of the world's steel.**
- **Coal is also important to cement manufacturing, other industrial processes, and can be used as a liquid fuel.**
- **Coal is the fastest growing fuel, rising 6.3% globally in 2004.**
- **The power sector's share of global coal demand will rise from 69% in 2002 to 78% by 2030.**
- **The benefits amount to a gain of billions of dollars to developed and developing countries alike.**
- **Coal is a valuable indigenous source of energy for many developing countries, such as India, China, Indonesia and South Africa.**
- **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.**
- **Around 1 billion people have gained access to electricity via coal in the past two decades.**
- **Coal directly provides 7 million jobs worldwide and coal production is the key economic activity in many communities.**

Sources: IEA, BP, WCI, UN

Africa has slowly increased, from 9% of the population in 1970 to 24% in 2005 (just over 20% if South Africa is excluded). However, despite this growth, around 500 million people are still living without electricity [World Bank 2006]. A further 575 million people rely on biomass for their energy [IEA 2004]. The extensive use of traditional biomass is incompatible with sustainable development.

Coal's role in electricity generation worldwide

South Africa	93%
PR China	79%
Israel	77%
Kazakhstan	70%
India	68%
Morocco	68%

Source: IEA 2005b

>> The energy needs of a growing population can lead to 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 36% in 1994 to 71% at the end of 2004, with rural electrification increasing from 12% to 51%. Over 3 million homes have been electrified since 1994 [Eskom 2006]. The electrification programme 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 2004, coal-fired generation accounted for nearly 92% (202TWh) of the power produced by South Africa's national electricity utility, Eskom; all of it fuelled by low-cost, locally sourced coal [Eskom 2006].

China also offers a striking example of the link between coal-based electrification and development. Over the past 20 years, China has connected some 700 million people to the electricity system. The country is now 99% electrified, the same level as most developed countries. Electrification was a vital component of its poverty alleviation campaign in the mid-1980s, which built up the basic infrastructure and created local enterprises. As a result, from 1985 to 2003, electricity production in China rose by over 1500 TWh, of which around 80% is coal-fired. China's economy grew by an annual rate of 9.5% during this period [IEA 2006b].

Coal and Economic Development

Surveys of the business and investment climate have consistently found that lack of electricity services is a "major and frequently severe obstacle to doing business" [World

Bank 2006]. Modern energy can greatly increase productivity. Electricity enables households to engage in activities that generate income – by providing lighting that extends the workday and powering machines that increase output. Electricity also raises the productivity of small businesses and shops and powers telecommunications.

Affordable supplies of energy are therefore essential. 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 prices have generally 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
- shipping costs have been reduced.

Coal is currently mined in over 50 countries, and worldwide the industry directly employs some 7 million people [WCI 2001]. 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.

Hundreds of millions of women and young girls spend hours every day gathering fuel wood and carrying water for basic subsistence needs. Photo courtesy: IFAD/F. Mattiolo

Investing in the Local Community

Coal provides a significant direct contribution to economic development at a local level, particularly in developing countries. 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.

Coal companies are actively involved with the local communities in which they operate. Education and skill development programmes 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. Improving the education and skill levels of the local community helps to attract further investment and thereby sustains the community after mine closure.

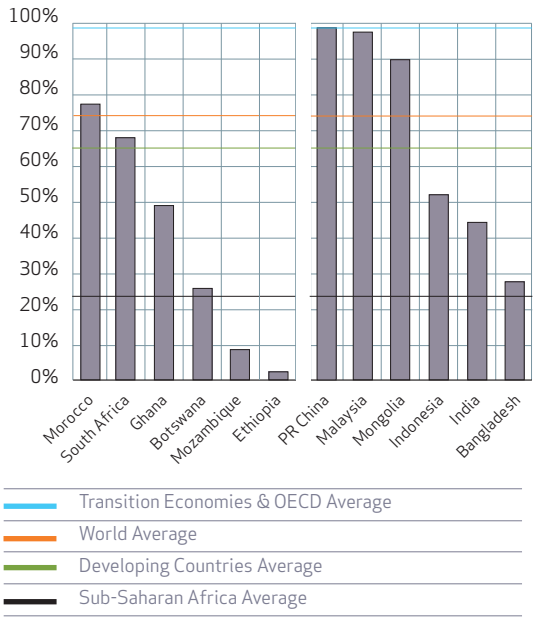
Some coal companies operate in areas facing severe challenges, where they have become closely involved in local projects aimed at overcoming them. In South Africa, for example, HIV/AIDS is having a major impact on public health and poses a significant threat to labour productivity and sustainable economic development. Sub-Saharan Africa has just over 10% of the world's population but is home to more than 60% of all people living with HIV – 25.8 million [UN AIDS 2005]. Coal producers in South Africa actively engage in the fight against HIV/AIDS - this includes actions not only in the workforce but also in the wider community.

For Anglo Coal South Africa, for example, initial efforts were focused on awareness, education and prevention but have now extended to include concrete steps to minimise the impact of HIV/AIDS and to improve the care of those affected. In 2002, Anglo Coal South Africa introduced an anti-retroviral therapy (ART) programme for employees with HIV or AIDS. The HIV prevention programmes extend to neighbouring communities, aimed at youth, expectant mothers and high-risk groups such as migrant workers and sex workers.

Anglo Coal is also involved in the collaborative Powerbelt HIV/AIDS Project. This initiative involves Xstrata Coal, Ingwe, Sasol, Anglo Coal and their associated industry partners and various governmental departments, who are working to implement sustainable long-term initiatives focused on managing and preventing the spread and transmission of HIV/AIDS within the community.

SECTION THREE END

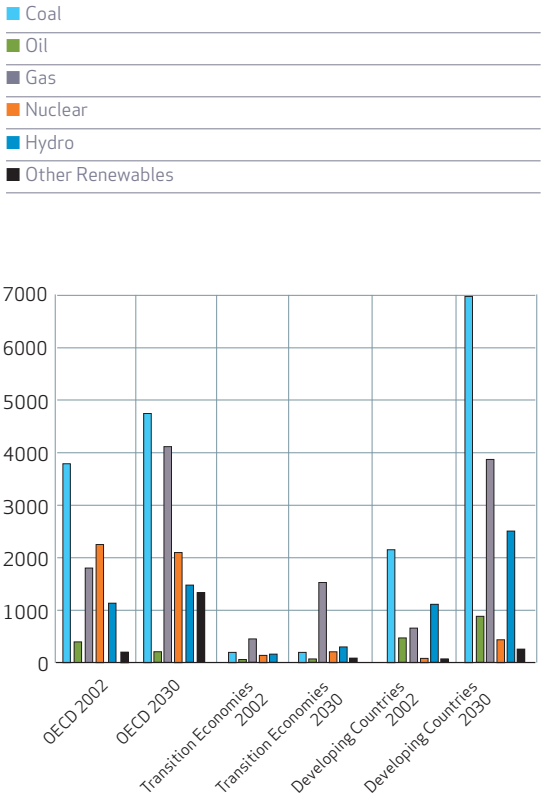
Electrification Rates for Selected Developing World Countries*



Source: IEA 2004

* Electrification rates indicate the number of people with electricity access as a percentage of the total population. Electricity access is defined by the IEA as the number of people who have electricity in their home. It comprises electricity sold commercially both on-grid and off-grid.

Fuel Shares in Electricity Generation (TWh)



Source: IEA 2004

SECTION FOUR

COAL – IMPROVING ENVIRONMENTAL PERFORMANCE

>> Most human activities have environmental consequences and all forms of energy raise their own environmental issues.>>

The coal industry is continuing to improve its environmental performance by working to ensure that coal is produced and used efficiently and that the opportunities for technological advancement are fully and vigorously pursued. Coal's technical response to its environmental challenges is ongoing and multifaceted[1]. There are essentially three core elements.

>> Reducing emissions of pollutants, such as particulate matter and oxides of sulphur (SOx) and nitrogen (NOx) to near zero levels. This has largely been achieved and the issue now is the application of 'off-the-shelf' technology.

>> Increasing thermal efficiency to reduce CO_2 and other emissions per unit of electricity generated. Major gains have already been achieved and further potential can be realised.

>> Reducing CO_2 emissions to near zero levels. The development of near zero emission technologies has commenced and is accelerating rapidly.

A fourth area of development is the potential for coal to provide an essential source of hydrogen for completely clean future energy systems for stationary and transport applications.

Reducing Emissions of Pollutants

A range of options already exist to improve the environmental performance of conventional coal-fired power stations. At a very basic level, the use of coal in modern coal-fired power stations 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 by the World Health Organisation that 1.6 million deaths a year in developing countries are associated with the inhalation of indoor smoke from the use of solid fuels [WHO 2002].

Coal cleaning by washing and beneficiation continues to play an important role in reducing emissions from coal-fired power stations. Particulate emissions can be reduced through the utilisation of electrostatic precipitators, fabric filters, wet particulate scrubbers and hot gas filtration systems. Technologies have also been developed to reduce and, in some cases, almost eliminate emissions of SOx and NOx.

Efficiency Improvements

Improving the efficiency of existing and new coal-fired power plants is a cost-effective way to limit the growth of CO_2 emissions. Significant advances have been made in improving efficiencies worldwide.

In many developing countries the efficiency of coal use is still at the level reached by OECD countries over 50 years ago. The average efficiency of coal-fired generation in

CO_2 Reduction through Efficiency Increases

Potential of Coal-based Power Generation in China, India and Russia, which Account for Some 40% of Global Coal-fired Power Plant Capacity

	Unit	China	India	Russia	**Total**
Coal-based power generation	TWh/year	1139	435.8	544.6	**2119.4**
Average efficiency	%	30	30	27.9	**29.5**
Average CO_2 emissions	t CO_2/MWh	1202	1120	1325	**1216**
CO_2 emissions for efficiency of 33%	t CO_2/MWh	1090	1020	1120	**1083**
CO_2 emissions reduction	Mt/year	127.6	43.6	111.6	**282.8**

Source: CIAB 2005

Life Cycle Issues

In quantifying greenhouse gas (GHG) emissions associated with a power station or factory, it is important to consider the entire process chain. The complete life cycle, encompassing emissions from fuel production, processing, storage, transportation and distribution, as well as fuel combustion, needs to be accounted for. Life Cycle Analysis (LCA) provides a systematic approach to measuring resource consumption and environmental releases associated with different processes.

Over 90% of the life cycle GHG 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 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) requires large amounts of energy.

On a full life cycle basis, GHG emissions from coal-based generation may not be significantly different from those of gas-based electricity. These are essential considerations when policy decisions are being made on the basis of the environmental impacts of fuels.

Sources: IEA CCC 2005a and CISS

[1] More detailed information on clean coal technologies and their use can be found in the World Coal Institute report *Clean Coal – Building a Future through Technology (2004).*

The 3900MW Niederaussem lignite-fired power plant in Germany has an efficiency level of 43%. Compared with average European efficiencies for a similar plant, it has saved 3 million tonnes of CO_2 per annum.
Photo courtesy of RWE Power

the OECD was 36% in 2002, compared with just 30% in developing countries. This means that one unit of electricity produced in developing countries emits almost 20% more carbon dioxide than a unit of electricity produced in an OECD coal plant [IEA 2004]. It is estimated that the worldwide average efficiency of coal power stations is below 32%, while new units using supercritical steam conditions can reach efficiencies greater than 46% [IEA CCC 2005b].

There are very large potential benefits from the transfer of modern combustion techniques from developed to developing countries. More than 240 high efficiency 'supercritical' units are in operation worldwide, including a number in developing countries. China, for example, currently has 22 supercritical units in operation, fuelling almost 14 GW of electricity. There are also 24 ultrasupercritical units operating worldwide, which achieve even higher efficiencies, with units in Denmark, Germany, Japan, the Netherlands, and USA [IEA CCC 2005c].

Another major technology stream – the gasification of coal in integrated combined cycle (IGCC) systems – is becoming increasingly well-understood and commercially practical. Some 2700 MW of this type of plant are now operating and another 1700 MW are planned for the future [IEA CCC 2005c]. IGCC offers high efficiencies, typically in the mid-40% range, although plant designs with close to 50% efficiencies are available. Further development and support of IGCC offers the prospect of net efficiencies of 56%. The appeal of IGCC technology also extends beyond the potential for increased efficiencies and further reductions in pollutants. IGCC technology may be one pathway for the near zero emissions system of the future, using carbon dioxide capture and storage.

Improvements in environmental performance can also be achieved when coal is used to complement renewable energy. Coal provides convenient, flexible, cheap baseload power while inherently more erratic renewables can be used to meet peak needs. It is no coincidence that countries with the highest penetrations of wind power also have high proportions of coal-fired capacity in their systems (see table).

The economics and efficiency of modern biomass fuels can also be greatly improved by co-firing the materials with coal. Co-combustion with fuel crops – such as sugar-cane bagasse – already occurs, enhancing cost-effectiveness and encouraging the use of a carbon-neutral resource. Up to 10% biomass can be utilised in existing conventional power stations with no need for modification, reducing greenhouse gas emissions by up to 10%.

Fuel Shares of Electricity Generation (%)

	Installed Wind Capacity 2003 (GW)	Coal	Solar Wind	Gas	Hydro	Nuclear	Oil	Others
Germany	14.6	50.7	4.2	10.3	3.4	27.9	0.6	2.9
USA	6.4	50.5	0.4	17.5	6.6	19.7	3.3	2.0
Spain	6.2	28.9	5.6	20.1	11.4	22.9	8.6	2.5
Denmark	3.1	46.4	16.5	24.2	0.1	-	4.1	8.9
India	2.1	68.3	0.6	11.5	11.9	2.8	4.6	0.3

Source: WCI 2005

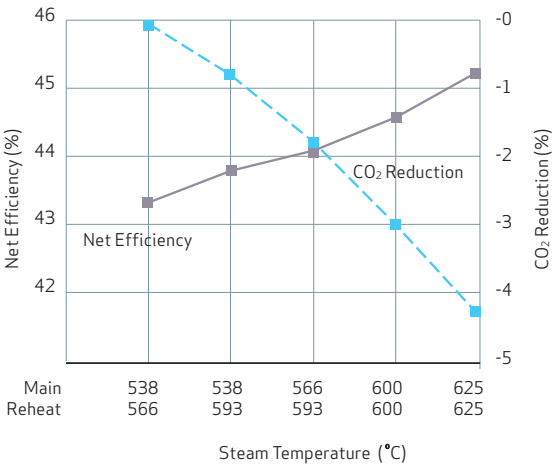
Reducing CO_2 Emissions

While efficiency improvements will play a vital role in reducing CO_2 emissions from coal-fired power stations, particularly in the short to medium term, further steps will be necessary to make the significant reductions in CO_2 needed. Carbon dioxide capture and storage (CCS) offers a longer term option for achieving near zero CO_2 emissions.

CCS technologies enable emissions of carbon dioxide to be 'captured' and 'stored'; that is stripped out of the exhaust stream from coal combustion or gasification and stored in such a way that they do not enter the atmosphere. CO_2 separation, capture and geological storage technologies have been developed beyond the stage of technical feasibility. Researchers and technicians are improving these technologies and working to demonstrate them in integrated configurations. In fact, all of the present day coal-fired technologies for power generation could be adapted to capture 80-90% of the CO_2 they release [IEA CCC 2005d].

Steps are being taken to push CCS technology forward. Projects such as Sleipner and Weyburn are demonstrating the viability of CO_2 storage options. New projects have been announced, including a storage project in Australia, a joint UK-China agreement on clean coal technologies together with CCS, the CASTOR project in Denmark demonstrating CO_2 capture, and an IGCC plus CCS project in Germany.

Efficiency Increases & CO_2 Reductions at Supercritical Power Plant

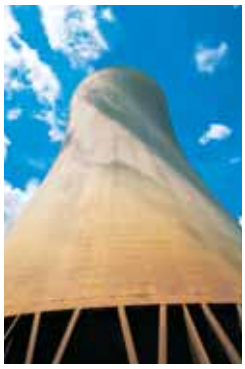


Source: Mitsubishi Heavy Industries Ltd

The FutureGen project[2] is a US$1 billion public-private partnership to build a coal-fuelled, IGCC plus hydrogen production plant, incorporating CO_2 separation together with geological storage. In Australia, the COAL21 Fund is supported by up to US$225 million from Australian coal companies. Numerous other governments are also initiating programmes of work for the further development of CCS, with the aim of lowering its costs and further demonstrating its viability.

An important development for CCS in 2005 was the publication of the Intergovernmental Panel on Climate Change (IPCC) *Special Report on Carbon Dioxide Capture and Storage.*

[2] Member companies are contributing up to US$250 million to help fund project development and include: American Electric Power; Anglo American; BHP Billiton; the China Huaneng Group; CONSOL Energy Inc; Foundation Coal; Kennecott Energy; Peabody Energy; and Southern Company.



The coal industry is continuing to improve its environmental performance by working to ensure coal is produced and used efficiently.
Photo courtesy of Stanwell Corporation Ltd.

The IPCC report has been significant in raising awareness of the role CCS can play in future climate change mitigation and enhancing its scientific credibility to a wider audience. The IPCC report found that: "…including CCS in a mitigation portfolio is found to reduce the costs of stabilising CO_2 concentrations by 30% or more". It also stated that most existing CCS technologies are mature or economically feasible under specific conditions and that CCS could contribute "…15-55% to the cumulative mitigation effort worldwide until 2100, averaged over a range of baseline scenarios". The report determined that leakage from appropriately managed geological storage sites was very likely to be less than 1% over 100 years, and likely to be less than 1% over 1000 years [IPCC 2005].

International Support

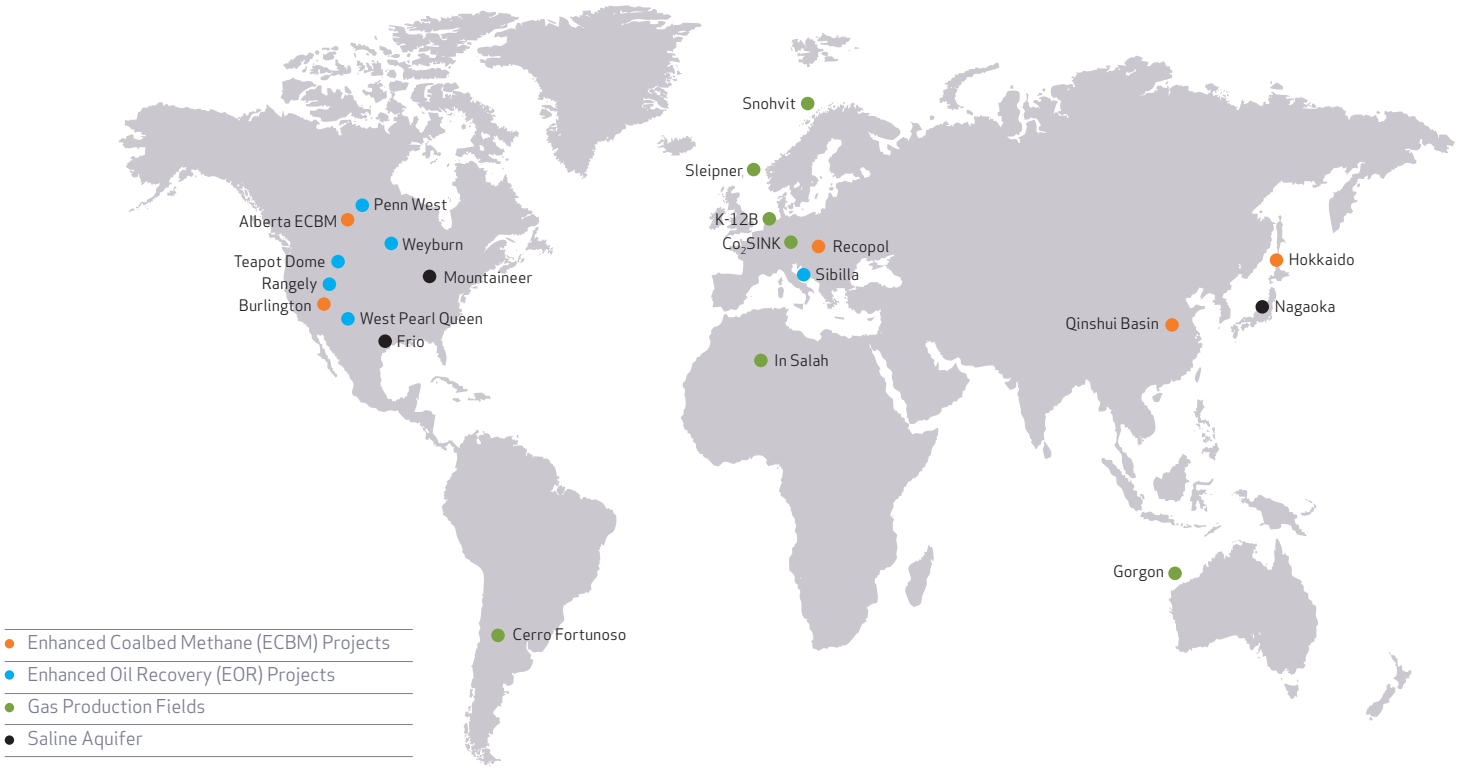
The publication of the IPCC report was also important in that it meant that CCS as a climate change mitigation option was discussed in Montreal at the first Meeting of the Parties serving as the Conference of Parties to the Kyoto Protocol (COP/MOP 1) and the eleventh Conference of the Parties (COP 11) to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2005. The IPCC report enabled technology solutions to GHG emissions to be discussed on an international stage, finally allowing technologies to receive due consideration and support. It also raised the issue of allowing carbon dioxide capture and storage projects to be included under the Clean Development Mechanism (CDM), which if permitted will also be vital in supporting the use of CCS technologies in developing countries.

The role of technologies in meeting the environmental challenges facing coal was given further attention in 2005 with the formation of the Asia-Pacific Partnership on Clean Development and Climate (AP6). AP6 consists of representatives from Australia, China, India, Japan, South Korea and the USA, who will develop and share cleaner, more efficient technologies that will meet climate concerns without negatively effecting economic growth. This includes an emphasis on cleaner fossil fuels. International collaboration on CCS is also being assisted by the Carbon Sequestration Leadership Forum (CSLF), an international initiative focusing on the development of cost-effective technologies for carbon dioxide capture and storage.

Such partnerships are key to making future advances in the environmental performance of our energy systems. Investment and cooperation on an international stage is essential to push these technologies forward – and give rise to environmental benefits for us all.

CO_2 Storage Demonstration Projects

Source: IEA Greenhouse Gas R&D Programme



Towards a Hydrogen Economy

And what of the longer term future? Research continues into energy systems for further into this century, such as a move towards hydrogen. The option for hydrogen to be used to produce electricity from fuel cells, both for stationary power production and for use in electric vehicles, is a promising one. However, a key uncertainty surrounding the widespread uptake of fuel cells relates to the availability of hydrogen. Hydrogen does not naturally occur in usable quantities so it would have to be manufactured. Fossil fuels are one possible source and 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.

SECTION FOUR END

SECTION FIVE

POLICY MEASURES

We face many challenges in meeting energy demand in the 21st century and balancing the goals of energy security, poverty alleviation and environmental improvements. Difficult decisions lie ahead.

It will be essential for all options available to us to be considered and for demands to be carefully balanced. Within this framework, coal's contribution to future energy systems will be vital. In terms of simply meeting global demand, the use of coal will be essential. When wider priorities are also considered, the role of coal becomes ever more significant.

Challenges remain with the use of coal, as they do with the use of all energy sources. The coal industry is looking ahead, investing and researching solutions to the challenges associated with the production and use of coal.

While international collaboration and strategic partnerships are essential in meeting our energy challenges, appropriate policies will also be essential. Governments have a crucial role to play in establishing an appropriate and stable policy context for investment in state-of-the-art coal plants.

Existing policies and mechanisms, such as those of the Kyoto Protocol, do not provide all the incentives necessary to address the challenges of our energy systems and further action is needed. A number of measures may be taken that will allow coal to fulfil its vital role in our energy future.

>> Policy support for clean and efficient use of coal in power generation can encourage the take up of existing advanced technologies for low emissions coal-fired electricity production – providing secure and clean energy. New incentives and mechanisms may be necessary to fully achieve this objective.

>> Policy support is needed for technology transfer to developing countries, through mechanisms such as the Clean Development Mechanism, bilateral and multilateral funds such as the Global Environment Facility and the Prototype Carbon Fund.

>> Policy support to reduce investment uncertainty, through good governance, transparency and long-term planning can facilitate the immense amounts of investment needed in the energy sector to meet growing demand, particularly in developing countries.

>> Policy support for research, development and demonstration into technologies such as carbon capture and storage can provide a very significant opportunity for the major reductions in emissions that are required by our modern societies.

>> Policy support can address environmental concerns in a non-discriminatory manner – while recognising the benefits that a diverse and secure energy mix can bring. Clear, long-term environmental policies provide certainty, allowing investments to be made in advanced coal technologies that bring enhanced environmental performance.

Progress has been made over recent years and the vital role of coal as an energy source is once again receiving wider recognition. The coal industry warmly welcomes these positive developments and looks forward to further collaborative opportunities both with other energy industry participants and more widely.

Coal is an energy source for the future and as an industry we are ready for the opportunities and challenges which lie ahead.

SECTION FIVE END

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World Coal Institute

WORLD COAL INSTITUTE

» The World Coal Institute is the only organisation working on a global basis on behalf of the coal industry. «

The World Coal Institute promotes:

» Coal as a strategic resource, essential for a modern quality of life, a key contributor to sustainable development and an essential element in enhanced energy security.

and represents:

» A progressive industry, committed to technological innovation and improved environmental outcomes within the context of a balanced and responsible energy mix.

The World Coal Institute is a non-profit, non-governmental association, funded by coal enterprises and stakeholders and operated by a London-based Secretariat.

The objectives of the World Coal Institute are to:

» Provide a voice for coal in international policy discussions on energy and the environment;

» Promote the role of clean coal technologies in improving the environmental performance of coal;

» Highlight the valuable role affordable and abundant coal resources play in a world ever more concerned with energy security;

» Improve understanding of the importance of coal as the single largest source of fuel for electricity generation, and its vital role in other industries – including steel production, cement manufacturing, chemicals and liquid fuels;

» Form strategic partnerships and alliances to coordinate actions and maximise resources to improve the perception of coal worldwide;

» Ensure decision-makers and opinion formers are fully informed of the contribution of coal to social and economic development;

» Address misconceptions about coal through the production and dissemination of information resources.

The World Coal Institute has strong contacts and relationships with important international agencies, including the International Energy Agency and the World Bank, and has accredited consultative status with the United Nations.

Membership is open to coal enterprises worldwide, including coal associations, with members represented at Chief Executive level.

For more information on the activities of the World Coal Institute, please visit our website: www.worldcoal.org

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Coal: Meeting Global Challenges updates the 2003 WCI report *The Role of Coal as an Energy Source*

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