In 2003, the International Energy Agency published the World Energy Investment Outlook, a first-ever attempt to quantify global energy investment needs, fuel-by-fuel and region-by-region. The outlook shows world energy demand rising by two thirds between now and 2030, and a faltering world economy if these energy supplies are not available. Uniquely, it estimates the level of investment needed. The sums are daunting and demand the right investment climate so that industry can respond in a positive and timely way.

In its response to the World Energy Investment Outlook, the IEA Coal Industry Advisory Board offers a perspective from senior executives in the coal-related industries. Their views and recommendations are presented, including over eighty individual responses to specific questions. Topics covered include coal mine and power plant investment, deployment of cleaner technologies, the hydrogen economy, poverty alleviation, carbon trading, market liberalisation and energy security. Numerous recommendations are made, but a common theme is one of collaboration to ensure a deeper understanding of what can be achieved if barriers to investment are removed.

This collection of CIAB responses, their summary and a record of the CIAB’s debate is published under the authority of the Executive Director of the IEA to promote discussion of the important issues they raise. It contains the views and recommendations of CIAB Members and does not necessarily reflect the views or policies of the IEA or of the IEA member countries.
Investment in Coal Supply and Use

An industry perspective on the IEA World Energy Investment Outlook
The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six of the OECD’s thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- to operate a permanent information system on the international oil market;
- to improve the world’s energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

The IEA member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission takes part in the work of the IEA.

The Organisation for Economic Co-operation and Development (OECD) is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to coordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

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COAL INDUSTRY ADVISORY BOARD

The Coal Industry Advisory Board (CIAB) is a group of high-level executives from coal-related industrial enterprises, established by the International Energy Agency (IEA) in July 1979 to provide advice to the IEA on a wide range of issues relating to coal. The CIAB currently has 40 members from 15 countries accounting for about 75% of world coal production.
FOREWORD BY THE EXECUTIVE DIRECTOR OF THE IEA

In November 2003, the IEA published the World Energy Investment Outlook 2003, a unique study of future investment needs, worldwide, in all parts of the energy-supply chain, including coal. Over the next thirty years, it estimates that USD 16 trillion might be required; a figure that will give policy-makers pause for thought and presents a significant challenge and opportunity for private industry.

The coal-related industries have a role to contribute constructively to the task ahead. An estimated USD 398 billion of the total will be needed for investment in the coal-supply chain, including coal mining, whilst a further USD 1,480 billion is called for to construct new, coal-fired electricity generation plant.

As such, it was a pleasure for me to participate in a meeting, organised by the IEA’s Coal Industry Advisory Board (CIAB) in November 2004, to hear the coal industry’s views on the World Energy Investment Outlook 2003.

To promote debate, and to focus attention on some key investment issues, CIAB Members submitted written responses to a series of ten searching questions. More than eighty responses informed the thinking at our meeting and contain many nuggets of valuable insight on where senior industrialists see obstacles to investment and, importantly, how these might be overcome. Greater co-operation is demanded, not only between coal producers and users, but also between industry and governments to bring forward wider investment into the cleaner, more efficient technologies that would allow coal to be recognised for the contribution it can make to secure, reliable and affordable energy supplies around the globe.

This collection of CIAB responses, their summary and a record of our debate is published under my authority as Executive Director of the IEA to promote discussion of the important issues they raise. It contains the views and recommendations of CIAB Members and does not necessarily reflect the views or policies of the IEA or of the IEA member countries.

Claude Mandil
Executive Director
FOREWORD BY THE CHAIR OF THE CIAB

The innovative IEA study, "World Energy Investment Outlook - 2003 Insights" (WEIO), aims to quantify the magnitude of future investment needs, worldwide, in all parts of the energy supply chain. The estimates suggest a need for USD 16 trillion of energy investment over the next 30 years of which USD 400 billion would be associated with coal supply, largely in mining.

The WEIO work raises many issues and uncertainties in regard to the deliverability of this investment, on which the Coal Industry Advisory Board offered to comment. This report addresses the issues raised from the perspective of CIAB Members operating in developed and developing nations, liberalised and managed markets and engaged in coal production, consumption, equipment manufacture and transportation. It serves as a compendium of Member responses summarised under the main headings of:

- How can coal-fired generation alleviate poverty in developing countries?
- How is investment in the coal industry affected by liberalisation of electricity generation and carbon policies, including emissions trading?
- How can the coal industry contribute to technological advances in the hydrogen economy and in carbon capture and sequestration?
- How can the coal industry contribute to international energy security?

Ten critical questions regarding coal chain investment were formulated from issues raised in WEIO and each CIAB Member was invited to respond on three of their choice. The level of response was very encouraging, resulting in a comprehensive coverage of the issues from all perspectives. The question topics covered electricity's role in alleviating poverty; the impact of market liberalisation on coal chain investment; the role of advanced technologies, such as hydrogen production, integrated gasification combined cycle (IGCC) and carbon sequestration; and, the role of coal as it relates to security of supply concerns.

CIAB Members' responses are summarised, highlighting areas of common consensus as well as points of contention, and points made in discussion at a full meeting of CIAB Members in November 2004 are included. Finally, Members’ responses are included in their entirety, allowing the reader the benefit of a broad perspective on each of the questions.

The summaries, discussion points and compendium of responses provide a unique industry perspective on the issues raised in “World Energy Investment Outlook - 2003 Insights” and will be of interest to governments and policy-makers worldwide.

Preston Chiaro
Chairman
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QUESTIONS POSED AND A SUMMARY OF THE INDUSTRY'S RECOMMENDATIONS

In April 2004, the Chairman of the Coal Industry Advisory Board posed ten questions to Board Members. These are reproduced below along with a summary of the key recommendations for future action that emerged during a meeting of the CIAB held in November 2004. Many countries are represented on the CIAB and Members are engaged in a number of coal-related activities from mining to power generation and steel manufacture. As might be expected, the views and opinions expressed by Members in response to the questions were wide ranging, and these can be found within the main body of the report. The summary presented here reflects not a consensus view, but rather the dominant themes to emerge - individual Member’s views may differ.

Poverty Reduction

1. How can the electrification of the economies of developing countries be accelerated to alleviate poverty, and how may the coal industry aid this acceleration?

Electrification is seen as key to achieving the UN Millennium Development Goals, but poses many challenges, mainly economic. In some developing countries, bringing low-cost coal resources to market might speed electrification, although mobilising capital for infrastructure development is likely to require government intervention, either through policy measures or partnerships with private industry. Where coal-fired power generation is economically attractive, this should not be at the expense of environmental performance - the IEA has a role in encouraging the adoption of clean coal technologies. In this respect, the Kyoto Protocol’s mechanisms (e.g. CDM), whilst positive in concept, are not making a positive impact in respect of clean coal technologies in developing countries - the IEA should promote their wider adoption and propose complementary mechanisms that are more flexible and effective. Finally, coal use should be driven by the principals of sustainable development and the IEA might consider better informing policy makers, by way of case studies, how the social, economic and environmental benefits of sustainable development interact with one another.

Electricity Market Liberalisation and Carbon Policies

2. How is the liberalisation of electricity generation affecting investment in the coal chain?

Where electricity market liberalisation has taken place, profits have generally fallen along with prices, discouraging investment in new coal-fired generation plant, but benefiting consumers. The greater
uncertainty has driven investment towards lower capital cost, gas-fired plants, or towards incremental investments at existing coal-fired plants where continued operation, often at higher capacity factors, can be profitable. Such short-term responses may not be strategically ideal for future prices, electricity supply security or the environment. In developing countries, strong electricity demand growth provides an appetite for investment in coal-fired plants and for the coal to fuel them. In all cases, liberalisation and deregulation will continue to drive coal production towards the lowest-cost regions. However, if policies and regulations continue to deter long-term investments, then investment in the coal chain may be deferred or even avoided.

The IEA should ensure that countries considering market liberalisation learn from the experience of those where liberalisation is largely complete.

3. How will the financing of coal production, rail and port infrastructure and coal-fired generation be achieved given the uncertainty surrounding future carbon policies?

It is clear that, in many cases, uncertain environmental policies, including carbon policies, are impacting the investment in new, coal-fired power generation. For certain atmospheric pollutants, abatement costs are known and investors can balance their risks, but not in the case of carbon dioxide emissions where capture and sequestration technologies are immature.

A different picture emerges for upstream coal supply where, in some key countries, the state continues to marshal investment in rail and port infrastructure in anticipation of strong demand. Improved information on power demand, and plans for new power station and mine development would assist with the timely development of infrastructure.

The IEA could report on the cost of reducing emissions from coal-fired plant, including a comparison with other generation options, to inform policy makers and assist towards better consistency between carbon policies and energy policies.

4. How will emissions trading of greenhouse gases affect coal mine and coal-fired generation development?

In theory, emissions trading is a market mechanism that can achieve a specific greenhouse gas emission reduction at least cost, but permit allocation is beset by equity issues, both national and sectoral. Beyond the risks and uncertainty that trading brings to investment decisions, it may lead to unintended outcomes: excessive gas prices following fuel switching away from coal, transfer of coal use (and emissions) to countries with only modest or no ambition to reduce greenhouse gas emissions, and a dearth of investment in coal mines and coal-fired power generation. The effectiveness of emissions trading will depend upon access to lower-cost abatement in areas covered by the trading regime which should be geographically and sectorally broad. Efforts to reduce the costs of abatement through technology development are urgently required to reduce the economic impact of such schemes.

The IEA should continue to identify the benefits and pitfalls of emissions trading, focusing on industrial competitiveness, energy security, the fate of existing assets, and how to favour improved energy efficiency. It should also consider if the adoption of clean coal technologies demands a global market for carbon dioxide credits, rather than the imperfect regional markets that are springing up.

Technological Advances

5. What are the prospects for coal to contribute to the hydrogen economy?

As a carbon-free energy carrier, hydrogen from zero emission technologies or renewable sources offers the prospect of a world with no man-made greenhouse gas emissions, other than water vapour. Assuming viable distribution and storage technologies are developed, hydrogen may become a significant transport fuel, with
the added benefit of reducing dependence on oil since it can be produced economically from coal in
gasification plants. With greater commercial experience of using coal in integrated gasification combined
cycle (IGCC) plants and clarity on the future strategic direction for the development of hydrogen as an
ergy carrier, the electricity and coal industries could contribute to development of a hydrogen economy.
Alongside carbon dioxide capture and storage, hydrogen is a long-term prospect and demands collaborative
R&D during the early stages.

The IEA should consider establishing a framework for international collaboration vehicles between
industrial, governmental and academic groups. The IEA might also encourage better public
communication of all energy issues so that attention is focussed on appropriate priorities.

6. How can the coal industry promote further advances in carbon capture and sequestration?

Carbon dioxide capture and sequestration is an essential technology for the continued, long-term use of coal,
but the short-term priority is to improve the energy efficiency of conventional plants. To develop capture
and storage as a viable option will require an international, collaborative effort to advance the technology
through pilot demonstration supported by governments and industry. Legal and regulatory issues must also
be addressed positively. The Carbon Sequestration Leadership Forum is an important vehicle to promote
progress, yet gaining public acceptance will demand wider stakeholder involvement.

The IEA and CIAB should continue to support and promote international collaborative efforts
though the IEA Implementing Agreements, and other efforts such as the Carbon Sequestration
Leadership Forum.

7. How can coal reduce energy import dependence for countries with indigenous coal
reserves and market, and reduce supply disruption risk for those countries without such
reserves?

Coal’s widespread availability, the ease and safety with which it can be transported, stored and used, and its
affordability, all contribute to its attractiveness in the energy mix of many countries. Where coal contributes
to fuel diversity for electricity generation, users benefit from the stabilising effect it has on prices, in contrast
to the impact of volatile oil and gas prices. That said, there remains a need to address the environmental
issues surrounding coal use if countries are to benefit fully from their indigenous reserves and others from
reliable imports.

The IEA should continue to provide timely information on the prospects for coal resource
development, and highlight any policy impediments.

Energy Security

8. How quickly can the coal industry respond to resolve energy security problems that
may occur in the future because of failures in energy supply, for example from
increased reliance on natural gas?

Coal’s vast resource places it in a position to address energy security concerns across the globe. Short-term
responses to tightening natural gas supplies are available subject to the ability to lift production from existing
mines and transport the coal. Longer-term, investment is planned in a co-ordinated manner along the whole
coal supply chain, but lead times are long. Some investments, especially at ports, involve significant
investment for larger step changes in capacity, and require clear and timely signals if capacity growth is to be
in line with demand.

The IEA should broaden its engagement to increase the global reach of its analysis, and communicate
policy issues and responses to policy makers.
9. How can the coal industry maintain its diversity of supply sources given changing economics?

Diversified coal supply is strategically desirable in developed and developing nations. In the former, market fundamentals and environmental legislation will determine coal’s position, although concerns over the availability and cost of future gas supplies may result in a greater coal demand than the current level of supply chain investment would suggest. In developing countries, such as China, energy policy often focuses on developing indigenous resources to meet electricity demand growth rather than diversity from foreign sources. Here, attracting the scale of investment needed becomes the principal challenge. The coal market has become truly global and diversity will be assured providing there is proper co-ordination of investment within both exporting and importing nations. This applies to rail and port facilities as well as to the coal mines themselves where productivity improvements are vital to maintain competitiveness and continue in business.

The CIAB recommends that the IEA studies the drivers of coal demand and identifies any regions or time periods where supply fails to meet demand or where diversity is compromised. Recommendations for addressing any mismatches or supply concentrations should follow.

10. How can continued robust coal investment worldwide promote more stable global energy markets?

A robust, global coal industry alleviates pressure on world oil markets. It creates greater energy supply diversity and lowers energy costs. The investment required to meet coal demand over the next thirty years cannot be assumed, particularly given the poor returns seen in the coal mining sector over the last twenty years, and current uncertainty on carbon policies. However, coal might have an advantage over other fuels in respect of the smaller scale and tractability of the investment task. Producers, infrastructure providers, users and those involved in the planning, financing and equipping of new coal mines and power plants must collaborate to understand and overcome any impediments to investment and look towards longer-term contracting. Such considerations have been greatly complicated by the increasing liberalisation and globalisation of markets, together with new and heightened concerns about the environmental consequences of coal use.

The CIAB proposes a joint effort with the IEA to illustrate how collaboration across an expanding coal supply chain can reduce the cost and price volatility of electricity supplies in all regions, advancing the quality of life in both developed and developing nations.
1. HOW CAN COAL-FIRED GENERATION ALLEVIATE POVERTY IN DEVELOPING COUNTRIES?

The “World Energy Investment Outlook - 2003 Insights” (WEIO) projects that 1.4 billion people will not have access to electricity in 2030. This represents a reduction of only 200 million people from today. Even to achieve this modest gain, the transition economies and developing countries will require USD 5.8 trillion for power sector investment.

The WEIO concludes that more private sector investment will be required, but that there are major uncertainties about when and from where the new investors will come. Renewed expansion of private sector participation will take time and call for appropriate policies to be implemented by governments.

The question posed to coal and electric power industry executives is:

Question 1: How can the electrification of the economies of developing countries be accelerated to alleviate poverty, and how may the coal industry aid this acceleration?

Summary of Responses to Question 1

There was a general consensus among respondents from both developed and developing countries and consumers and producers of coal that electricity plays a vital role in the realisation of the UN Millennium Development Goals, particularly the alleviation of poverty, and is a key enabler for economic growth. In addition to powering industrial and commercial development, electrification brings about an improvement in the standard of living, improves the overall economic environment and stimulates small business development. Electrification also provides many environmental and socioeconomic benefits such as improved air quality and job creation. Total alleviation of poverty solely by means of energy provision is not realistic, although it does create an opportunity. Examples of where coal has underpinned electrification initiatives were also highlighted. Therefore, for any nation or region to move forward and become competitive in the global market, providing reliable and affordable electricity is crucial. This is particularly true for African countries where it is estimated that only 17% of the population has access to electricity. Given the increasing world population, 1.4 billion people will still lack electricity in 2030 according to the IEA “Energy and Poverty” study. To provide modern energy to the entire developing world by 2030 would require new supplies to almost 100 million people per annum, according to the World Energy Council, when only 70 million cumulatively have gained access since 1970.

Following the comments summarised above, the majority of the respondents went on to note that large-scale electrification poses many challenges, including:

- Establishment of backbone infrastructure - generation capacity and transmission infrastructure.
- Reducing the cost per connection.
- High costs associated with the supply of electricity to remote areas.
- Affordability and payment.
- Financing and lack of investment appetite.
- Slow uptake of electricity and thus slow realisation of benefits and development of markets.

Many of the respondents observed that coal resources are available at a reasonable price in more than fifty countries worldwide and in quantities which will allow its continued use for many years into the future. Thus, the use of coal to generate electricity can result in lower cost electricity which contributes greatly to its affordability. One area where there was not consensus was that of alternative energy sources to coal. Some respondents indicated that coal was the only reliable, low-cost option for electrification, while others indicated that fuel choice needs to be determined on a case-by-case basis, given each country’s available energy resources and existing infrastructure. Due to the limited availability of capital in developing countries, the specific capital requirements of different energy sources may have a greater influence on the choice of energy for power generation than elsewhere. This may be overcome, to some degree, through investment by independent power producers who may also select advanced technologies with reduced environmental impact and increased efficiencies. Whatever the investment route, the domestic production of coal will provide energy security for many developing countries, with the added benefit of local job creation. One developing country respondent commented that strong government intervention during the early stages of growth is required when socio-economic development of the country is a priority - especially in financing the basic infrastructure. Thus, mechanisms for leveraging state financing, official development assistance and private sector investments should be assessed to optimally manage the overall development of infrastructure.

One of the other electrification dilemmas raised was the choice between centralised generation, with its extensive distribution infrastructure, and decentralised approaches. Both have their benefits. Large, centralised systems are more flexible and can allow for increases in consumption; but, they are generally more capital intensive. It is essential therefore, that the market or demand for electricity develops alongside new supply capacity, thus enabling reasonable returns on investment. The coal industry can assist electrification in developing countries with the provision of practical, affordable, and environmentally acceptable solutions to grid expansion. One respondent indicated that this should include not only the use of optimal technological solutions, but also operational options to reduce costs such as the use of modelling as a tool to develop options to manage load distribution.

In addition, a number of respondents indicated that the transfer of appropriate technologies was important. This can assist in meeting energy requirements in a more sustainable manner by “leap-frogging” to the latest generation of technologies. For example, state-of-the-art, efficient coal combustion equipment to reduce emissions or technologies to strengthen infrastructure, including greater interconnectivity between countries and regions. In Africa, the New Partnership for Africa’s Development (NEPAD) will play a critical role in this area, and in the optimisation of regional energy resources, of which coal is an important component. Aligned with the technology transfer is consideration of appropriate financing mechanisms, including the impact of carbon trading.

One developing country respondent highlighted more specific interventions to assist with affordability, including that the cost recovery of electrification programmes should be linked with affordability to the users, with consideration of how to maximise benefits over both the shorter and longer terms, and with the use of focused, demand-side management interventions. It was also suggested that the contribution of electrification to socio-economic development and progress towards improved quality of life should be quantified.
In addition to those outlined above, many more specific suggestions were given with regard to the role that the coal industry can play in electrification initiatives, including the following:

- Electrification of communities adjacent to coal mines as part of overall community development programmes.
- The development of more efficient, lower cost and cleaner ways of burning coal in domestic applications as an interim measure until electricity uptake is improved.
- Technologies for smaller, distributed energy supply could be developed for stand alone rural applications, e.g. small-scale, coal-fired generation.
- Partnerships between suppliers and end users to optimise the supply chain and increase benefits.
- Stating the coal industry’s case in various forums to outline the improvements in the use of coal and to argue for clear and balanced policies that reflect energy market realities and the development aspirations of developing countries.
- The development of appropriate financing mechanisms.
- Exploring new coal technologies for consumers, e.g. gasification.

Discussion

Dr. Lennon led the discussion of this topic by CIAB Members by reinforcing the importance of access to electricity for economic growth and development. He saw three main issues:

- Capital availability for new capacity construction.
- The question of how developing countries can provide affordable electricity while addressing the environmental impacts of the fuel used to generate it.
- The need for industry-government partnerships to address the long-term challenge of electrification.

Members (Chiaro, Lennon, Stadelhofer) emphasised the role of electrification in providing open access to knowledge through information technology, quoting China as an example. Those in business in developing economies needed to take a holistic approach, for example by developing local infrastructure in schools and hence the future labour force, or investing in R&D capability.

Coal has many competitive advantages, but ways need to be found to enable developing countries to adopt advanced technologies. It was observed that some areas are difficult to supply with electricity, notably those where the population is widely dispersed. Too often in such situations, satisfying basic electricity needs using distributed energy production from renewable sources is seen as the only requirement. However, expanding electricity demand for industrial and commercial development needs to be taken into consideration and coal can be part of the solution to this, providing a cheaper and more secure solution. Efficient electricity production plants and technologies will often be attractive on their own merits, but affordability remains a key issue. The IEA could play a role in encouraging the search for more affordable and efficient ways to use clean coal technologies and to ensure they become an accepted solution. The focus of development aid to developing countries should evolve from the initial focus on medical and food aid towards the provision of education to accelerate up the learning curve and speed development (Stadelhofer). With its competitiveness and reliability, the use of coal can accelerate electrification and therefore broaden access to the knowledge base.

Members agreed the need to establish clear messages on the benefits of coal: coal is important to development and poverty alleviation; it is improving its environmental performance; and, through the use of technology, it can contribute to long-term sustainability.
Recommendations for Future Action

The Kyoto Protocol created mechanisms, such as Joint Implementation (JI) and the Clean Development Mechanism (CDM), could play vital roles in accelerating efficient electrification and poverty alleviation in the developing world. However, experience with their implementation has been disappointing and opportunities are being lost as developing nations make technology decisions without recourse to the Kyoto mechanisms. The IEA could provide its member governments with deeper insight into how these mechanisms might be more widely and effectively adopted. In addition, the IEA might consider mechanisms to complement JI and the CDM, which better couple technology transfer and poverty alleviation for the developing world.

Effective coal utilisation must firmly embrace the principles of sustainable development. These principles provide added benefits to developing regions or nations as they can enhance electrification capacity. Often, the public and policy-makers do not fully understand the additional benefits that sustainable development can bring to their economies. The IEA might consider publishing a series of case studies as a means of communicating these additional benefits of coal utilisation to policy-makers in its member countries.
2. HOW IS INVESTMENT IN THE COAL INDUSTRY AFFECTED BY LIBERALISATION OF ELECTRICITY GENERATION AND CARBON POLICIES, INCLUDING EMISSIONS TRADING?

The “World Energy Investment Outlook - 2003 Insights” projects that the coal chain (coal production, coal shipping terminals, and coal-fired electricity generation) will require investment of USD 1.9 trillion from 2001 to 2030. Of this amount, USD 400 billion needs to be invested to fund the growth in coal supply from 4.6 billion tonnes in 2000 to 7.0 billion tonnes in 2030. The greater portion of USD 1,480 billion is required for new, coal-fired electricity generation.

Over the next 30 years, the European Union alone will need nearly 650 GW of new capacity to meet rising electricity demand and to replace 330 GW of existing power stations. These capacity additions are greater than the current total installed capacity in Europe.

Prior to the liberalisation of electricity markets, electricity companies were able to pass on full costs to consumers. In regions with liberalised markets, there are concerns about the greater commercial risks that these companies now face.

The WEIO states that market liberalisation has created new challenges and uncertainties. Indeed, there is a new concern about the adequacy of investment as markets adapt to new conditions. Policy-makers need to address this concern by providing a market framework that sends the right market signals to investors. The question posed to coal industry executives is:

**Question 2: How is the liberalisation of electricity generation affecting investment in the coal chain?**

The WEIO also states that the key uncertainty facing future coal demand and investment is environmental policy. This uncertainty is discouraging investment. In recent years, little or no new, coal-fired electricity capacity has been built in developed countries outside of Asia. The primary concern is that investments may become stranded due to tightening environmental policies - particularly the imposition of costs for CO₂ emissions that may render the investment uncompetitive. Thus, another critical issue is:

**Question 3: How will the financing of coal production, rail and port infrastructure, and coal-fired generation be achieved given the uncertainty surrounding future carbon policies?**

The WEIO suggests that European governments will need to intervene to encourage greater investment in technologies that emit less CO₂. The EU-wide, cap-and-trade system, now in place, will influence power-
sector investment in this direction over the longer term. Although Europe is the first region to face this challenge, the potential for wide-spread application begs the question:

**Question 4: How will emissions trading of greenhouse gases affect coal mine and coal-fired generation development?**

### Summary of Responses to Question 2

As the respondents were all from countries or regions with varying degrees of liberalisation in their electricity markets, the issues raised reflected their specific experiences and were thus varied. What was clear was that the pressures and opportunities in the liberalisation of electricity generation were very different depending on the level of implementation. Many did report, however, that liberalisation of the electricity market had resulted in reduced power prices to customers due to competition, and that some companies had expanded their operations into foreign markets in order to increase profitability.

There were, however, a number of respondents who highlighted major influences, other than liberalisation, on investment decisions in the coal chain. Environmental considerations linked to gaseous emissions, action on climate change and renewable energy targets were viewed as adding to investment risk. In practice, the increased costs of compliance with new and more stringent regulations represent an additional burden to the entire coal chain; new mechanisms and technologies must be sought to control and manage these costs.

Most respondents also pointed out that electricity market liberalisation resulted in greater uncertainty, in terms of prices and sales volumes, and that this led to a reluctance by investors to fund the higher, up-front capital costs and longer lead-times of coal-fired plants, despite their lower operating costs. Within a market-based approach, many investors were looking for more flexible options, such as gas, with shorter-lead times and lower capital costs, albeit with higher operating costs. Electricity utilities are also, in some cases, moving away from centralised investments in large-scale electricity generation, despite the economies of scale, to smaller, decentralised units with greater flexibility. This has implications for coal infrastructure investments, where coal supply and use technologies generally call for large-scale application.

Some respondents pointed out that liberalisation will have different impacts on new, as opposed to existing, coal plants and supply chains. In existing plants, variable costs need to be managed in order to remain competitive; thus, there is an increased focus on efficiency, maintenance and fuel costs, rather than on “sunk” capital costs. If coal plants, either new or existing, can produce electricity at a competitive price, then they will be operated at high capacity factors and demand for coal will increase. However, respondents from the UK and North America pointed out that few, new, coal plants were being built or were expected to be built at present, primarily due to uncertainty and risk. The North American respondents noted a trend back towards partial market regulation in North America which may have some benefits along the coal chain, including the means to make a return on incremental capital investment. Given this, a greater investment in environmental control technologies and an improved level of supply security should follow. In the EU, it was pointed out that coal’s importance is likely to grow with enlargement, but that a long-term strategy was needed to maintain coal’s place in the market.

It was generally accepted that a reduction in market volatility will allow longer-term, more strategic decision making. Long-term strategy, as opposed to shorter-term responses to market drivers, is key. Sub-optimal resource allocations can ultimately result in increased electricity prices for the consumer. As such, any negative external impacts, especially in developing countries, could be significant. Another common thread in many of the responses was that of energy security. Since this is a concern around the world, countries will look to using indigenous energy reserves and this will have an impact on technology choices and thus on the coal industry.
A number of the respondents believed that the rate of increase in electricity demand has a significant influence on the impact of market liberalisation. Where demand is increasing, such as in a developing country, there will be an appetite for investment. In more mature markets, where the increase in electricity demand is slowing, different pressures will apply. Higher rates of electricity demand growth in the developing countries, coupled with the competitiveness of coal-fired electricity generation and the abundant availability of coal, will ensure that the robust and growing global demand for coal continues. The on-going deregulation of electricity markets, and the removal of subsidies, import barriers and other market distortions, will continue to drive coal production towards the lowest-cost regions.

Recommendations for where the coal industry should focus include:
- Short lead time technologies and processes.
- Low up-front capital technologies.
- Improving environmental performance.
- Carbon sequestration technologies.
- Influencing policy and regulatory frameworks to ensure an environment conducive to making long-term investment decisions.
- Cutting costs in the production, transport and combustion of coal.

**Summary of Responses to Question 3**

There is a strong consensus view, amongst utility respondents, concerning the direction of environmental legislation in their geographical regions; specifically, that it is not creating the right climate for investment in new, coal-fired power generation. In Europe, there is already strong pressure to comply with the Large Combustion Plants Directive which is impacting on the profitability of coal-fired generation. The additional, uncertain impact of the EU Emission Trading Scheme on production costs and electricity prices, and the lack of clear government policies on the role of coal in the future energy mix of member countries, are shaking the confidence of potential investors.

Even if European governments recognise that coal-fired generation is more reliable than renewables and that there are certain risks with a strong and rapid growth in the use of gas for electricity production, they need to provide some certainty on policy, and its impact on long-term pricing to encourage investment. Even then, because of the emission abatement costs, it is hard to envisage any growth in coal-fired generation in Europe other than the simple replacement or modernisation of existing capacity.

In the USA, although there is no Federal commitment to Kyoto-style, carbon reduction targets, uncertainties over the final content of the energy bill have led to the postponement of some coal-fired power plant construction and upgrade projects. This is having a knock-on impact on investment in coal production and rail transportation infrastructure. Despite this, most of the large mining concerns have enjoyed huge gains in market capitalisation and this will aid the investment decisions necessary to support the inevitable growth of coal mining in the USA.

A second issue of concern to investors in coal-fired power generation plants is the commercially unproven nature of the emerging technologies that are needed to provide the level of environmental performance necessary to position coal favourably with alternative fuels. In fact, technologies to reduce sulphur and nitrogen oxides are commercially relatively mature, but those that decrease mercury and CO₂ emissions are still in the early stages of development for application to large power plants. There is, of course, a good deal of financial risk associated with investing in a first-of-a-kind, novel plant whose reliability and performance...
is unknown. Some government incentive to offset this risk in the form of a capital grant and/or operating subsidy may be required. Continued government stimulus to sustain adequate levels of RD&D is also required, with close international collaboration being vital for effective, timely solutions.

Away from the major, developed countries, where carbon policy issues have greater visibility and impact, there will continue to be significant growth in coal-fired power generation to meet energy demand. In Russia, China and India, the growth in coal use is likely to compensate for the reductions in other regions of the world where regulatory uncertainty exists. This being the case, countries with a strong presence in the upstream end of the value chain (coal producers and equipment manufacturers) are not experiencing the same pressures on investment. In South Africa, for example, over USD 6 billion will be raised from public/private partnerships to support rail and port infrastructure improvements. The government support and guarantees, which are needed to sustain such expansion, are also a feature of mining and related infrastructure investment in India; while in China, production and infrastructure investment will be achieved predominantly through state-owned companies. In Russia, most of the mining industry has transferred into the ownership of large, vertically integrated organisations and investment will be market led; but, investment into rail and port infrastructure will still have to come from the government.

**Summary of Responses to Question 4**

The respondents emphasised key common issues. In theory, emissions trading is a market mechanism that can help achieve specific greenhouse gas emission reduction goals. It is not emissions trading itself which impacts on development of coal mines and coal-fired power generation, but the mandated emission reduction targets and the policies which will be pursued to reach any such targets.

There was consensus, across the Members, that trading of greenhouse gas emissions will bring additional costs to coal mining and power generation. Furthermore, it imposes additional risks to be factored into investment decisions.

The traded price of CO₂ directly affects coal’s ability to compete with other fuels, especially natural gas. This could lead to large-scale fuel-switching from coal to gas, especially in the short term. However, gas is becoming a more expensive commodity and there are strong question marks over the ability to supply today’s demand, regardless of any future increases.

There was also strong concern that regional emissions trading, e.g. the EU-wide cap-and-trade scheme, is likely to result in a transfer of coal production and industrial utilisation, including power generation, to countries with only modest or no ambition to adopt the modern, clean coal technologies required to limit growth of greenhouse gas emissions.

The capital intensity and the long-term nature of investment in improved power plant efficiency mean that any uncertainty over the nature of future energy policies and resulting regulation will discourage investment in coal development. Unless there is a stable regulatory framework, only minimal investment in coal development will be made over the coming years.

The future of coal is likely to be dependent on governments recognising its strategic value and taking action to address its role in the energy mix. Addressing these issues will be country specific, and therefore, future coal development is likely to be focussed in countries where it is supported by government policy.

**Discussion**

Leading the discussion, Dr. Maichel balanced the negative aspects of energy market liberalisation - greater price volatility, reduced security and increased risk - with the positives of quicker exploitation of efficiency potential, lower electricity costs for consumers and more transparency.
New challenges to coal use include:
- Climate protection measures.
- Energy taxation.
- Emissions trading.
- Faster introduction of renewable energy sources.

These could limit the use of coal for power generation, adding significantly to electricity costs and limiting international competitiveness. Several Members referred to the lack of planned or actual investment in coal-fired electricity generating plants in their own countries or regions. Some Members (Shirakawa) stressed the need for suppliers to help maintain the relative cost benefits of coal.

Members (Nakagaki, Maichel) questioned the value of carbon taxes, which could have an adverse effect on industrial competitiveness in developed economies, causing industry to move to regions without such taxes.

Members (Lennon, Nakagaki) pointed out that the process of de-industrialisation in developed economies resulted in CO₂ emissions “leakage” to developing countries because it becomes too expensive to do business in developed countries. To achieve a net positive benefit at a global level, requires complementary policy mechanisms, including the efficient implementation of the Kyoto Clean Development Mechanism and Joint Implementation, to encourage the adoption of advanced coal-fired generation technologies in the developing nations. Implementation of Kyoto mechanisms was seen as difficult, limited and bureaucratic from the start. The mechanisms appear to only focus on renewables, not efficient coal generation, and need to be more flexible and effective.

The key issue with new CO₂ emissions trading schemes is whether national emissions allocations will be seen as fair and just. For example, Finland has a high proportion (one third) of electricity generation from efficient plants, making it more difficult to improve overall electricity generation efficiency. Regulation of companies (e.g. nuclear and hydro generators) able to make windfall profits is an important issue, as electricity market prices rise with the additional cost of emission permits.

Although sometimes seen as an industry delaying tactic by many governments, technology advancement is the only long-term solution to the issue of carbon abatement (Clayton). Taxation and emissions trading in just a few countries do little to promote the development of this technology, whereas a global market for CO₂ credits would act as an incentive for new investment in clean coal technologies (Maichel). Existing technology can improve electricity generation efficiency and should be put to use now.

Members (Yaxley for McPhie, Maichel) agreed that investment would take place in a truly liberalised market, but pointed out that, in practice, governments can apply so-called market mechanisms, such as emissions trading, in ways that force desired policy outcomes. For example, the UK’s, National Allocation Plan, submitted under EU Emissions Trading Scheme rules, assumes coal use will fall by 30%, while renewable energy is encouraged by targeted support measures. This encourages short-term responses to energy investment and inhibits the investment necessary to ensure that coal can meet the demands required of it in the medium term.

Recommendations for Future Action

Question 2
The coal chain consists of long-life assets that are capital intensive. Today, investment is urgently needed in the coal chain. Certain aspects of electricity market liberalisation have increased actual and perceived investment risks and volatility of returns, requiring higher rates of return on new investment in the coal
chain. If these are not attainable, then investment may be deferred or even avoided. The CIAB views it as important that the IEA is fully aware of any potential and unanticipated impacts of national or regional electricity market liberalisation on coal chain investment. Special focus could be paid to markets that have undergone liberalisation (EU and US) and the lessons from these that could be transferred to other countries considering or undergoing market liberalisation.

Question 3
Investment in the coal chain is affected by the health and growth of the end-use sector and this is being adversely affected by current uncertainties over environmental legislation and energy policy. Where there is some clarity of policy, in respect of coal’s part in the future energy mix of a country, then there is a more certain investment climate; but, where there is uncertainty, there is an understandable reluctance to invest. With support from CIAB Members, the IEA could consider providing further evidence on the cost of improving efficiency and reducing emissions of coal-fired generation so that policy-makers can compare the relative costs of all options from a more informed standpoint. IEA leadership, on the development of frameworks for stimulating RD&D into clean coal technologies and ensuring that international collaboration is optimised, would be welcome.

There is also the danger of setting environmental carbon policies that are inconsistent with, or even mutually exclusive to, desired energy policy. The IEA might consider identifying areas of concern relating to energy policies that favour liquefied natural gas and renewables, including an examination of the carbon intensity assumptions for other fuel options relative to coal. Where inconsistencies are identified, proposals for corrective action would be helpful.

Question 4
Trading carbon emissions offers potential benefits and pitfalls to energy competitiveness. The IEA is well positioned to help define the key parameters of carbon emission trading schemes that ensure improved energy competitiveness. Special focus is recommended on creating a framework that favours improved energy efficiency, preserves the value of the existing generation fleet, ensures energy security is not compromised, and creates sufficient market liquidity and participation.
3. HOW CAN THE COAL INDUSTRY CONTRIBUTE TO TECHNOLOGICAL ADVANCES IN THE HYDROGEN ECONOMY AND IN CARBON CAPTURE AND SEQUESTRATION?

The “World Energy Investment Outlook - 2003 Insights” states that advanced, energy technologies can change the long-term, investment outlook. Technologies most likely to modify the investment picture appear to be: carbon sequestration, hydrogen and fuel cells, next generation nuclear, and advanced electricity transmission and distribution systems. Hydrogen can be produced from fossil fuels, but production without CO₂ emissions requires carbon capture and sequestration technologies.

Although nuclear and renewable technologies are often cited as potential energy sources for hydrogen production, the large coal reserve base, and the low-cost of its recovery, certainly beg the question:

**Question 5: What are the prospects for coal to contribute to the hydrogen economy?**

The WEIO concludes that carbon sequestration technologies are relatively mature, but face unresolved environmental, safety, legal and public acceptance issues. If these issues are resolved, very large reductions of CO₂ emissions could be achieved through carbon sequestration in the electric power industry. The WEIO estimates that carbon sequestration will increase power plant investment costs by between 30% and 120%.

The question posed to coal industry executives is:

**Question 6: How can the coal industry promote further advances in carbon capture and sequestration?**

**Summary of Responses to Question 5**

As a carbon-free energy carrier, hydrogen offers the prospect of a world with no man-made greenhouse gas emissions, other than water vapour. In many ways, hydrogen is akin to electricity since consumers benefit from high end-use efficiency with few or no pollutant emissions; but, unlike electricity, hydrogen can be stored in large quantities, bringing an additional flexibility to future energy systems.

The reduction of CO₂ emissions from the transport sector is seen as the key driver towards the hydrogen economy, although other benefits are identified. Significantly, both distributed and central power generation can be run very efficiently and cleanly on hydrogen, particularly where use is made of fuel cells. The carbon intensity of natural gas supplies can be reduced by introducing hydrogen into the gas supplied through existing infrastructure; a CO₂ reduction of 10-15% is quoted.
In terms of energy security and diversity, the promise that hydrogen fuel may reduce dependence on oil and gas is viewed positively by many Members, especially where hydrogen production is able to benefit from the price stability offered by coal.

Although it is the world’s most abundant element, pure hydrogen does not exist naturally in exploitable quantities. It must therefore be manufactured and, for this reason, should only be considered as a source of secondary energy or an energy carrier.

Approximately 160-170 mtoe of hydrogen are produced each year, about 2% of world energy demand that is used mainly in chemicals production (e.g. ammonia and methanol) and oil refineries. The bulk of this is produced from natural gas, oil and coal - with natural gas meeting about half of today’s demand after a simple steam reforming process. While electrolysis of water is used to produce small quantities of high-purity hydrogen, this production route is seen as an inefficient use of electricity.

Other potential hydrogen production routes include high temperature, thermo-chemical processes driven with heat from nuclear reactors, photo-electrolysis using sunlight, biomass fermentation, photosynthesis using genetically modified algae, and the rather speculative suggestion to remove and dispose of solid-phase carbon from coal to yield hydrogen. These are long-term prospects that present formidable research and development challenges. While none are viable today, those that rely on renewable energy do offer a fully sustainable target and, as such, are likely to be pursued.

However, in the short-term, natural gas is seen as the cheapest source of hydrogen, with coal gasification and other production options becoming attractive in the mid- to long-term, depending on the future demand for hydrogen and the price of natural gas.

With abundant reserves of around 200 years at the current level of consumption, coal is seen as a potentially significant source of bulk hydrogen. Indeed, with hydrogen-fuelled transport, a huge market would re-open to coal producers. The economics of large-scale hydrogen production from coal gasification point to low prices - one Member quotes a price today comparable to the ex-refinery price of gasoline. Others believe hydrogen to be more expensive. However, all recognise that storage and distribution costs are very high, thus making hydrogen an unattractive alternative to gasoline. The hope is that a technological breakthrough will reduce future storage and distribution costs.

Underpinning this optimism is the availability of integrated coal gasification combined cycle gas turbine (IGCC) technology that is well suited to the production of clean hydrogen. With the relatively simple step of removing CO2 for storage, the production of hydrogen from coal can be virtually emission free. The future prospects for this technology are enhanced further when coupled with energy efficient fuel cells - an electrical generation efficiency as high as 65% is quoted. The EAGLE (coal Energy Application for Gas, Liquid and Electricity) project in Japan is notable since it aims to produce high-purity hydrogen and demonstrate an integrated coal gasification fuel cell (IGFC) plant. As the cost of fuel cells falls, this should become an attractive technology, especially since a single plant can co-produce electricity and transport fuel.

A number of Members note that the syngas from coal gasification can be converted not only to hydrogen but also to liquid fuels, such as methanol. These provide a practical means of distributing hydrogen for transport applications using fuel cells, although there would still be CO2 emissions from on-board reformers. With a number of energy system options available, some based on coal, the importance of life cycle analysis that properly accounts for the totality of greenhouse gas emissions, is clearly stated.

All agree that during the transition period to a fully sustainable energy system, coal will be strategically important. However, only a few Members suggest a timescale for this which might begin as early as 2020, although the creation of a hydrogen distribution infrastructure is seen as a major task that will dictate the rate of progress.
Members report positively on coal’s contribution to a hydrogen economy. However, they are not naive to the challenges coal faces if it is to act as a bridge to a fully sustainable energy system. The cost of producing hydrogen from coal is expected to fall as more IGCC plants are built and become competitive with steam reforming of natural gas. This will be especially true at those plants that are able to benefit from the arbitrage opportunities offered by the co-production of electricity, hydrogen and perhaps liquid fuels.

Coal’s future role in hydrogen production is recognised by all to depend crucially on being able to demonstrate a positive benefit in terms of reduced greenhouse gas emissions. Co-gasification of coal with biomass might go some way towards this, but success ultimately depends on CO2 capture and storage becoming a publicly acceptable mitigation measure.

In any event, Members see success of the long-term, “hydrogen economy” vision only if collaborative research and development is undertaken at an early stage.

**Summary of Responses to Question 6**

There is strong consensus amongst the respondents that carbon capture and sequestration (CCS) is an essential technology for the continued long-term use of coal, in that it offers the potential to reduce greenhouse gas emissions as will increasingly be required by governments.

The universal theme emerging from the respondents was the need for international collaboration in advancing the research and development on carbon capture and sequestration, and the need for technologies to be proven through pilot demonstrations. Numerous respondents pointed out that whilst the coal industry is dependant upon coal-using customers to take appropriate action, it has a key role to influence development and deployment of CCS by supporting collaboration and taking direct stakes in demonstration projects.

Support for the Carbon Sequestration Leadership Forum was consistently mentioned by producers as a key step in taking forward carbon capture and sequestration, and the important role CIAB Members can play in the national chapters of the CSLF in their respective countries. Within this forum, and separately by governments, there is a need to address policy, legal, technical and social acceptability issues.

Making investments in projects to pilot the technology was also seen as an important response for the industry. There was consensus on the need for small- and large-scale demonstrations that focus the attention of engineers and provide a foundation for commercial designs. There was also strong agreement on the need for greater international collaboration due to the costly nature of these demonstration projects. The shared interest of the oil and gas sector was noted.

Other actions included working with governments on policy settings, the research community on the development of the technologies, and the wider community to address issues of public confidence. In this regard, the need for high quality information and timely engagement was highlighted.

However, it was also pointed out that the coal industry needed to recognise its perceived vested interest in this issue. CCS needs additional champions from the scientific, technical and NGO communities who are independent and credible on the basis of their understanding of the technology. The coal industry can best engage these champions by supporting the pilots and trials which will improve the level of knowledge and demonstrate that carbon capture and sequestration is a feasible option.

There were some differences between respondents on setting the longer-term priorities. Some producers saw the capture stage of CCS as being more difficult and called for demonstration of IGCC. Others felt that CO2 storage should be demonstrated as a priority, specifically to demonstrate the required monitoring regime.
The respondents were generally in agreement that drivers are not in place for the commercial development of these technologies, and therefore the role of governments in taking forward this research will be critical. In the longer term, the development of markets for carbon sequestration credits was mentioned as an important driver for wider deployment, once the technology has been demonstrated and proven.

There was also general agreement amongst respondents that CCS is a medium- to longer-term option, and the priority for short-term reduction of CO₂ emissions is through improved energy efficiency of existing, conventional plant.

Other responses of note included the need for improved understanding of the science of climate change, and the potential for CO₂ sequestration by restoring mined areas to productive forests.

In summary, the role of the coal industry in supporting carbon capture and sequestration is seen as important, and best achieved through a combination of support for development projects, support for collaborative activities, and the formation of alliances with other key proponents and observers.

**Discussion**

Leading the discussion, Mr. Chiaro noted that carbon capture and sequestration was an important enabler for a longer-term move to a hydrogen economy, and highlighted the need to support the Carbon Sequestration Leadership Forum as a key organisation of nations advancing this technology. He emphasised the need for collaboration at an international level to achieve the objective of efficient development of new technologies such as carbon capture and sequestration and hydrogen fuel cells.

Such collaboration will require:

- Demonstrations to validate technology at a pilot scale.
- Engagement of key stakeholders, particularly with respect to winning wider acceptance of the safety of these technologies.
- Government action to reduce investment risk where possible, particularly with respect to legal and regulatory uncertainty.

Obvious benefits of collaboration would be development of more effective technologies, ensuring wider public acceptance and avoiding development of any technologies which lack popular support.

Members (Stadelhofer, Jones) noted a major difference between the coal industry and other industries, such as oil and pharmaceuticals, in the size and financial resources available for research and development. The coal industry is small compared to the oil industry and enjoys only limited financial resources to allocate to technology development. It has been further hampered by liberalisation of the power generation industry, which has reined in R&D spend in response to a weakened financial position. These points highlight the need to prioritise technology development programmes and to collaborate with other industries where joint interest exists. Areas such as integrated gasification combined cycle (IGCC) and carbon capture and sequestration (CCS) are much more manageable and realistic in the intermediate term than progress with hydrogen technologies. As a result, priority should be given to IGCC and CCS technology development.

Members (Yaxley for McPhie, Chiaro, Maichel) highlighted public misunderstandings regarding hydrogen technology. For example, many are not aware that hydrogen can be produced from coal as a feedstock. In addition, there is the need to communicate that, like electricity, hydrogen is an energy carrier and that, unlike coal, it is not a primary energy source. Finally, the public needs to understand that hydrogen production and utilisation is not very efficient. The coal industry plays an important role in ensuring accurate communication of such facts to the public. Actively participating and contributing to the IEA Clean Coal Centre would assist the industry’s communication efforts.
A number of Members (Nakagaki, Lennon) pointed out that the industry is missing opportunities for better collaboration on technology development and adoption, and that coal producers and consumers needed to work more closely together. Significant investments into the coal chain are being made currently across much of the globe, either for growth of electricity generation in developing countries or replacement of aging fleets in developed countries. Unfortunately, little of this investment is being used to deploy advanced technologies, meaning that conventional technology is being locked in for the life of this new plant. Energy research and development expenditure has declined over a long period of time, and this highlights the need for more focused and more collaborative international research effort. If properly and fully utilised, processes such as the Clean Development Mechanism (CDM) and Joint Implementation (JI) found in the Kyoto Protocol would better facilitate technology development and transfer.

**Recommendations for Future Action**

**Question 5**

The CIAB believes that hydrogen production from coal should be developed as an important strategy in any move towards the “hydrogen economy”. IGCC technology offers an immediate route for bulk hydrogen production, but greater commercial experience of using this technology with coal is urgently required, especially when configured to co-produce electricity, hydrogen and liquid fuels. The development of large-scale fuel cells must be supported since these will provide the next step increase in gasification power plant efficiency.

Despite these promising aspects of hydrogen production from coal, the magnitude of the required development and investment indicates that only governments can set the strategic direction needed for new hydrogen distribution infrastructure and technology breakthroughs for hydrogen storage. The IEA should consider establishing a framework for international collaboration vehicles between industrial, governmental and academic groups on the basic R&D activities that will facilitate the long-term hydrogen vision.

Finally, there is only limited public understanding of the benefits and challenges of hydrogen production from coal. The IEA could encourage better public communication of all energy issues to focus attention on appropriate priorities in the coming years.

**Question 6**

There is agreement amongst coal producers that the Carbon Sequestration Leadership Forum is a prime vehicle for addressing this agenda, and deserves the support of the coal industry. Numerous projects are proposed to demonstrate technologies, and coal producers have a critical role in providing direct support to such projects.

With the industry’s perceived vested interest, the public promotion of CCS will need the support of additional champions from the scientific and technical communities. The coal industry must therefore promote further advances in carbon capture and sequestration through partnerships and alliances with the principal stakeholders who will influence the adoption of CCS. The CIAB would be very willing to support the IEA in recommending a framework for development of these potential alliances.
4. HOW CAN THE COAL INDUSTRY CONTRIBUTE TO INTERNATIONAL ENERGY SECURITY?

The “World Energy Investment Outlook - 2003 Insights” emphasises that the world’s steam coal reserves are more widely dispersed than those of oil and natural gas, allowing for a much closer, geographic fit with demand. A number of factors have provided a stimulus to international coal trade, including: highly competitive markets, growing demand for high quality coal, a narrower distribution of coking coal reserves, growth in demand for coal in high-cost producing areas, and electricity market liberalisation. Coal trade is projected to grow by 65% between 2000 and 2030 - a rate faster than the rate of growth of total production.

Coal industry executives were asked to comment on the question of coal’s role in energy security:

Question 7: How can coal reduce energy import dependence for countries with indigenous coal reserves and market, and reduce supply disruption risk for those countries without such reserves?

In the WEIO’s chapter on natural gas, a warning is raised of a danger that investment in some regions and parts of the natural gas supply chain might not always occur quickly enough. In that event, supply bottlenecks could emerge and persist due to the physical inflexibility of the gas supply infrastructure and the long lead times required for developing gas projects. Such investment shortfalls would drive up natural gas prices and accelerate short-term price volatility. The question is:

Question 8: How quickly can the coal industry respond to resolve energy security problems that may occur in the future because of failures in energy supply, for example from increased reliance on natural gas?

The WEIO projects that the USD 400 billion investment needed in coal production over the next 30 years will be split evenly between developing countries and the rest of the world. Investment in the OECD countries is expected to be USD 131 billion. China, alone, will account for USD 123 billion of the global investment needs. Diversity of supply has been a major strength of the coal industry in comparison with other fossil energy sources, raising the question:

Question 9: How can the coal industry maintain its diversity of supply sources given changing economics?

The WEIO concludes that almost USD 10 trillion of the projected USD 16 trillion capital needs in the energy industry will be required for the power sector. If oil and gas investment in the Middle East is not
forthcoming or if natural gas bottlenecks emerge, investment shortfalls will accentuate short-term price volatility and drive up prices. The coal industry can play a major role in reducing energy supply risk. The question to coal industry executives is:

**Question 10: How can continued robust coal investment worldwide promote more stable global energy markets?**

### Summary of Responses to Question 7

There was a high degree of consistency amongst the responses to this question, but with some regional variations reflecting Members’ particular circumstances.

Members referred to the stabilising effect on energy markets of coal, which remains a major source of primary energy. Fuel diversity, especially from coal in the electricity sector, was thought to benefit all users to a greater or lesser degree.

Respondents went on to emphasise the particular characteristics of coal that underpin its prevalent use and make it an especially attractive component of the energy mix for many countries. These included coal's:

- **Availability** - that economic reserves of coal exist in large quantities in many different locations around the world mean that exploiting indigenous coal resources or importing coal economically are practical options for most countries.

- **Usability** - that coal is relatively easy and safe to handle and store was thought to enhance its usefulness in mitigating risks, both physical and commercial.

- **Affordability** - that coal is a low-cost fuel option in most markets means that it has an important role in supporting economic development, especially in newly developing countries.

In these respects, coal was contrasted with oil and gas; these being characterised by smaller reserves, concentrated in a limited number of countries. Many respondents noted the risks associated with a shift in reliance from coal to gas.

A number of Members highlighted the role of coal within a changing, international landscape; a natural fit was believed to exist between coal availability and use, and patterns of economic and political development.

That said, respondents were conscious of the need to address the environmental issues surrounding growing coal use, and were optimistic about the scope for substantially reducing emissions through the application of current and emerging generation technologies, provided energy policies were supportive.

### Summary of Responses to Question 8

The respondents emphasised key common themes. Perhaps the most striking one being the universal recognition that coal represents the single largest and most abundant fossil fuel resource in the world today. Coal’s vast resource allocation across the globe places it in a position to address numerous energy security concerns in both developed and developing nations. As a result, coal must continue to play a vital role in energy policy moving forward.

This is especially true when one compares coal’s position to that of its most popular alternative, natural gas. Many respondents regarded increased reliance on natural gas for future electricity generation needs as somewhat risky, especially when one considers the potential for price volatility and supply disruptions. Members anticipated some degree of disruption to natural gas supplies, along with price spikes, in the future.
However, despite increased price volatility and lower security of supply relative to coal, natural gas currently enjoys an advantage with regard to future environmental regulations for emissions such as SO₂, NOₓ, mercury, and particulates. This advantage becomes even greater when one considers current or potential climate change initiatives. To address this challenge, those working in the coal supply chain must continue to adopt the tenets of sustainable development and focus efforts on developing zero emission technologies, including IGCC and carbon sequestration.

There was consensus across the Members that coal’s ability to respond to extreme natural gas price spikes or supply disruptions would depend on timing. This reflects the reality that the coal chain, from coal mine to power plant, is a heavily capitalised and complex system. Possible, short-term responses from the coal industry to tightening natural gas supplies are somewhat limited, being driven by incremental production from existing operations and infrastructure. Bottlenecks and capacity limitations within the coal chain would limit the ability of the industry to respond quickly to large natural gas supply or price disruptions in the short term.

Longer-term responses to potential natural gas disruptions result in a much different picture. Here, the industry would be able to focus and co-ordinate investment into the coal mining, coal processing, transportation, and power generation links of the chain to increase the base capacity of regional and global production. This, in turn, would allow coal to address the potential price and supply risks of natural gas on a much larger scale - coal chain infrastructure would be augmented to match the increased demand.

All respondents agreed that the coal chain represents an increasingly complex and integrated series of components. This results in longer lead times for supply increases relative to other fossil fuel alternatives or to what was required in the past. Bottlenecks in the coal chain need to be identified, investment needs to be committed, and linkages between different components of the coal chain need to be developed. The coal industry has the resources and reserves to respond to energy security concerns over the long term; but, the ultimate success or failure of these efforts will depend on coal’s ability to respond innovatively and to coordinate efforts across producers and consumers, industry and government, and developed and developing nations.

**Summary of Responses to Question 9**

Considering the diversity of the respondents, there was good agreement on this issue. Many responses portrayed current energy markets as lying at opposite ends of a spectrum: EU/US developed markets and China/India developing markets. Although these two extremes may have very different characteristics, they both display the strategic desire to include a diversified supply of coal for power generation needs.

In developed nations, the ability to maintain diversity of supply will be affected by changing market fundamentals and uncertain future environmental regulatory issues. Although electricity demand growth continues to be linked to gross domestic product growth, the expected availability of key fuels has changed over the past two years. Today, there is a growing realisation that natural gas supply may be limited and may only be available at much higher prices than previously assumed. This is likely to result in much higher demand for coal than previously projected.

Although developed nations’ policy-makers and power generators may anticipate this higher demand for coal, uncertainty regarding future environmental and power market regulations often retards the investment needed in the coal supply chain. This uncertainty may even result in deferral of investment, whether in coal mines, coal transportation, or power generation plants, which could ultimately threaten diversity of supply.

Respondents pointed out that the situation facing developing nations is different. For nations such as China, the growth in energy demand is much higher than that found in developed nations. In addition, there is often a much more defined commitment to coal in energy policy. Emphasis is placed first on development of indigenous coal reserves and then on diversity of supply from foreign sources.
However, developing nations face huge investment hurdles to build the coal chain required to meet their growing energy demand. Investment will need to be attracted from a wide range of sources - their own national governments, foreign investment into private companies, global entities such as the World Bank, etc. Multi-national corporations will play a critical role by investing further in current operational bases (e.g. Australia) and by expanding into developing countries (e.g. China), both of which would help to meet the growing demand from developing nations.

Many respondents highlighted the important roles that co-ordination and collaboration between developed and developing nations will play in preserving diversity of supply within the coal industry. A good example of this is international coal transportation, where investment needs to be sufficient and properly co-ordinated between rail and port facilities within both exporting and importing nations.

A further example is the way in which growing demand in developing nations often impacts on coal pricing and diversity of supply in developed nations. Market equilibrium between fuels and coal supply sources is no longer the preserve of isolated national or regional markets; it is attained in a truly global market.

Finally, the point was made that continuing productivity improvements will be necessary to maintain and improve diversity of coal supply in the face of a highly competitive market that has become more volatile in recent years. Higher productivities may best be achieved through on-going advances in mining equipment and techniques, and perhaps through consolidation of key assets or producers.

**Summary of Responses to Question 10**

Members noted that a robust, global coal industry alleviates pressure on world oil markets. It creates greater energy supply diversity, in geopolitical terms, reducing the likelihood that a disruption in one region would affect the broader global marketplace. Other energy sources are relatively more expensive than coal, which is abundant and widely distributed. Thus, more investment in coal would lower the overall cost of energy supplies.

Several Members emphasised the size and nature of the coal investment required to meet demand over the next thirty years. While it should not be assumed that this expenditure will automatically take place, coal might have an advantage over other fuels in regard to the smaller scale and tractability of the investment task.

In focusing on continued coal investment, Question 10 elicited a number of views on future policy requirements. Members identified three key requirements:

- Investors require certainty and clarity of regulation.
- Governments need to take a long-term, strategic approach to energy and environmental objectives.
- The development of clean coal technologies should be supported by governments as a means of reconciling long-term environmental goals with the need for a high level of energy security.

**Discussion**

Mr. Harvey, leading the discussion, pointed out that coal now plays a critical role in assuring energy security and providing a stable foundation to meet energy demand growth across the globe. There are many reasons for coal’s critical role, which include:

- Long-life, proven reserves across the globe.
- Wide diversity of major supply regions.
- Low extraction costs.
- Safe transport and storage.
- Reliable transportation infrastructure.
Established fleet of coal-based power plants.

Despite coal’s strong positioning, the industry faces a number of challenges looking forward. The most critical of these are co-ordinating efforts between the strategic trio of coal producer, transporter and consumer (most often, a power generator), alongside achieving clarity with respect to potential environmental regulations that may affect future investment. Lack of co-ordination across the producer-transporter-consumer chain, and uncertainty over the future “rules of play” will delay necessary investment into the coal chain. This, in turn, will slow economic advancement and quality of life in both developed and developing nations.

Members (Stadelhofer, Nakagaki) discussed the balance that is required between coal prices and coal demand. On the one hand, delivered coal prices paid by utilities need to be high enough to yield an acceptable rate of return on capital investments made by coal producers and transporters. Dr. Stadelhofer highlighted the overall poor returns in the sector over the past twenty years and the consequent exit of the oil majors from coal mining. Without an acceptable rate of return, not only will new investment be lacking, but current supply may be curtailed due to production plant idling or shutdowns. On the other hand, pricing levels that become excessive will destroy demand for coal and will not allow coal-fired generation to play a leading role for new power plant build. Dr. Maichel highlighted inter-fuel substitution effects and that other fuel options such as natural gas, or even oil, could displace coal.

Others (Harvey, Nakagaki, Maichel, Stadelhofer, Lennon) pointed to the importance of further development of efficient markets, but cited the need for coal producers and consumers to work together by agreeing to longer-term fuel supply contracts that would spur investment into new mines and bring greater stability to power prices. Without such contracts, spot markets can work against both generators and coal producers in that coal price volatility creates risks for both. Although coal mines and power plants offer significant investment opportunities, one should not overlook the importance of the transportation infrastructure in between.

Dr. Lennon pointed out four major factors in coal’s contribution to energy security:

- Delivery infrastructure constraints limit supply and enhance price volatility; hence, attention to infrastructure planning and investment is required.
- The high, up-front capital cost of coal-fired plants limits investment flexibility and so lengthens investment approval times. Can the magnitude, timing and nature of investment be altered to increase flexibility and thus enable new plants to be brought on-line more quickly? In particular, is there any potential for smaller-scale, coal-fired plants which would be also inherently better able to overcome planning approval issues?
- To reduce energy demand, energy efficiency initiatives need to be pursued and offer value to all while increasing the overall efficiency of resource use.

Members (Lennon, Stadelhofer) raised the concept of coal-to-liquids technologies, such as used by SASOL, as a means to reduce price volatility of other fuels and, ultimately, to cap oil prices.

**Recommendations for Future Action**

**Question 7**

Preserving the value of coal reserves relies on resolving the tensions between the economic and environmental aspects of coal use. This is of vital interest to countries that possess indigenous coal reserves and wish to enhance energy independence and economic opportunities. It is also of interest to other countries that benefit from the increased fuel choice and global energy market stability that results from widespread coal production and utilisation.
A key role for the CIAB is to promulgate the economic efficacy of coal as a fuel for power generation and industry, and to inform policy-makers about the steady progress of coal towards long-term, environmental sustainability. The IEA has an additional and essential role in evaluating the prospects for coal resource development on a global, regional and country-by-country basis, highlighting practical and policy-related impediments to that development.

**Question 8**

The IEA should play a lead role in communicating to policy-makers two key points regarding coal’s ability to increase future energy supply. This could include a communication effort to Member governments as they consider future energy policy.

First, the coal industry enjoys substantial opportunities to increase supply capacity due to the tremendous reserves that lie accessible in many regions. In respect of energy security, this strong position makes coal a real and viable option for meeting future energy needs, especially when the potential for advanced technology development is considered.

Second is the evolving complexity associated with any supply capacity increases within the coal chain. This results in longer lead times for capacity additions that could be otherwise used to mitigate short-term disruptions to the supplies of other fuels, such as natural gas. The ability of the coal industry to respond more quickly to energy shortages demands a co-ordinated effort between coal producers and consumers, industry and government, and developed and developing nations.

**Question 9**

Diversity of supply within the coal industry is strongly linked to the projected demand for coal, itself driven by three critical components:

- Future environmental regulations.
- Supply and pricing of natural gas - the most obvious competitor to coal.
- Electricity demand growth in developing nations.

The CIAB recommends that the IEA considers initiating a work programme that examines these drivers of coal demand alongside expected coal supply. The programme should identify regions and time periods where supply and demand do not match or where diversity of coal supply is compromised. Recommendations for addressing any mismatches or supply concentrations should follow.

**Question 10**

Strong growth in energy demand is forecast to continue for the foreseeable future, driven mainly by the economic and social development needs of developing countries. However, this is occurring at a time when energy policy considerations have been greatly complicated by the increasing liberalisation and globalisation of energy markets, together with new and heightened concerns about the environmental consequences of using fossil energy sources, including coal.

In this complex and uncertain setting, it is important that the major participants in the coal chain collaborate to understand and overcome potential impediments to investment in the industry. This includes producers, infrastructure providers, users and those involved in the planning, financing and equipping of new coal mines and power stations. The CIAB proposes a joint effort with the IEA to illustrate how efficient collaboration across the coal chain, leading to an increase in the supply of coal for power generation, can reduce the cost and price volatility of electricity supplies across all regions.
5. CIAB MEMBERS' RESPONSES TO INVESTMENT QUESTIONS

Responses to Question 1

How can the electrification of the economies of developing countries be accelerated to alleviate poverty, and how may the coal industry aid this acceleration?

Responses submitted by:

- Mr. John Smith, Chief Operating Officer, Energy Coal, BHP Billiton
- Mr. Greg Boyce, President and Chief Operating Officer, Peabody Energy
- Dr. Jürgen W Stadelhofer, President and CEO, RAG Coal International
- Mr. Ömer Ünver, Head of Project Studies, Turkish Coal Enterprises
- Ms. Barbara Altizer, Executive Director, Eastern Coal Council
- Dr. Steve Lennon, Executive Director, Resources & Strategy, ESKOM

Global coal producer response

Lack of electrification correlates strongly with poverty, preventing the major structural changes needed to transform agrarian societies into industrial economies. The benefits of electrification in lifting people out of poverty and generating industry, particularly in rural areas, has been demonstrated in countries such as China, South Africa, Thailand, Malaysia and India.

However, electrification can involve difficult and complex choices for developing countries in contexts where needs are great and resources limited. Grid-based power is capital intensive and often presents policymakers with the problem that the market required to enable decent returns on power investment cannot develop in the absence of access to the electricity to be provided by it. In addition, finance can be hard to obtain and increasingly decisions must seek to reconcile environmental sustainability with affordability and energy security.

The coal industry can assist electrification in developing countries by helping them meet these challenges - that is, by contributing to the conditions under which the development and expansion of grid-based power is practical, affordable and environmentally acceptable. Above all, the industry can assist by helping developing countries to efficiently and sustainably utilise their indigenous coal resources, where available and economic, and otherwise by supplying high quality, low-cost coal for them to import.
This is because coal is the most accessible fuel, in terms of practicality and cost, for base load power generation in most developing countries. It is the most abundant of the fossil fuels and has advantages also over non-fossil options such as unutilised hydropower, which is limited, and nuclear power, which faces particular risk and cost hurdles. Coal is reliably the cheapest option for base load generation, except where natural gas is abundant and readily available, and is much less capital intensive than gas in terms of establishing new supply - the 2003 WEIO report found that forecast increases in world gas supply to 2030 would require investment of USD 28 per tonne of oil equivalent compared to less than USD 5/toe for coal and USD 22/toe for oil. This difference will be particularly telling for developing countries in which gas transport and storage infrastructure is undeveloped, and project finance is harder to obtain due to perceptions of higher market and country risk.

Nevertheless, access to funding for any large-scale power development is likely to be a key issue for developing countries. Many will continue to rely heavily on external capital from multilateral lenders such as the World Bank Group (WBG), which is why a recent stakeholder review report on the WBG’s involvement in extractive industries was difficult to understand from a sustainable development point of view. Entitled Striking a Better Balance, it recommended that the WBG withdraw from investment in coal development, and instead concentrate its energy sector lending on promoting a transition to renewable energy and endorsing natural gas as a bridging fuel.

While that recommendation has not been adopted - the WBG decided to “remain engaged in coal and oil projects while doing more on renewable energy and energy efficiency” - it highlights another important means by which the coal industry can aid electrification in developing countries. This is to challenge simplistic notions such as that contained in the Extractive Industries Review report, and argue for rational energy policies that reflect a more sophisticated and balanced view, which the industry did on that occasion through the World Coal Institute (WCI).

Through bodies such as the WCI and the CIAB, the industry needs to articulate the environmental improvements in coal use that have occurred and are in prospect in developing countries, and place these within the context of these countries’ particular development needs. The industry also needs to put the case to governments and non-governmental organisations like the World Bank for clear and balanced policies that reflect energy market realities and the aspirations of developing countries to improve their circumstances through practical and affordable development strategies, including coal-based electrification.

Mr. John Smith  Chief Operating Officer, Energy Coal  BHP Billiton

North American coal producer response

“Reliable energy is a key component of economic and social development, and lack of energy is among the key forces slowing down poverty reduction and growth of the rural sector.” These pointed observations were declared by the World Bank in 2002.

In the past two decades, about 1 billion people have gained access to electricity via coal, and world energy demand is predicted to grow by two-thirds over the next thirty years. Most of this growth is expected to take place in developing countries. All fuels will play their part, and coal’s role will be vital, thanks to a huge
reserve base, reliable supplies, low cost and technological advancements that contribute to continuous environmental improvement. Increasingly clean, coal-fuelled energy carries enormous benefits for society by ensuring affordable electricity, a strong economy, a clean environment and energy security.

Consider China’s success story, where 84 percent of the country’s electricity comes from coal. In the past 15 years, 700 million people have been linked to electricity, and the country is now 98 percent electrified. At the same time, China’s economy grew by an annual rate of 9.1 percent during this period. India has the opportunity to achieve greater electrification though use of its extensive coal reserves, and other nations lacking domestic coal resources would benefit from the world’s abundance of coal by participating in the expanding world coal trade market.

“Of all factors that combine to degrade health, poverty stands out for its overwhelming role,” said the World Resources Institute in 1998. If developing countries can spend less on energy, they can place more wealth on other essential development items. Since coal is the low-cost energy solution for most countries, it can play a prominent role in reducing poverty and improving the health of individuals.

To accelerate electrification in developing countries, access to affordable fuel is essential, along with the ability to construct centralized electrical generating stations, and transmission and distribution systems. Completing electrical generation, transmission and distribution projects requires significant capital and lead time, making the integrity of the procurement process and ability to complete construction imperative. When the right government systems are in place, coal can help developing countries provide low cost electricity for their citizens.

Mr. Greg Boyce President and Chief Operating Officer Peabody Energy

European coal producer response

The United Nations and other development agencies identified electrification as one major pre-condition for poverty alleviation in developing countries. Improved access to energy services is an underlying component linked to the achievement of the Millennium Development Goals adopted by the World Bank, the IMF, and other agencies in September 2000.

Today, some 1.6 billion people have no access to electricity. In the absence of vigorous new policies, 1.4 billion people will still lack electricity in 2030 as the IEA states in the study “energy and poverty”. Referring to UN projections 95% of the increase in population until 2030 will occur in urban areas. This requires high on-grid capacity expansions within the next three decades.

Coal, with its widespread and abundant reserves, is capable of providing power supply for on grid applications in a cost effective and secure way based on established technologies. In addition, in developing countries with indigenous coal reserves, coal-based power generation offers a secure long-term option while increasing indigenous production and reducing import dependency, as well as the energy import bill.

In many developing countries, the major barrier for investment in power generation capacities based on coal, as well as other fossil fuels, is the lack of domestic capital. For this reason, specific capital requirements of different energy sources might have a greater influence on the choice of energy for power generation in developing countries compared to industrialised countries.
In developing countries with indigenous coal reserves coal might be the energy of first choice because of less capital required for exploration than for oil and gas offsetting higher investment requirements for building power generation capacities based on coal compared to other fossil fuels.

In those countries that do not have indigenous coal reserves, coal might be the energy source of first choice only if lower capital requirements for import infrastructure and inland transportation compared to the capital requirements for gas import infrastructure (e.g. pipelines) offset higher capital requirements for coal-based power generation capacities compared to gas plants.

One option to overcome the obstacle of lack of capital for investment in power generation in developing countries is the engagement of power generating companies based in industrialised countries as independent power producers (IPP). IPP as operated by Steag a subsidiary of RAG stands for domestic power generation with the power generator being independent from grid operators generating electricity for large companies who supply end users. The investing company takes full responsibility for all phases of a power project - from project development to project realisation and finally to operation and maintenance management. Besides the foreign investment, the customer benefits from competitive energy prices, customized solutions based on proven concepts, high availability, use of regional fuels, environmentally friendly technology, innovative recycling concepts and regional development. In the developing country, IPP projects help to alleviate poverty, build capacity and help to protect the environment.

Therefore it is crucial that development agencies as well as national governments do not discriminate against coal and allow for investment in coal-fired power generation in developing countries to increase electrification and to help alleviate poverty. A key contribution would be the development of financing methods to enable the construction of state-of-the-art coal power stations in developing countries. Offsets against any agreed national CO₂ reduction targets will be an important element of this.

**European coal producer response**

Total alleviation of poverty by means of energy may not be realistic, although electrification of the community or accessibility to electricity may help to create at least an opportunity for even development in the developing economies. Accessible electricity implies a cost that everyone can afford.

Coal is the only source worldwide that can be utilized with reasonable price. Its availability is a big advantage from the standpoint that it is produced in more than 50 countries and is available without geographic restrictions. Coal reserves are abundant and its availability has never been a subject of speculation. Recent developments in oil and gas (its political character, price, turbulence and unreliable supply positions) stress the fact that reliance on these fuels by the developing economies carries a lot of economic and political risks. It is evident that, for the developing economies as well as developed economies, oil and gas carry unacceptable risks for economic development. Bearing in mind the problematic character of nuclear and the cost of renewable energy, the only reliable and least cost decision is coal-based electrification.
North American coal producer trade association response

A combination of two major factors, acting together, creates barriers to rural electrification in many developing nations: lack of investment capital available for electrification, given the risks of potential capital recovery; and lack of legal and market structures (such as property rights protections) that would be necessary to reduce the risks of major investments in those nations.

Whether or not the coal industry has the capacity to address these problems on a regional or global level is questionable, although the industry certainly has opportunities to do so in countries where it operates. The industry’s support for efforts by international institutions to advance democratic, transparent, and corruption-free governments committed to advancing citizen welfare through market economies will contribute to solution of these problems over the longer term.

Ms. Barbara Altizer  
Executive Director  
Eastern Coal Council

South African coal consumer response

Electricity plays a vital role in the realisation of the Millennium Development Goals and the alleviation of poverty and is a key enabler for economic growth. In addition to powering industrial and commercial development, electrification brings about an improvement in the standard of living and improves the overall economic environment by stimulating small business development. Electrification also provides many environmental and socioeconomic benefits such as improved air quality and job creation. Therefore, for any nation or region to move forward and become competitive in the global market, providing reliable and affordable electricity is crucial. This is particularly true for African countries where it is estimated that only 17% of the population has access to electricity. Developing countries need to assess all available energy resources in order to determine the most appropriate basket of options for providing low cost electricity. As coal is widely available worldwide, it is likely that it will continue to play a dominant role in many countries’ electrification projects. Even with upward pressure on coal prices, all indications are that coal may still be a less costly option than many other energy sources.

Large scale electrification does however pose many challenges including the following:

- Establishment of backbone infrastructure - generation capacity and transmission infrastructure.
- Reducing the cost per connection
- High costs associated with the supply of electricity to remote areas
- Affordability and payment
- Financing and lack of investment appetite
- Slow uptake of electricity and thus slow realisation of benefits

Areas of focus to accelerate electrification can include the following:

- Strong government intervention at early stages of development when socio-economic development of the country is a priority - especially in financing the basic infrastructure.
Quantification of the contribution of electrification to socio-economic development and progress towards improved quality of life.

Use of optimal technological and operational options in any electrification programme as well as associated reduction of costs.

Cost recovery of electrification programmes linked with affordability to the users.

Consideration of how to maximise benefits over both the shorter and longer terms.

Modelling as a tool to develop options to manage load distribution.

Use of focused demand-side management interventions to assist with affordability.

Leverage of state financing, ODA and private sector investments to optimal manage the overall infrastructure development.

The role that the coal industry can play in electrification initiatives includes the following:

- Electrification of communities adjacent to coal mines as part of community development programmes.
- The transfer of appropriate technologies which can assist in meeting energy requirements in a more sustainable manner, in other words by “leap-frogging” into new technological areas - e.g. state of the art efficient coal combustion equipment.
- New and advanced coal technologies which are cost effective are key to the continued use of coal, such as underground coal gasification. This must also include more efficient, lower cost and cleaner ways of burning coal in domestic applications as an interim measure until electricity uptake is improved.
- Technologies around smaller and distributed energy supply sources could be developed for stand alone rural applications - e.g. small-scale coal generation.
- Technologies that increase and strengthen infrastructure are also critical. This could include interconnectivity between countries and regions and thus a more robust infrastructure. In Africa, the New Partnership for Africa’s Development (NEPAD) will play a critical role in this area and the optimisation of regional energy resources, of which coal is an important component.
- Partnerships between suppliers and end users to optimise the supply chain and increase benefits.

Responses to Question 2

How is the liberalisation of electricity generation affecting investment in the coal chain?

Responses submitted by:

- Mr. J. Brett Harvey, President and CEO, CONSOL Energy
- Dr. Steve Lennon, Executive Director, Resources & Strategy, ESKOM
- Dr. Gert Maichel, President and CEO, RWE Power AG & Executive Vice President, RWE
North American coal producer response

Liberalisation, or what I will refer to as deregulation, in the North American power generation sector has had a significant impact on investment in the North American coal chain. There are two major time periods that should be assessed: (1) the period when states were moving en masse towards deregulation (up to the Enron collapse) and (2) today where there is significant movement in the opposite direction towards re-regulation.

The first period saw the removal of government guarantees that increased generators’ costs of capital and the forcing of market participation on both generators and customers. These resulted in generators pushing their increased risk profile to their primary supplier, the coal industry. As a result, coal sales volumes became more volatile, more emphasis was placed on spot market participation, and fuel sales contracts became shorter in duration and more market-based in price. Market immaturity also played a role by not efficiently recognizing that coal is a multi-product commodity, by not matching coals to power plant designs optimally, and by creating a mismatch between durations of power sale and fuel supply contracts. The impacts were volatile fluctuations in coal prices, increased risk of coal company cash flows, increased costs of capital, and lower investment.

Today we find ourselves in the second period, with significant movement towards re-regulation. Note that this is a movement towards regulation and not necessarily a move to complete regulation. There is a difference and I believe that the best position lies somewhere between the extremes of complete regulation and complete deregulation. The benefits of partial re-regulation on coal chain investment include:

- A mechanism for recovery of and return on incremental capital investment. This reverses the trends of the first period, increasing long-term reliability of asset operations and also cash flow generation. If implemented properly, this would encourage needed capital additions for reliability while ensuring maximum utilisation of existing capacity.

- The potential for significant reductions in emissions of SO\(_2\), NO\(_x\), and mercury at a time when the utilisation of coal should increase. This would result from power generators being able to invest more capital into environmental control technologies at existing coal plants.

- An improved level of security of supply, which includes the ability to access indigenous fuel sources and to utilize fuels that provide the best plant equipment availability (i.e., typically this equates to utilizing coals that the power plants were originally designed to burn).

- The inclusion of key stakeholders into the long-term decision-making process surrounding power generation. This would allow fuel commitments to match longer-term horizons for generation planning, allowing for greater coordination of development cycles for capacity addition in the power and fuel markets.

In conclusion, a movement away from pure deregulation and at least a partial return to regulation will decrease the volatility to which the power sector is currently exposed. This reduced volatility should allow...
the power industry to take a longer-term view of strategic decisions such as fuel supply, capital deployment, and sustainable development. This in turn should provide better visibility, lower risk, and longer lead times for the coal industry to commit needed resources to future projects.

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**South African coal consumer response**

Based on the projections of world electricity demand, the electricity sector is expected to spend almost USD 10 trillion\(^1\) over the next three decades, with the largest portion of this being spent on electricity generation. On average, investment in the coal industry and in coal-fired electricity generation plants combined is significant and is expected to be around USD 1.9 trillion\(^1\). In Africa, and specifically South Africa, the need is for significant investment in the coal industry to meet growth in coal consumption for electricity generation and to maintain and expand exports.

Higher rates of electricity demand growth in the developing countries, coupled with the competitiveness of coal-fired electricity generation and the abundant availability of coal ensures that global demand growth for coal remains robust.

It is likely that the liberalisation of the electricity generation industry will pave the way for players in the coal chain to participate in the electricity supply industry, and vice versa, as less capital will be required and smaller, competitive players can enter the markets. The continued deregulation of electricity markets and the removal of subsidies, import barriers and other market distortions will continue to drive a shift in coal production to the lowest-cost production regions.

The liberalisation of the electricity generation market is also resulting in the electricity sector evaluating the risks of investments in the long- and short-term. Many businesses are focusing on investments with lower up-front capital requirements and more flexibility in terms of lead times and expansion opportunities. This tends to work against investments in coal-based technologies which are typically capital intensive and which require long lead times. Electricity utilities are also in some cases, moving away from centralized investments in large scale electricity generation with economies of scale, to smaller more decentralized and flexible units. This has implications for coal infrastructure investments in terms of coal supply mechanisms and technologies. It can be argued that liberalisation of electricity markets is resulting in non-optimal investments - with short-term considerations over riding long-term life cycle cost considerations. This can further result in non-optimal resource allocations and ultimately increased electricity prices for the consumer. As such, the negative external impacts, especially in developing countries, could be significant.

There are also increasing pressures on electricity and other businesses to address sustainability along the supply chain in order to improve, for example, environmental performance. This could mean a decrease in coal related projects. Thus investments in coal will need in future to focus on increased efficiencies and, on the coal supply side, investments in coal beneficiation projects.

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In addition, in order to meet the challenges posed by the liberalisation of electricity markets, it is clear that the coal industry should focus on:

- Short lead time technologies and processes
- Low up front capital technologies
- Carbon sequestration technologies
- Influencing policy and regulatory frameworks to ensure an environment conducive to long-term investment decision making

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**European coal producer/consumer response**

The liberalisation of the power market amounted to a deep incision in the underlying conditions of electricity production; Great Britain and Germany have already reached a market liberalisation of 100%. Others like France and Greece have opened less of their electricity markets to competition. The E.U. as a whole reports an approx. 70% degree of market opening, and, in the next few years, liberalisation will affect all EU-25 countries.

Experience gained by the liberalised British and German power markets proves that pricing is market- and not cost-oriented, which resulted in an erosion in power prices. The liberalised power market is characterised by strong price volatility. This calls for high flexibility in capacity utilisation of coal-fired power plants. Investments are only made if price expectations are positive. In investment decisions, coal is weighed against natural gas. Short-term thinking and high market uncertainty are the rule. However, a long-term strategy will have to be developed and pursued in any of the EU-25 countries to maintain market access for coal in the long run.

Today, coal is a significant player in the power generation sector of Europe. In the short-term, there must be a further adjustment to the liberalised market. Coal’s importance in Europe is in fact set to grow with E.U. enlargement. In many of the accession countries, hard coal and lignite play a key role in the energy supply sector. However, the costs of coal and coal-based power will have to be competitive, and the transition process to a market economy will take a long time, especially in the accession countries.

The liberalised European market for electric power will strengthen the industrial base and offer electricity to the consumer at a reasonable price. The goal must be to maintain ample and competitive supplies of power. That is a field to which coal makes a major contribution.

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**North American coal consumer response**

The liberalization of electricity generation is a dual edged sword. Allowing competition to set prices in the electric marketplace clearly drives cost down and forces electric generators to seek more efficient and lower
cost methods of operating. Because the production cost from a coal plant is significantly lower than that of a gas-fired plant, coal-fired plants will typically be operated at much higher capacity factors in a competitive environment. This will result in existing coal plants being operated at a higher capacity factor, which increases coal demand and encourages more investment in the coal supply chain.

On the other hand, in a liberalized marketplace, the market sets the price of electricity regardless of the cost. If there is sufficient or excess capacity available, which is a requirement of the electric grid, the market price of electricity is often enough to cover the fuel and operating cost, but not high enough to allow the investor to recover the capital investment in a facility. This situation discourages investing in new, capital-intensive, coal-fired plants until the market signals indicate that the market price of electricity will be high enough on a sustainable basis to allow both recovery of the capital investment and to earn a profit on the capital investment. However, because coal plants are more capital intensive and can take twice as long to build than natural gas combined cycle plants, waiting until the market signals call for new capacity could favour the installation of natural gas combined cycles plants over new coal plants.

The liberalized marketplace in the United States led to an abundance of investment in new gas-fired combustion turbines and investment in very few new coal-fired plants during the past decade because the developers of new power plants were complying with market signals as above rather than taking the long-term strategic approach of installing coal-fired plants. It is believed by many experts in the industry that re-regulation of the electric industry in the United States will facilitate strategic approaches which encourage investing in new coal-fired plants rather than following the market which has encouraged investing in new gas-fired combustion turbines, provided coal plants can meet the necessary emission requirements.

Asia-Pacific coal consumer response

In Japan, deregulation of the electric power industry has moved forward since the middle of the 1990s. In 1995, liberalization of the wholesale electricity market started. In 1999 retail sales were deregulated for major customers (comprising 26% of the market) such as large office buildings or factories with electricity usage greater than 20kV or 2,000kW. In April 2004, the threshold for deregulation was decreased to 500kW and this figure will be further decreased to 50kW in April 2005. At that point, up to 60% of energy demand will be deregulated. Furthermore, studies aiming at deregulation of residential customers will start from 2007. Power exchange in the wholesale market will start from next year, enabling power procurement through the market in addition to long-term, “over the counter” contracts. Under such circumstances, many companies in various industries have entered the IPP or retail sales businesses. The Japanese power business is about to enter a new phase of “market” and “competition”.

We expect that expansion of the deregulated power markets will lead to diversified procurement of electricity by utility companies and that coal-fired power plant as well as LNG power plant will have more importance as low-cost merchant plant. Japan produces only a small amount of natural gas domestically and 97% is imported in the form of LNG. Imported coal currently costs about 1.5USD/MMBTU (CIF, FY2002 average) and this is one third of the LNG price. Therefore the deregulated power market, which favours low price electricity, will promote investments for coal-fired power plant and coal-related infrastructure. As a matter of fact, a lot of new sub-bituminous coal mines have already been developed in Indonesia as Japanese power companies expand their use of low-cost sub-bituminous coal.
However, from the viewpoint of capital investment, lead times and construction costs for coal-fired power plant are greater than those for LNG-fired plant. At the same time, several risks of environmental regulation such as carbon tax need to be considered because coal use produces higher CO₂ emission per kWh.

The current situation in Japan is a transitional period for the liberalizing power industry. Although conventional long-term contracts are starting to be “eroded”, power-trading markets with moderate liquidity have yet to be established. Therefore, now is a difficult period in which to make effective investment decisions that will produce acceptable financial returns.

Asia-Pacific coal consumer response

It is often said that liberalisation will hamper new investments in any type of electricity generation, whether it may be coal, gas or another type. This is true to some extent because generators may lose their markets when they are not competitive enough and investments may be stranded. But at the end of the day as long as demand is growing, generators never lose their appetite for new investments.

The problems in developed countries are those of concurrent liberalisation and market maturity. Without future demand growth, generators do not need new capacity. It is the case not only with coal but also with other types of generation.

When generators replace old generation units and determine new fuels, they take energy mix, environmental restrictions and prices into consideration. In liberalised energy markets, coal has merits such as flexibility and competitive prices. It has been the natural first choice, but LNG also has some flexibility and price competitiveness. In view of the increased price levels and volatility of coal these days, the traditional merits of coal have decreased and the relative attractiveness of LNG has increased.

In addition, lack of future clarity regarding environmental regulations has a negative influence upon coal.

European coal consumer response

In summary, the liberalization of electricity generation in Great Britain is having a relatively small effect on the choice of fuel source when compared to the current environmental considerations.

The England and Wales generation market is highly competitive with a mix of power stations owned variously by the Vertically Integrated (VI) players, large players like British Energy and the independent merchant operators. The fuel type is roughly split between coal, at large power stations mainly built in the era of the Central Electricity Generating Board (CEGB), nuclear of varying ages and different technologies,
and gas fired Combined Cycle Gas Turbine (CCGT) built since privatisation in the 1990s. There is also a drive by the U.K. Government to increase renewables generation, mainly wind and biomass, by obligations on electricity suppliers and subsidies to investors in the form of Renewable Obligation Certificates (ROCs).

To further the E.U. drive for cleaner generating technologies and to reduce CO₂ emissions the Large Combustion Plant Directive (LCPD) and Emissions Trading Scheme (ETS or “Carbon Trading”) are being implemented. LCPD will strictly limit the remaining life of a coal-fired power station unless it complies with strict emission limits for NOₓ and SO₂ which requires coal-fired power stations to fit suitable NOₓ abatement technology and costly Flue Gas Desulphurisation (FGD) if they have not done so already. Some owners have decided to fit FGD, but it is thought that many owners will ‘opt out’. This would mean that these coal-fired power stations will have to severely reduce load factor and then shut, according to the current rules, early in the next decade. The ETS creates an incentive for lower CO₂ power generation, so the amount of generation from coal will depend on the price differential, including the cost of carbon, to alternative fuels and the generating technology.

Due to the uncertainty that coal-fired generation faces, and the relative economics of building CCGTs, there are no current plans to build new large coal-fired power stations in the U.K. The test is actually whether it is economic to fit FGD to the remaining coal-fired power stations, but the rules are complicated and decisions to ‘opt in’ have to be made while the future economics are still uncertain and before the rules have been fully agreed.

The U.K. Government would want generators to retain some coal-fired capacity, operating at lower load factors, on security and fuel diversity grounds at least until it has confidence that the U.K. has access to diverse sources of gas and the infrastructure is there to deliver it, and renewables are making a substantive contribution. However, it remains to be seen whether it will structure the market and regulatory framework to support this. Given the importance of reducing CO₂ emissions and the Government’s continuing commitment to market based policies, further investment by generators in new coal-fired capacity is unlikely until carbon capture and storage becomes a real commercial option and is competitive with other low carbon options.

Dr. Tony Cocker
Managing Director, Energy Wholesale
E.ON UK

European coal consumer trade association response

The liberalisation of electricity generation has immersed the electricity industry into competition. The traditional power suppliers have to cope with competition from new market players and, in addition to the threat of squeezed margins and loss of sales, with severe cost-cutting programmes, re-organisation, and new combined products and services. Also, in many cases, companies have gone international, looking for new market opportunities as a way to try to maintain the same level of profitability. Power prices to customers have dropped due to competition. Prices quoted on the power wholesale markets make it clear that the greatest pressures of liberalisation and deregulation affect power generation. Liberalised and competitive power markets are not only giving new opportunities for utilities, but also creating new risks, the most important of which are price risks and sales risks.

In a competitive market, prices are largely determined by the specific marginal costs of the last generation unit. All other generators with lower marginal production costs receive this price for their supplies.
For the existing power plants, the investments made are often regarded as “sunk costs”, and thus considered irrelevant for the decision of whether to produce or not. In this context, the cost components of the power plants are very important for their ability to compete. In other words, in a competitive market, the variable cost of individual plants is the key factor. This is basically determined by the efficiency of the plants and maintenance and fuel cost, with the latter offering some cost-cutting potential. Power plants with low variable generation costs are at an advantage in the wholesale power market (e.g. coal-fired plant), however this advantage can be partially or totally neutralised by the new climate change restrictions.

For the new plants in a liberalised power market, it is much more difficult to assess their economic feasibility and competitiveness. On the one hand, this depends on the uncertainty of the long-term development of power prices and fuel prices, and, on the other hand, increasingly stringent environmental and climate protection. Because of the amount of capital tied up and the long amortisation periods, capital-intensive generation technologies hardly have a chance in a liberalised power market. Due to the market price risks, less capital-intensive power plants, which can also be built more quickly, are the preferred option, which implies the construction of GTCC power plants in detriment to coal-fired power plants.

The external cost arising from tougher environmental and climate protection controls applied to the different power generation plants may lead to some changes in the merit order and thus in their relative competitive position. Internalising these external costs would represent an economic burden for coal-fired power generation with a detrimental effect on its ability to compete, unless relative coal prices remain so attractive that they could offset a certain portion of these costs. We can expect that changes in the power market will likely affect the coal chain in a negative way. To face these challenges, the coal chain will have to make some efforts to cut cost in all areas (production, transport, combustion technologies) in order to keep coal as a competitive option in the new context.

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Responses to Question 3

How will the financing of coal production, rail and port infrastructure and coal-fired generation be achieved given the uncertainty surrounding future carbon policies?

Responses submitted by:

- Mr. Preston Chiaro, CEO Energy, Rio Tinto plc
- Mr. Bret Clayton, President and CEO, Kennecott Energy Company
- Dr. Grant Thorne, Managing Director, Rio Tinto Coal Australia Ltd
- Mr. Susumu Shirakawa, Managing Director, Tokyo Electric Power Co. Inc.
Asia-Pacific/North American coal producer response

Energy demand continues to rise steadily. This trend is expected to continue over at least the next 20 years. Energy demand is linked with economic growth, which in turn is a sign of a healthy economy. IEA have forecast that up to USD 16 trillion in energy-related investment, primarily in the power sector, will be required over the next 25 years to service this rising energy demand. Coal investment is much smaller at USD 400 billion, or USD 1.9 trillion if coal-fired power stations are included.\(^2\)

New investment is welcome as it provides the opportunity for best practice outcomes in cost, efficiency, and environmental performance. Financing these investments will be a challenge as there is strong global competition for funds, and much of the investment will be required in developing countries. In the case of electricity infrastructure, the utility sector in many economies is extremely competitive. This, combined with the uncertainty around future policy on GHG emissions, has led to an uncertain investment climate.

The extent and rate of abatement of emissions from coal-based generation will depend upon the development and deployment of new technologies. Understanding the risks associated with new technologies will be essential if new investment is to be forthcoming.

Key actions required to assist this financing are to:

- Engage Financial Institutions - The source of finance for these industries will be multi-lateral agencies and private and commercial lending institutions. Public funding is vital to attract private finance, and these agencies enhance project credibility through independent analysis, risk mitigation, debt provision and credit guarantees. Actions are required to assist finance institutions to more fully understand the elements of project and technology risk.

- Work with Governments - The investment climate will be shaped by the policies pursued by governments, and their ability to attract finance. Engagement with governments is required to ensure that best practice in financing is followed as much as possible. 10 priorities for project finance have recently been discussed at the APEC Energy working group and are appended.

- Research and Develop Advanced and Zero Emissions technologies - In the next 10 to 15 years, research effort will focus on demonstration of priority technologies for addressing climate change. This has important implications for energy policy and the respective roles of government and industry. Demonstration-scale plants for technologies, such as CO\(_2\) capture and storage and oxy-firing, will involve significant funds. Industry will need government assistance if it is to invest in these first-of-a-kind integrated facilities. There is a range of direct and indirect instruments available to government, and projects will differ in scale, risk profile and market circumstances.

- Careful Direction of Industry Funding - Industry and government will have to ensure that development expenditure is carefully targeted to avoid duplication of effort and accelerate the most prospective

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technologies. Close collaboration across the international research, development, and deployment efforts is required to assist the progress of priority technologies.

**Attachment to response (Chiaro/Clayton/Thorne)**

**APEC Energy Working Group - Ten Priorities for Financing Energy Infrastructure Projects within the APEC Region**

This list has been developed following the ‘Financing Energy Infrastructure Workshop’, an initiative of the EWG Business Network (EBN) held in Hong Kong, China, 19 March 2004. The priorities are designed to help guide APEC economies as they face the significant challenge of mobilising private capital and international financial resources to fund the estimated USD 3.4 trillion to USD 4.4 trillion in energy infrastructure investments required over the next 20 years.

- Energy infrastructure projects must be consistent with an economy’s specific energy security and sustainable development objectives (e.g. strengthening the security and reliability of affordable energy to all, achieving environmental improvement of energy production and use). Government policies in these areas should be specified in sufficient detail to provide clear guidance to project developers and their financiers to facilitate long-term investment and financing decisions.

- Economies should establish stable, transparent, independently administered, predictable and non-discriminatory legal, fiscal, regulatory and trade regimes that support the enforceability of project contracts and consider the interests of all participants, including for projects of a cross-border nature.

- In the longer term, full cost and benefits of energy infrastructure projects should be underpinned by end-user demand for such services and the ability for customers to pay for such services at tariffs that make projects financially viable.

- Energy infrastructure project contracts, which are commercial in nature and to be resolved by the negotiating parties, should include provisions to address financial risk, including for inflation, interest rate and foreign exchange rate fluctuations, and investor returns.

- Energy infrastructure projects should:
  - be well planned and supported by credible demand forecasts;
  - be clearly described to potential investors;
  - be supported by an open, transparent and competitive bidding process to facilitate participation from a broad range of potential investors (banks, institutional investors, pension funds, multilateral financial institutions);
  - have stable, transparent, non-discriminatory, timely and administratively efficient project approval processes; and
  - have competent and experienced project sponsors.

- The participation of multilateral and/or international financial institutions in energy infrastructure projects can enhance their quality, credibility and credit standing through services such as independent analysis and evaluation, risk mitigation, debt provision and credit guarantees.
Project developers should be able to exercise effective operational and management control of projects with minimal government intervention. Decisions for government intervention, for example, to address credit and political risk, should include consideration of the needs of developers and financiers and the long-term viability of projects.

Project financiers should have a proven track record in project financing, a capacity for long-term commitment and for communicating with project stakeholders throughout the life of the project, and a willingness and capacity to effectively partner with project developers and share project risk.

When establishing or reforming energy market structures, economies should recognize that the energy infrastructure can be owned by government or the private sector (domestic and foreign).

Economies should permit project financiers to undertake capital transfers and unrestricted repatriation.

**Asia-Pacific coal consumer response**

The following points are focused on coal-fired electricity generation.

Under very uncertain circumstances in which we do not know future environmental regulations and available R&D resources for carbon reduction, I feel hesitant, as a generator, to consider new long-term investments. Even if we have a desire for investment, terms and conditions for financing will be difficult.

Policy-makers need to show roadmaps for future coal generation.

It is necessary to link finance conditions with project environmental friendliness. Those projects with less environmental impact could well be given better finance schemes. Particularly in developing countries, the introduction of high efficiency coal units will significantly improve environments. Finance allocations for clean coal technology could justifiably be created at such institutions as World Bank, Asia Development Bank and EBRD.

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Mr. Susumu Shirakawa  
Managing Director  
Tokyo Electric Power Co. Inc.

**European coal consumer response**

At this point, coal is a very competitive fuel for power generation purposes. This is likely to remain the case on a world scale, despite emission issues. In Europe, high emission costs would push coal generation to the margin of the merit order, effectively turning coal plants into peak plants, resulting in lower coal consumption. But even if emission costs turn out to be very high, restrictions and bottlenecks within the gas system will leave room for coal-fired generation. Renewables will dampen coal demand as well, but cannot compete with the reliability of coal-fired generation. Therefore, coal is expected to stay well represented in the European fuel mix, but possibly losing some share due to emissions cost. Yet, in other regions of the world, CO2 emission will be less of an issue. Growth in these areas is likely to compensate any potential loss from emission constraints.

So overall, world demand for coal will stay at current levels or increase if 1) emission costs do not get to high, 2) growth areas (Asia) show strong growth. As long as upstream companies (coal producers) and governments from exporting countries believe in this scenario, they should feel confident to invest in required capacity and infrastructure.
With respect to coal-fired generation, investment plans are quite uncertain. No additional coal-fired capacity can be expected in Europe. Existing capacity might be replaced or modernized, but growth is expected to come from alternative generation sources (gas and renewables). Only significantly lower coal forward prices could change this.

Mr. Aad Atteveld  
General Manager, Production Department  
Essent Energy

**European coal consumer response**

Following on from the answer to question 2 there are currently no advanced plans that we are aware of to invest in coal generation infrastructure in Great Britain. The only current investment in coal-fired power stations is at operating stations to extend their lives by normal maintenance activities and the relatively costly fitting of FGD and supplementary low NOx combustion technologies to comply with new legislation. The investment is funded by the owners, typically the large Vertically Integrated players, on the back of the economics of their portfolio of power stations.

It is likely that financing of new coal-fired power stations and infrastructure will only be required:

- Following a technological breakthrough, e.g. carbon sequestration becoming viable, or
- If there is a reassessment of environmental considerations or relative fuel mix, involving stronger messages from U.K. Government on the possible role for coal.

In any event, new coal-fired power plant would have to comply with very stringent requirements in respect of allowable emissions. This would almost certainly have to involve state of the art SOx and NOx abatement technologies and the highest plant efficiencies possible in order to reduce the level of CO2 produced per unit of electricity generated. In the extreme, some measure of carbon capture and storage may also be required. In all respects, the coal-fired power plant of the future would have to contain many technologies that are beyond the current design experience of power plant manufacturers and the prospective owners of the first installations would face considerable risk in respect of plant availability and performance.

To incentivise companies to consider first demonstration of an advanced concept would almost certainly require a financial contribution from government to offset the perceived risks. Successive clean coal RD&D programmes in the USA, managed by the Department of Energy, have allowed full scale demonstration of a range of advanced power concepts. The Vision 21 and FutureGen programmes are current demonstrations of the US Government’s commitment to maintain ‘clean coal’ as a cornerstone of the US energy mix. Governments elsewhere have generally not demonstrated a similar level of support. The European Union has supported the demonstration of a limited number of technologies at large scale (notably the IGCC installations at Buggenum and Puertollano), but the U.K. Government has mostly restricted its support to the R&D level.

The case for U.K. Government support for the large-scale demonstration of a clean coal power generation technology was reviewed about three years ago and ostensibly rejected. However, the more recent Energy White Paper is more encouraging and the scope of a carbon abatement RD&D programme is currently being defined and could include an emphasis on demonstration. Preliminary engineering studies on the suitability of both supercritical pulverised coal and IGCC (both with and without CO2 capture and
storage) are likely to attract funding support from U.K. Government under an existing clean coal programme. Proposals to build an IGCC plant are fairly well advanced, but such a scheme is unlikely to go ahead without the government support that the new carbon abatement programme might provide.

**European coal consumer response**

Generally, because of E.U. carbon policy, bioenergy has a favoured position with respect to public financing - direct or through subsidies or taxation, although it will not be a large-scale solution in combating the challenge of global warming. In developed countries, nuclear power will be the choice to expand carbon-free capacity. From a public opinion or political view, it is not favourable, but in Finland we have managed to achieve the political support for a new nuclear unit. That will probably be the roadmap in future for many other developed countries.

The countries/companies which have made highest efforts to reduce emissions will be in a situation where they have to buy emission certificates from countries which have emissions to sell. Previous successes in reducing emissions have been only partially taken into account in setting the targets (EU NAP). Because of other environmental restrictions or taxation policies buying allowances will be more profitable than to invest in new coal production under deregulated markets.

Basically, it is not a question of financing; the main issue in Europe under liberalised electricity market is how to find profitability for coal-fired production. Investment decisions will be affected by the degree to which E.U. emission trading scheme increases electricity prices and production costs.

If the rules are changing all the time, nobody dares to invest. E.U. emission trading policy should be supplemented by Kyoto flexible mechanisms (CDM, JI). Furthermore possible investors should have a long-range certainty that there will not be any new environmental restrictions for coal and that emission trading has replaced taxation as a tool in environmental policy. To ensure this, the E.U. should have a fixed long-term climate policy that acknowledges coal-based power plant technology as a part of an energy portfolio to achieve reliable, sustainable and competitive energy supply.

**North American coal transporter response**

Coal-based energy financing will be difficult and expensive given the regulatory uncertainty with respect to carbon policies. A “Kyoto-like” carbon program in the U.S. would render most coal-fired generation plants useless well before their economic life expires. This is based on the fact that there is no current technology to remove CO₂ from coal-fired generation plants. With regulatory uncertainty, utilities have been and will
continue to be reluctant to invest in coal-fired generation. However, we do not believe that electricity generation can be curtailed. It would appear that utility re-regulation will occur assuring higher prescribed pricing but also prescribed investment.

A Kyoto mandated carbon policy in the U.S. would mean a decision has been taken to reduce electric consumption significantly, a policy that could cause political and economic upheaval. This conclusion is based on the fact that coal accounts for 51% of electricity generation in the U.S. and the only currently available method for reducing CO2 emissions is to burn less coal or to produce more electricity with more efficient boilers. The absence of a rational plan for carbon and other emissions such as mercury, SO2, and NOx is adding to the lack of energy availability by creating extra volatility in the various coal markets. Prices must increase, and increase significantly, in response to pay for these risks and lack of investment as actual shortages seem more probable as the utilities postpone major generation plant construction and upgrading as a result of the perceived uncertainty. The lack of certainty has also resulted in reduced investment in eastern U.S. coal production.

Higher prices in North America will drive many energy intensive industries offshore to China and South America. A reduction in the living standard of most Americans would likely result from higher energy prices because of restrictive carbon reduction policies, tightening emissions plans, scarcity of natural gas and lost jobs.

While awaiting certainty from a new energy bill, which has not passed, financing for coal-based generation is being postponed. Recently, huge numbers of new natural gas generation plants were built and written off as uneconomic in a short period of time because of high gas prices. This has left a mark on the investment community. Investors will be much more reluctant when financing is sought for new coal-based generation given that a subsequent revision of a carbon reduction program could likewise render such new investments worthless in relatively short order.

Rails depend upon coal movements for over 43.6% of the originated tons and 20.6% of their combined revenues. The effect on the rail industry from the closure of coal-fired power plants under a tight carbon reduction regime would be significant. Even with coal markets improving, rails are still not earning their cost of capital but are making progress each year towards that goal. Obviously, this economic backdrop precludes any new investments of capital where the market, a facility or demand for production is uncertain.

Mr. David R. Goode Chairman, President and CEO Norfolk Southern Corporation

North American/European mining equipment manufacturer response

Carbon policies will affect the competitiveness of coal as a utility fuel. The carbon policy issues appear to have greater visibility and concern in the “developed” countries such as USA, Japan and in Europe, than in “developing” countries. The major users of coal for power generation in developing countries are likely to be China, India, and Russia. Whilst the need to reduce carbon emissions in these countries is recognised and talked about, it is unlikely that their economic development will be restricted to comply with carbon policies without significant financial support from the developed world.
In the US, the larger coal companies will continue to jockey for competitive position with investment strategies that balance risk for all industry participants. Rail, barge, lock and dam investment will need to be viewed with a long-term vision that not only supports the inevitable growth of coal mining, but also supports fundamental maintenance of the existing infrastructure.

The free market, combined with close working relationships with shippers and long lead times for new investment in mines, will ultimately determine success. Solid strategies and good execution will win support of the associated industries. That will drive investors to successful players. Most of the major mining concerns in the US have enjoyed huge gains in market capitalisation over recent times. These increases in stock value will allow investment in new projects and infrastructure.

In South Africa, investment in the mines and infrastructure will be essential. Investment in rail, port and coal-fired power generation will be funded by the market with government support and guarantees. It is estimated that 42.5 billion rand will be required and raised from public/private partnerships for rail and port infrastructure investment alone. Projects of this type and magnitude will involve global players and will only be possible with government support and guarantees. The projects will also be negotiated with provisions to utilise local industries to support the projects.

In China, production and infrastructure investment will be achieved through state-owned companies. However, companies like Shenhua International have plans to generate extra capital liquidity through an IPO. New companies are being created with joint state/private ownership. Major power generation companies are becoming involved in mining operations. Others are forming joint ventures with western companies or discussing future bond placements.

India will rely very heavily on coal for the future huge growth in demand for energy. This demand will be met from both indigenous and imported sources of coal. In the short and medium term, and possibly long term, the government will play a central and critical role in any investment in mines or infrastructure. It is difficult to forecast the outcome at this stage, as there is no defined strategy and regular changes in government and policy.

In Russia, there has been a major change in mine ownership over recent years. Most of the industry is now in private hands and a large proportion is owned by large vertically integrated organisations. Signs are that investment in mines is forthcoming but any investment in rail or port infrastructure will have to be government supported.

Mr. John Hanson
Chairman, President and Chief Executive Officer
Joy Global Inc.
Responses submitted by:

- Mr. Preston Chiaro, CEO Energy, Rio Tinto plc
- Mr. Bret Clayton, President and CEO Kennecott Energy Company
- Dr. Grant Thorne, Managing Director, Rio Tinto Coal Australia Ltd
- Mr. Peter Coates, Managing Director & Chief Executive Officer, Xstrata Coal
- Mr. Eric Ford, Chief Executive Officer, Anglo Coal Australia Pty Ltd.
- Mr. Peter Coates, Managing Director & Chief Executive Officer, Xstrata Coal
- Dr. Gert Maichel, President and CEO, RWE Power AG & Executive Vice President, RWE
- Dr. Tony Cocker, Managing Director, Energy Wholesale, E.ON UK
- Mr. Angel L. Vivar Rodriguez, Director of Energy Resources and Environment, UNESA

Asia-Pacific/North American coal producer response

The impact of ‘greenhouse gas emissions trading’ (emissions trading) will depend entirely upon the extent of the emissions reduction target adopted, the measures taken to reach that target, and the specifics of the proposed trading scheme.

Emissions trading is a market mechanism that can help achieve specific greenhouse gas (GHG) emissions reduction goals. It is not emissions trading itself that will impact development of coal mines and coal-fired electricity, but the mandated emission reductions target and the policies that will be pursued to reach any such targets. Much will also depend upon the rules of the emissions trading regime, which can be an efficient mechanism if well designed.

Affordable coal-fuelled electricity plays an important role in the economies of many countries. The implementation of mandated greenhouse gas emission reduction targets within a short-term horizon, with or without emission trading programs, could reward short-term reductions achieved by fuel switching from coal to gas and drastically reduce investment in new coal development. For example, most default “cap-and-trade” regulations based on achieving short-term reductions, result in coal market contractions, excess capacity and decreased return on investment. A recent study in the United States predicted that coal producer equity values would fall by 50% if carbon emissions were reduced by 23% in the short term (largely due to the timing of emissions reduction mandates). Obviously, this level of potential wealth destruction will strongly discourage investment in new coal development.

Short-term policies that negatively impact the development of technologies that enable the deep cuts that will ultimately be required will only increase the cost of abatement. For example, a policy that reduced coal producer equity values by 50% would make it impossible for the coal industry to invest in the development of promising near zero emissions technology.
The development of near zero emissions coal technologies offers the potential, in the medium-term future, to make a significant contribution to the stabilisation of atmospheric CO2 concentration. It is increasingly being accepted that continued use of fossil fuels, combined with Carbon Capture and Storage (CCS) through geo-sequestration, might be one route that minimizes the long-term cost to society. Recent modelling published by the IEA implies a 30% higher emission reduction for a given economic cost if CCS is used as one of a suite of tools to reduce emissions. This implies an increase in coal use of 175% by 2050 in comparison to scenarios without CCS technologies. Given that coal will play a critical role in the future energy mix of many nations, the failure to develop these technologies will limit the ability of society to address climate change concerns while balancing other societal goals, such as poverty alleviation.

The capital intensity and long-term nature of new coal developments also mean that uncertainty over the nature of future energy policy and potential regulation will discourage investment in coal development. Under any energy policy, with or without emissions trading, the future of new coal is likely to be dependant on society’s understanding of coal’s strategic value and this will depend on the willingness of industry to address the emissions from the use of coal. The extent to which society addresses these issues will be country specific, and therefore future coal development is likely to be focussed in countries where it is supported by government policy.

Continued investment in new coal development will require long-term energy policy that provides investment certainty over the life of the project, delivers technologies which can minimise the cost of abatement and supports the transition to the ultimate goal of zero net emissions.

Asia-Pacific coal producer response

The cost to power stations of emissions trading can to some degree be offset. This can be achieved by investments in developing countries (or Eastern Europe). This may take the form of replacing existing old coal-fired plants with modern gas plants, by buying cheap sources of emission credits from other countries, companies or projects, and by investing in processes which produce emission credits that can be utilised by the power stations.

In the case of new coal-fired power stations, their development may be slowed as the extra cost of increasing or raising the plant’s efficiency is incorporated. Increasing the efficiency of the plant means that lower greenhouse gas emissions occur for the same kWh output. These will include ultra-critical coal-fired plants, along with other hybrids which raise the efficiency of plant to greater than 50% (c.f. existing 33% to 44% units). Other alternatives exist for some degree of co-generation, which also raises the thermal efficiency of coal-fired plant.

The impact of the above will be a slower uptake of coal than originally planned based on coal-fired plants, resulting in coal mines growth at a lower level.

The use of coals with lower pollution potential will result in new mines producing higher energy coal with less ash and sulphur, or improved washing plants to minimise the poorer quality attributes of the coal. It may
also result in a requirement for higher energy coals, away from the recent expansion of sub bituminous coals in overseas markets. Other possibilities include coal mines being developed along with emission credits from dedicated forestry plantings, i.e. emission credits are incorporated into a total package that is supplied to power stations.

It should be recognised that, unless greenhouse penalties are very high, coal mine and coal-fired power station developments will occur anyway as the lowest cost fuel is still coal. Additional costs of electricity production associated with an emissions trading scheme are likely to be passed on to the end user (consumer), thus reducing the impact on the electricity producer (power station).

Mr. Peter Coates  
Managing Director and Chief Executive Officer  
Xstrata Coal

Asia-Pacific coal producer response

It was once widely thought that the development of wind and solar power and other renewable energy sources, combined with improving energy efficiencies and fuel switching from coal to gas would be sufficient to arrest global growth in greenhouse emissions while meeting increased energy demand - at least until new energy technologies are developed to replace fossil fuels in the longer term. This vision of re-aligning the mix of energy sources in the short to medium term, and leaving material technical development for the longer term, underpins emissions trading as a least cost mechanism for short- to medium-term adjustment.

It has now become apparent that the magnitude of global energy demand growth, particularly in the developing world, will overwhelm the emissions reduction scope provided by any partial re-alignment process. In the absence of practicable alternatives, coal will inevitably continue as a mainstay of global energy supply. A material curtailment in the growth of greenhouse gas emissions will therefore depend, at least in part, on the uptake of clean coal technologies.

Against this background, the effects of emissions trading on coal production and coal-fired power generation will depend very much on the type and coverage of the scheme or schemes adopted. If emissions trading is restricted to developed countries, the likely effects in those countries will include a heightened “dash for gas” for new power generation, retirement of older, less-efficient coal-fired generation capacity, and a more competitive position for wind power and other renewable energy sources. The cost of mining coal in those countries or importing coal into those countries will increase relative to production in, and imports to, exempt developing countries.

Emissions trading will encourage investment in the development of clean coal technologies and geosequestration in participating countries. Provided the trading mechanisms are appropriately designed, they should encourage the emergence of the most economical abatement technologies. However, the application of such technologies will inevitably drive up energy costs and lead to a loss of international competitiveness - particularly in developed countries with a high energy intensity and dependence on coal - such as the United States and Australia.

Unless developing countries also participate in emissions trading there is likely to be a transfer of energy intensive industrial growth to those countries - particularly those with major coal resources, such as China and India. In the absence of explicit costs associated with carbon emissions, there will be limited incentives for the uptake of clean coal technologies in non-participant countries and as a result emissions growth in those countries will tend to offset the reductions fostered by emissions trading in developed countries.
It seems clear that a restricted emissions trading scheme, encompassing only developed countries, is likely to result in a transfer of coal production and industrial utilisation (including coal-fired power generation) to developing countries with relatively modest incentives for the uptake of the clean coal technologies required to arrest the growth in global greenhouse emissions.

**European coal producer response**

Economists, the International Energy Agency and many governments are wedded to emissions trading because, in theory, it should ensure emission reductions are made where the costs of reduction are lowest. In the case of greenhouse gas emissions, there is a certain logic to trading since the benefits will accrue wherever in the world reductions are made.

The European Union is leading the way with legislation in place to commence the trading of carbon dioxide emission allowances from over 14,000 large, point sources from 1 January 2005. Member states should by now have submitted National Allocation Plans to the European Commission for approval, defining how emission allowances will be allocated to companies or installations. The generosity, or otherwise, of these allocations for the initial 2005-07 trading period has been the subject of much political debate with strong lobbying from all the industrial sectors affected and other stakeholders such as environmental NGOs. In some member states, notably Germany, allocations have been relatively generous which raises not only state aid issues, but also suggests that political interference will undermine the economists’ ideal of a perfect market in emission allowances. This should not be viewed with any surprise, because no government is going to willingly jeopardise the competitiveness of its industrial and commercial base.

Estimates for the future traded price of carbon dioxide abound, but many would agree that a figure of USD 10/tCO₂e for 2010 is a reasonable guess. This is equivalent to a punitive tax on coal of over USD 20/t that would certainly affect coal’s ability to compete with other fuels, in particular with natural gas. Emissions from gas at the point of use are typically less than half those from coal such that, in the case of electricity generation, an emission allowance price of USD 10/tCO₂e effectively adds over 0.5c/kWh to the cost of coal-fired generation vis-à-vis gas-fired.

On the face of it, such a price differential could lead to large-scale fuel switching from coal to gas and this is certainly why oil companies, such as BP and Shell, have actively promoted emissions trading, setting up their own internal schemes. However, the reality is that gas is becoming a more expensive commodity and there are question marks over the ability to supply today’s demand, never mind an increasing future demand.

In conclusion, the outturn may not have a significant impact on coal demand:
- Political interference will protect some coal users.
- Other coal users will shift production outside of regions subject to emissions trading.
- Costs will be passed on to consumers.

In the absence of a large-scale, viable source of CO₂-free energy, there will continue to be a demand for coal. However, what we have seen in Europe is the almost total elimination of planning horizons. For example, with less than six months before emissions trading starts, National Allocation Plans are still essentially in draft
form and, even when approved, they cover only the three-year period 2005-07 with no visibility at all beyond that. It is for these reasons - the lack of a stable regulatory framework - that minimal investment in coal mines and coal-fired generation within Europe will be made over the coming years.

It is the short-term nature of European energy policies that is more damaging than the challenge of reducing carbon dioxide emissions, since this could be achieved with long-term investment in improved power plant efficiency and the development of CO₂ capture and storage technologies.

Mr. Gordon McPhie  
former Chief Executive  
UK Coal plc

European coal producer/consumer response

The introduction of the emissions trading scheme can have an impact on both the use of existing power plants and decisions to build new plants.

The operating mode of existing power plants is determined by the marginal cost level. A CO₂ penalty can cause a change in sequence of the various energy sources along the industrial cost curve. So depending on the allowance price level and the fuel price relations, coal (mining and power generation) could be ousted from the market by natural gas.

When it comes to replacing existing power plants by new installations, the decisive factor is full cost. Depending on the above parameters, i.e. allowance price and cost of fuel use, investment into the renewal of the power plant fleet desired from an energy policy viewpoint in order to maintain a well-balanced energy mix could be impaired as well.

This would be disastrous in terms of energy and employment policy. What is more, it would not serve the cause of climate protection either. The construction of a new 1,000 MW state-of-the-art lignite-fired power plant alone, for example, that replaces existing old units yields an annual CO₂ reduction of some 3 million tonnes.

A comparison of the specific CO₂ avoidance costs also shows: the most cost-efficient steps to CO₂ mitigation are the use of nuclear energy and the renewal of power plants based on fossil energy sources; and, expanding wind power and photovoltaics in countries such as Germany is a very inefficient road to CO₂ reduction from a cost-benefit viewpoint.

The renewal of all coal-fired power plants that have been in operation for more than 20 years around the globe with state-of-the-art technology would cut CO₂ emissions by 1.4 billion tonnes per year.

Replacing coal with gas in Europe, by contrast, will bring no decisive benefits for precautionary climate protection. For when the overall chain of electric supply is considered, the climatic relevance of the different fossil energy sources is converging. Moreover, additional supplies of gas from Russia to the EU would cause gas use in Russian power plants to be reduced and coal use increased.

Dr. Gert Maichel  
President and CEO  
Executive Vice President  
RWE Power AG  
RWE
European coal consumer response

The process of coal mining and the generation of power from fossil fuels leads to the emission of greenhouse gases, primarily CO₂, and also some methane and nitrous oxide.

The trading of emissions of these gases will bring an additional cost to the process that leads to their emission and this will be a function of the current and future price at which the gases are traded, and the nature of process itself (including the fossil fuel used).

For power generation the use of coal results in about twice the CO₂ emissions per MWh generated as would result from generating the same amount of power using natural gas.

There is no significant variation in the carbon content of coal from different mines on a heat basis to favour coal from one source over another.

Emissions of nitrous oxide and methane from coal- and gas-fired plant are small compared to CO₂ emissions on a greenhouse gas equivalence basis and therefore relative differences between emissions of these gases from coal- and gas-fired plant would not feature significantly in a coal versus gas investment analysis.

An emissions trading system (ETS) creates an environment in which CO₂ emission permit availability and emission abatement costs drive decisions concerning fuel usage within the power industry. Because a large percentage of the costs of generation are associated with the cost of fuel, and the competitiveness of coal versus gas is a strong function of the fuel price differential, the higher emission factor of coal acts so as to increase the advantage of gas.

The introduction of an ETS imposes an additional risk to be factored into investment decisions because of the (current) unpredictability of the CO₂ price over the long term. Investment in coal-fired plant needs to take into account the high CO₂ emission from conventional (even high efficiency) coal plant. In the next few years these factors will tend to decrease the investment in coal-fired plant.

Over the long term, it will increase interest in CO₂ removal technologies and, in particular, IGCC technology where the removal of CO₂ before combustion has the potential for being the most efficient removal process. In the U.K., retrofit CO₂ removal and/or additional efficiency improvements may also be an option. If the CO₂ is captured, it will need to be stored, probably in saline aquifers or old oil/gas reservoirs (with the possibility of enhanced oil recovery reducing costs to some extent). The disposal of CO₂ into old coal mines and the recovery of the displaced methane (for industrial use) may also be possible.

There are therefore technologies that may be applied to coal plant to reduce CO₂ emissions (perhaps by 90%), but the cost of these technologies is high and none are commercially proven at present. Many of these technologies are also equally applicable to gas plant.

Therefore, expansion of the UK coal generation portfolio with these technologies may be possible over the long term given a large enough and sustained CO₂ market price and a significant coal/gas price differential. However, at present there are no positive indications that this will be the case over the next decade.

Overall, it may be concluded that, in the medium term, the increased costs in the generation of power that an emissions trading scheme will lead to will favour the development of gas-fired generation over coal-fired and hence is likely to lead to a reduced demand for coal. Any reduced demand for coal in the U.K. would, in turn, reduce the need for further coal mine development.
European coal consumer trade association response

When the emissions trading scheme comes into force, it will mean, in principle, the introduction of a cap on CO₂ emissions. Climate change commitments to the reduction of greenhouse gas emissions are expensive and will lead to increased power generation costs.

The introduction of the emissions trading scheme will alter operating costs in the power generation sector insofar as generators will have to internalise the market value of the CO₂ emission. Emission trading will have an influence not only on the operation of the existing generating capacities, but also in the future investment and the technologies chosen.

As a result, in the short term, there can be a shift in competitiveness from coal plants to combined cycle gas turbine plants due to the introduction of a CO₂ cap if the CO₂ price reaches a certain level. The carbon emissions trading will increase the variable costs for fossil-fuel power plants and, to the greatest extent, those of the coal-fired plants, as long as coal has more carbon content and coal technologies have lower efficiency than new natural gas technologies.

A key issue for this to happen will be the impact on the wholesale power market price, and the way generators will be able to pass through the CO₂ costs. As a result of the emission restrictions, power plants, as well as other emitting industries, will increase the industry’s marginal cost either by the purchase of emission allowances or by abatement costs.

Power generating companies under the emissions trading scheme will have to integrate CO₂ trade into the optimisation of their electricity generation and trading portfolio. Depending on the CO₂ prices, over time companies might decide to continue running or decommissioning old amortised installations or take decisions on new investment.

When deciding a new power capacity investment, power generators essentially have to choose among various combinations of fuel prices, technologies, CO₂ emissions, etc. Even when these combinations yield identical production costs, in many countries CCGT is already the prevalent technology chosen. In a long term dominated by uncertainty, CCGT, with lower specific investment and lower specific emissions, appears to be the preferred option among new fossil-fired power plants.

In other words, one important impact of the emissions trading scheme might arise due to the uncertainty it creates, i.e. the uncertainty in the gap between free allocation and the allowances needed as well as the uncertainty surrounding future CO₂ prices. These uncertainties may well lead to either restraining power companies from new investment or focussing these investments towards CCGT power plants. This impact is more evident in liberalised electricity markets.

What is clear is that this external cost will have to be internalised by power companies and this will be transmitted, to some extent, along the coal chain. The whole coal chain will have to make some efforts to cut cost in all areas (production, transport, combustion technologies) in order for coal to remain a competitive option in the new context.

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Global coal producer response

There is a growing consensus that the world will eventually undergo a transition from hydrocarbon- to hydrogen-based energy systems, although there is considerable uncertainty about when such a transition might start and how long it might take. The potential importance of hydrogen lies in its ability to act as a store and carrier for intermittent renewable energy sources, and provide a means for fossil fuels to continue to be used with significantly reduced or eliminated CO₂ emissions. However, its introduction faces considerable challenges at all stages in the supply chain - production, storage and distribution, and conversion. The practicalities and costs of H₂ production and use will have to be considerably improved if its is to compete with conventional hydrocarbon energy sources, and, for hydrogen to realise its full potential in distributed applications, will probably require the installation of entirely new networks of gas transportation and storage infrastructure.

For these reasons, it is likely that the earliest large-scale applications of hydrogen as a fuel will be those that have the lowest production costs and can utilise existing energy delivery systems. The production of hydrogen from renewable energy is unlikely to fulfil these conditions for many years, its viability being dependant on the costs and practicalities of renewable power generation itself. Because of this, there is growing recognition that fossil fuels will, at the very least, act as a bridge from the carbon-based present to the hydrogen-based future. It is during this potentially long transition period that coal, due to its abundance and low cost, could play a key role.

Current hydrogen manufacture methods reflect production costs - natural gas reformation is the lowest cost method and makes up the bulk of H₂ production. Reformation of petroleum products and coal gasification are much less used, and a small percentage is made from electrolysis of water, which tends to be limited to applications requiring high-purity hydrogen. However, total global output of H₂ only equates to 170 mtoe, or two percent of world energy consumption, and the bulk of that is used in chemical applications rather than as fuel - present sources are not necessarily those that will support future large-scale hydrogen production for energy.
Whether permanently or in transition, the hydrogen economy will require abundant, secure and widely available sources of H₂. Coal is easily the most abundant and dispersed of the fossil fuels - the ratios of proven reserves to current production of oil and gas are 41 and 67 years respectively, compared to almost 200 years for coal. It is also the most secure - unlike coal, known oil and gas reserves are heavily and increasingly concentrated in only two regions of the world, the Middle East and Russia.

The potential uses of coal for cleaner energy from hydrogen are varied, and include:

- Coal gasification, with carbon capture and storage, for the production of H₂ for use in combined cycle power generation and/or the generation of electricity in fuel cells and, ultimately, the supply of hydrogen for distributed energy applications such as transportation.

- Coal gasification for the production of syngas for use in an integrated fuel cell and combined gas/steam turbine cycle to generate electricity with considerably greater efficiency (as high as 65%) and lower CO₂ emissions (40-50% lower) compared to ultra supercritical PF generation. This could also substantially reduce the load upon and cost of carbon capture and sequestration.

- The production of synthetic liquid hydrocarbons, particularly methanol, for use in early fuel-cell-based vehicles, producing substantially reduced CO₂ emissions from transportation with minimal changes to infrastructure.

These options have in common a reliance on the development of key technologies - Integrated Gasification Combined Cycle and carbon capture and storage, with syngas to liquids technology also potentially having an important role in regard to the transport sector. The need for coal industry commitment to the advancement of these technologies, and the means by which the industry can assist their development and adoption is outlined in the answer to Question 6.

Asia-Pacific/North American coal producer response

There are significant moves within several countries to shift towards an economy in which hydrogen would be used as a carbon-free energy carrier in both the power generation (both centralised and distributed) and transportation sectors. The latter option would offer a significant market opportunity for coal.

A number of factors will facilitate the move to a hydrogen economy.

- The global trend towards increasingly efficient energy use favours hydrogen due to its high end-use efficiency.

- Hydrogen produces no point-of-use greenhouse emissions; and, if greenhouse emissions can also be minimised during production, then a hydrogen economy offers a solution to greenhouse issues.

- Longer term, hydrogen is the logical energy storage medium as renewables become increasingly incorporated into the electricity grid.

Hydrogen use offers further advantages - other point-of-use emissions are eliminated; and the high efficiencies involved in hydrogen use, together with economies of scale in large-scale industrial hydrogen manufacture, offer the potential for low delivered energy costs.
Hydrogen is widely believed to be expensive to produce. In fact, ex-refinery costs are comparable to gasoline on an energy equivalent basis; the cost issues to be addressed relate to the distribution and storage of the hydrogen, rather than to hydrogen production.

Hydrogen can be produced by a variety of routes with different life cycle impacts for both CO₂ emissions and energy resource use. Which of the production routes becomes widely used will be determined by the cost and carbon intensity of the production process.

Hydrogen production from coal offers a number of advantages.

- Coal offers energy diversity and security, and is widely available.
- The process co-produces a sequestration ready stream of pressurised CO₂ - which will be significant in any carbon-constrained future as carbon capture and storage will be required to produce near-zero emission hydrogen from coal.

The timetable for the transition to a hydrogen economy is difficult to estimate, as it will involve complex and radical change, some market disruption, and will occur over a long timeframe and to an uncertain end state. The timetable will be impacted by policy measures taken to address global warming and the availability and cost of fuel cells and hydrogen distribution infrastructure.

Against this background, the role of coal in this transition will be facilitated by

- Further reductions in the costs of coal gasification resulting from increased plant build.
- Increased acceptance by the public of carbon geosequestration.
- The co-production of power, hydrogen or liquid fuels from coal gasification.
- The co-gasification of biomass in coal gasification plants.

Given that coal-based hydrogen production costs are broadly comparable to other hydrogen costs, with the potential for significant cost reductions with increasing experience in coal gasification and carbon geosequestration, then the potential exists for coal to become a significant future source of hydrogen.

Mr. Preston Chiaro  
Mr. Bret Clayton  
Dr. Grant Thorne  
CEO Energy  
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Rio Tinto plc  
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North American coal producer trade association response

Technologies that use coal to produce hydrogen gas (H₂) are available and operational, and coal is plentiful. Looking forward, it is hard to imagine a future where world energy demands change in any direction but upward. If we factor into this vision a carbon constraint on global economic activities, there would appear to be an opportunity for coal-based facilities to serve as hydrogen suppliers. The questions to be faced are: at what level would coal be a hydrogen-supply contributor; and, for how long?

If the world economy were to experience an abrupt transition to a carbon constraint, there is little doubt that coal would be in an excellent position to become a primary source of bulk hydrogen supplies. In the abrupt carbon-constraint scenario, coal’s chief competitor would be natural gas. This observer expects that coal-
based hydrogen production would expand rapidly in such an environment, as an increasing spread between
market prices for coal and natural gas could be expected. Coal-based hydrogen production facilities would
be most competitive if developed as large-scale facilities due to the economics of coal handling and of
pollutant removal and control, and scale economies associated with CO₂ sequestration. Thus, a major
potential constraint on coal-based hydrogen would be the hydrogen distribution and supply infrastructure,
as methane-based fuels would be in a far more advantageous position for dispersed applications.

In the longer run, this observer would expect natural gas to decline as a major competitor with coal for
hydrogen generation due to increasing demand coupled with limited supplies, and thus increasing price
spreads. However, other technologies may develop to fill that void. Further development of solar-based
technologies, for example, could provide a competitive threat to coal-based hydrogen production. This
observer does not see electrolysis of water as developing into a major hydrogen source by reason of its
relatively low efficiency combined with the fact that a primary hydrogen market would be for powering of
fuel cells to produce electrical output. New solar hydrogen technologies are being developed which, if
commercialized, would provide coal with greater competition. For example, consider the developing
technology known as photoelectrolysis. Instead of first converting sunlight to electricity and then using an
electrolyser to produce hydrogen from water, photoelectrolysis combines these two steps by pairing the
photovoltaic cell with a catalyst which acts as an electrolyser and splits hydrogen and oxygen directly. It is
quite possible that such technologies, if successfully developed, could be deployed as relatively small units
and in dispersed locations. Also looking at the longer run, biological mechanisms for producing solar
hydrogen are being investigated. Such technologies are based on the fact that the first step of photosynthesis
is the splitting of water into hydrogen and oxygen. If this step could be isolated from the subsequent
photosynthetic combination of hydrogen with atmospheric carbon to produce carbohydrates and thus to
yield H₂ directly, bio-based solar-powered hydrogen conversion could occur. Researchers in this field
anticipate that emerging genetic manipulation technologies will allow them to develop algal-organism-based
solar hydrogen converters. Whether or not these promises will be realized eventually is impossible to predict.
However, we can predict that a transition of the world economy to a carbon constrained status would
stimulate a dramatic increase in the flow of capital to development of these and similar technologies.

To summarize: if a severe carbon constraint were to be imposed upon the world economy abruptly, this
observer believes that coal would be in an advantageous competitive position as a bulk hydrogen supplier. In
the longer run, the potential for development of technologies capable of more direct water-hydrogen
conversions powered by solar energy at dispersed locations could pose difficult challenges to coal’s hydrogen
supplier role. Regardless of the time scale considered, the development of an infrastructure to enable cost-
effective hydrogen distribution from centralized production facilities to markets would be supportive of
coil’s competitive position as a hydrogen supplier.

European coal producer response

As the most carbon intensive fossil fuel, the challenge faced by coal in a carbon-constrained world is of
pressing concern. However, if CO₂ capture and storage becomes an established mitigation measure, then the
ease and economy with which coal can be converted to hydrogen - through gasification, water-gas shift and
CO₂ scrubbing - becomes a distinct advantage. In particular, it opens up the vast transport sector as a new
market for coal-derived energy.
Governments have been reluctant to tackle the rising CO₂ emissions from the transport sector for fear of upsetting the voting population. However, hydrogen offers an attractive route to eliminate CO₂ emissions from this sector and others. Establishing the infrastructure to supply the hydrogen as a transport fuel presents significant engineering challenges and the technologies to store hydrogen safely at a sensibly high energy density are not established. However, the benefits are so great, in terms of being able to offer the performance and convenience of gasoline with minimal environmental impact, that moves towards a hydrogen economy are gathering pace.

Outside of the transport sector, hydrogen can be used to de-carbonise natural gas supplies. By introducing 10-15% hydrogen into gas pipelines, a mixture of gases can be supplied with a lower carbon intensity that can reduce CO₂ emissions from all gas use with no infrastructure changes or equipment modifications.

The technology to produce hydrogen from coal is well established and in large-scale, commercial operation at chemical plants around the world, including the capture of CO₂. Over one billion cubic metres of hydrogen are produced each day (on an annual basis, the energy equivalent of 160 million tonnes of coal). Half of this is produced from natural gas, 30% from oil and almost 20% from coal. One quarter of production is used in oil refineries to upgrade oil products (hydrotreating, hydrocracking and sulphur removal). The bulk of hydrogen production (three quarters) is used to produce ammonia in the manufacture of fertilisers and methanol as a precursor to chemicals manufacture.

It should be noted here that hydrogen can also be produced by water splitting electrolysis. The inefficiencies of electricity production, coupled with the inefficiencies of electrolysis make this an unrealistic production route. Unless copious quantities of surplus electricity from renewable (or nuclear) sources are available cheaply, then electricity can be put to better use than the production of hydrogen.

Perhaps the most important driver towards the hydrogen economy is the issue of energy security. The concentration of oil and gas reserves in regions of the world that suffer from political instability is of increasing concern to governments in countries which are dependent upon imported energy supplies. If hydrogen from coal, and ultimately from renewable sources, can be developed as a commercially viable alternative to oil and gas, then it could reduce the vulnerability of many countries to volatile energy prices and energy supply interruptions.

Thus, the prospects for hydrogen from coal are healthy, but suffer from a major obstacle. The existing infrastructure to supply liquid transport fuels is not suited to hydrogen-fuelled vehicles. Only governments can influence the development of a completely new infrastructure by funding R&D and offering incentives to those wishing to demonstrate hydrogen applications. This is happening in a number of countries, albeit at a relatively small scale.

In conclusions, hydrogen from coal is an interesting, longer-term prospect and it is essential that R&D and demonstration work proceeds towards this objective.

Mr. Gordon McPhie
former Chief Executive
UK Coal plc

European coal producer response

Concerns over global climate change and the eventual depletion of fossil resources have been the driving forces behind the concept of the hydrogen economy, where hydrogen is used as an energy carrier.
By consuming hydrogen, energy can be produced without emitting air pollutants. However, hydrogen, the most common chemical element on earth does not exist in nature in its pure form. It has to be separated from other compounds such as water or fuels that contain carbon.

Today, hydrogen is recognized as a feedstock with growing importance in the industry sector. The synthesis of bulk chemicals, such as ammonia or methanol, consumes the major part of annual production. On a long-term basis, significant increase in hydrogen consumption is expected due to the application of fuel cells in the automotive and the decentralised power generation sectors.

Current technology allows for many different methods of producing hydrogen. Obviously, regional policies and economics determine which method prevails in a certain part of the world.

At present steam reforming of natural gas is the most commonly used hydrogen production process. It is a mature technology, and currently the least expensive. The level of air pollutants connected with the process is low. A clear disadvantage of this production method is the ever-increasing volatility of natural gas prices, which, furthermore, indicate a clear upward trend on a long-term basis. In comparison to coal, natural gas supplies are far more limited, both in terms of total proven reserves and their distribution around the globe.

The alternative, coal gasification, is currently more expensive than steam reforming of natural gas, mainly due to higher investment costs. As coal gasification is not as widely commercialized as steam reforming, there is more potential for technical advancements that, in turn, will result in lower initial costs. Coal gasification offers several advantages:

Coal is cheaper than natural gas. Moreover, total proven reserves are high and more evenly distributed around the world in comparison to natural gas. On the other hand, hydrogen produced by coal gasification releases more carbon dioxide per unit of energy and the solid waste produced from the ash has to be disposed.

Electrolysis, a method using electricity from renewable sources (hydro, wind and solar) to split water into hydrogen and oxygen, is a production technology with almost no pollution. One major disadvantage is the power generation costs, which on average are several times higher than those based on fossil fuels.

From this short analysis, it can be estimated what the future for hydrogen production might be. In the short term, it is very likely that natural gas steam reforming will dominate in regions where natural gas is readily available. Presently, the key advantage is the low cost of the process.

Coal gasification is the alternative in regions with large supplies of coal or in regions where natural gas is not readily available. Coal gasification could also fulfil mid- to long-term demand for hydrogen in many parts of the world. Costs of production will come down with more applications and more standardized plants. Finally, should natural gas become unaffordable in any particular region, coal could be a competitive alternative.

Large-scale implementation of electrolysis, however, appears unlikely unless natural gas prices reach extremely high levels or strictly enforced environmental regulations demand costly sequestration methods to capture all the carbon dioxide generated during the coal gasification process.

Dr. Jürgen W Stadelhofer
President and CEO
RAG Coal International
Asia-Pacific coal consumer response

Today about 40% of hydrogen is produced as a by-product in chemical engineering processes and is consumed as chemical material at the same time. R&D efforts for the mass production of hydrogen, aiming at direct use of it in the future, are underway throughout the world.

Hydrogen is produced from natural gas, oil, biomass, or water. The most widely used method is steam reforming using a light hydrocarbon, such as natural gas or LPG. It will be necessary to diversify hydrogen resources to deal with growing future demand. It is projected that coal will become more important as a material for hydrogen production on the grounds of low cost, price stability and abundance. The “IEA World Energy Outlook 2002” forecast that, during the period 2010-2030, annual price increases for crude oil, natural gas and coal would be 1.6%, 2.0%, and 0.6% respectively. Moreover, recent crude oil and natural gas price hikes emphasise the relative economic advantage of coal.

The hydrogen production process from coal goes through gasification, water-gas shift reaction, methane reforming, etc. During these steps, it is important to remove impurities from the syngas in order to avoid reactor corrosion. IGCC (Integrated Gasification Combined Cycle) and IGFC (Integrated Gasification Fuel Cell system) technologies have highly-advanced syngas purification techniques that could aid development of the hydrogen production process from coal as a fundamental technology. It is expected that coal could be one of the most likely candidates for a future hydrogen source and R&D activities have been carried out by many coal industry organisations. In anticipation of practical application in the 2020s, EPDC has been working on an IGFC R&D project called EAGLE, (Coal Energy Application for Gas, Liquid & Electricity) which enables multipurpose use of gasified coal for power, hydrogen, and chemical materials. Additionally, IGCC and IGFC also enable effective CO₂ capture from syngas, synthesis of DME fuel, and application of syngas for C1 chemistry.

Hydrogen production from coal is expected to be available commercially and widely used in advance of other methods such as water decomposition by nuclear power or fermentation of biomass. Therefore, production from coal could be a “de facto standard” in several methods. We recognize that hydrogen production from coal, derived from IGCC or IGFC technology, should be developed as an important strategy for the upcoming hydrogen society. Industrial, governmental, and academic groups should collaborate on R&D activities for elemental technologies such as gasification, purification of syngas, and so on.

Responses to Question 6

How can the coal industry promote further advances in carbon capture and sequestration?

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Global coal producer response

Carbon capture and sequestration (CCS) is a key enabling technology for major reductions in CO₂ emissions from coal-fired electricity generation. Its advancement is important for the long-term environmental sustainability of coal use and needs to be a collective priority for coal producers and users worldwide.

CCS will fulfil its greenhouse mitigation potential only if it is proven to be both technically feasible and commercially viable, and is accepted by governments and the community as a reliable and environmentally responsible means of reducing CO₂ emissions. The coal industry can most effectively assist the advancement of CCS by supporting the organisations that are dedicated to resolving the issues - technical, economic, regulatory and political - that are associated with the technology.

Over the last decade, the attention and resources devoted to CCS and related fossil fuel technologies has increased markedly, and there are a number of significant RD&D programs in America, Europe and Australasia that have CCS as a major focus. The coal industry has an important role to play in directly supporting these programs and in promoting effective collaboration among them. An example of the latter is the COAL21 program, through which the coal industry has assumed a national coordinating role for the development and adoption of zero-emissions coal technology in Australia.

Coal companies need to participate in CCS programs to ensure they retain an adequate ‘coal focus’, although it should be recognised that the interests of coal and other fossil fuel producers are closely aligned on many aspects of CCS development. An important feature of COAL21 is its support for field trials of geological sequestration irrespective of the source of CO₂ - whether from coal gasification or natural gas treatment - in the interests of improving understanding of the technology and demonstrating its use under Australian conditions.

The coal industry needs to support co-operation and co-ordination among countries on CCS, and in particular the work of the Carbon Sequestration Leadership Forum (CSLF) that was formed in 2003 to facilitate the development and availability of cost-effective technologies for the capture and safe storage of CO₂ and guide development of the legal and regulatory frameworks that will be needed to support CCS activities. Australian resource companies and industry associations have been actively involved in the Australian geosequestration reference group that assists in formulating Australian positions on matters before the CSLF, and which is developing principles for a national regulatory framework for the conduct of CCS in Australia. We encourage all Members of the CIAB to become similarly involved in their national chapters of the CSLF, and to work with their governments on the legal and regulatory arrangements that will be needed to support investment in CCS and maintain public confidence in geological sequestration.
The issue of public confidence is a critical one - overcoming the technical and commercial hurdles to CCS will count for little if geological sequestration does not have community acceptance. The coal industry can play an important role during this formative period for public opinion by helping to raise the general level of knowledge of the technology and its potential - a good example of this is the video, The Zero Emissions City of the Future, recently produced for the IEA Asia Pacific Conference on Zero Emission Technologies, which in simple but informative terms explains CCS in the context of world energy demand and the range of emerging cleaner energy options.

However, the coal industry needs to recognise the effectiveness of its public promotion of CCS will be limited by its perceived vested interest. CCS needs additional champions from the scientific and technical communities who are independent and credible on the basis of their sound understanding of the technology. The coal industry needs to support these champions by supporting the field trials that will improve their level of knowledge and demonstrate that geological sequestration is a safe method of permanently storing CO₂.

Mr. John Smith
Chief Operating Officer, Energy Coal
BHP Billiton

North American coal producer response

Prudent policymaking requires careful action. The coal industry must continue to improve the scientific understanding of climate change and advance technologies to capture and sequester carbon dioxide. Technology is the answer and provides a superior approach over government mandated carbon caps, taxes or limits.

Government mandates without the proven ability to economically capture and sequester carbon will only damage economies by limiting the use of electricity and transportation. These mandates would most greatly impact developing nations and their low-income families, because limiting carbon means increasing the cost of using fossil fuels and ultimately the cost of electricity. Since fossil fuels are typically the lowest cost and most abundant resources, developing nations are unlikely to participate in any mandated limits on carbon.

There is a body of science demonstrating the link between personal wealth and improved health fuelled by low-cost electricity. High energy costs serve as a regressive tax, using up available household income for groceries, prescription medicine and medical attention. Under mandatory carbon restraints, families would be forced to pay more for energy and would likely go without other essential needs. Mandatory limits should not be placed on carbon emissions until all costs are considered. In fact, when evaluating the carbon intensity of different types of electricity generation the entire life cycle of production should be accounted. This includes greenhouse gases emitted during equipment manufacturing, construction, fuel production, transportation and generation. Research and development must be the path promoted by the coal and power industry to reduce life-cycle carbon intensity.

Several technology development programs are under way in the United States that are open to involvement of other countries or companies. The coal industry should take an active role in these initiatives and other technology development efforts occurring globally. These programs include:

- The Carbon Sequestration Leadership Forum (CSLF) - a group of global partners, including developing countries, that are working cooperatively on research, development and deployment of carbon sequestration technologies in the next decade. The forum is chaired by the U.S. Secretary of Energy.
FutureGen - a 275 MW coal-based, zero-emission electricity generation and hydrogen production demonstration facility that has been proposed by the United States government. The 10-year, USD 1 billion project is aimed at demonstrating integrated coal gasification, carbon sequestration, electricity production and hydrogen production. The project is a public-private partnership that is inviting coal and power companies to share in the research and development with the United States government. Other governments are also being asked to join the project.

Regional Department of Energy partnerships - alliances formed to research regional abilities to sequester carbon throughout the United States.

**Asia-Pacific/North American coal producer response**

Carbon capture and storage (CCS) is an essential technology for the continued use of fossil fuels like coal and could be one of the most important levers to address climate change. The challenge for the coal industry is convincing its customers to implement CCS. The coal industry’s role is one of influence and support of those who will have direct control.

To do this, the coal industry must form partnerships and alliances with other stakeholders to positively influence development and deployment of CCS. These partners and allies will include generators (our customers), governments, researchers and local communities.

A shared understanding of concerns will be needed amongst the stakeholders in jointly working together to address the issues. The coal industry will need to provide human and financial resources in supporting this collaboration.

Work with customers: It is our customers who must adopt CCS technologies. They have concerns over the cost of capital, the retirement of infrastructure and their capacity to operate the new technologies. Awareness of these issues is important so that we can work with our customers on the necessary research and on a workable policy regime.

Work with governments: Governments set energy policy that influences the market conditions under which CCS can be adopted. They have a role in setting the legal and regulatory framework for CCS deployment. They also have a role in balancing community expectations and managing their short-term needs with long-term issues. The industry will need join with other stakeholders in working co-operatively with government to influence the policy changes, and recognising and addressing the issues of all stakeholders. There are a number of international government fora, such as Carbon Sequestration Leadership Forum, where the industry can play a supportive role. It is in our interests that these multi-government fora are successful. By providing a consistent, proactive position to each of the governments involved, the coal industry will improve the potential for success.

Work with researchers: CCS will be a global technology with local technical specifics. It is essential that the global research is complimentary and there is minimal ‘reinvention of the wheel’. The coal industry can provide a role in promoting collaboration and enabling sharing of resources. The coal industry could develop an aligned research priority list to provide a consistent message into the relevant research organisations towards achieving some consistency in the research priority agenda. Research into technologies that are directly aligned with enabling CCS will help the coal industry to have a long-term future.
Work with local communities: The coal industry must work with local communities to firstly hear their concerns and then communicate clearly our approach. The debate will be enhanced if we promote CCS as part of the solution rather than the only solution and if we are also supportive of diversity in energy sources. Developing alliances with NGOs, or other community groups who are engaged in the climate change debate, to promote a change in the way the world currently acts to address the climate change challenge has potential to raise acceptance of CCS as part of the solution.

The coal industry must promote further advances in carbon capture and sequestration through partnerships and alliances with the principal stakeholders who will influence the adoption of CCS.

North American coal producer trade association response

Coal is a major emitter of atmospheric carbon. If one both assumes that an eventual restriction of carbon emissions is likely and considers the negative effects of a commonly discussed alternative to carbon capture and sequestration (regulatory restrictions of carbon-based fuels), one might conclude that the coal industry has much to gain if both capture and carbon sequestration technologies are developed and adopted as the preferred mechanism for mitigation of atmospheric carbon increases.

One sequestration option that can be implemented at low cost in the near term is for the industry to advance its practices in restoring mined areas to productive forests when reclaiming active mines. This option has the greatest potential for implementation by surface coal mining operations operating in moist, temperate climates where land-surface values are relatively low, such as the Appalachian region of the USA. Technologies for reclaiming mined lands to forest have improved dramatically over the past decade, and current practices have a great potential for improvement in ways that would not have a major cost impact on operations. In addition to sequestering carbon, implementation of improved mine reforestation practices will create ancillary benefits to local communities and the coal mining industry. In areas where the coal industry suffers from negative public perceptions associated with environmental influence, establishment of productive forests with native species on mined lands would be a highly visible action that would be perceived positively and could bring indirect but tangible benefits - as well as sequestering atmospheric carbon.

Another option for the coal industry that could be both implemented in the short run and would yield ancillary benefits is to encourage and support deployment of integrated gasification combined cycle (IGCC) power generation systems by its customers. At present, very little capital is being invested in the construction of coal-powered generation systems in the industrialized nations, while gas-fired generation is expanding rapidly. Certainly, reasons for this situation include the expense of controlling conventional air pollutant emissions, combined with government policy uncertainty regarding future air pollution control requirements. The IGCC technology is capable of generating power with reduced emission of conventional air pollutants, compared to direct combustion even when coupled with today’s standard, stack-based air pollution controls. Another advantage of IGCC is that such facilities are expected to be far more easily retrofitted to enable carbon capture than conventional combustion. It would appear reasonable to expect
that, as experience is gained in IGCC deployment, the technology will be improved and costs will decline. Thus, it would appear that the coal industry would have much to gain by supporting development and deployment of IGCC into the commercial marketplace, as a “new generation” of coal-based electric power technologies will be necessary if the coal mining industry is to sustain its installed customer base.

Development of geologic sequestration in deep coal seams, aquifers, and depleted gas reservoirs, if linked with an appropriate economic incentive structure, holds much promise for the coal industry. Sequestration reservoirs must be developed if carbon capture technology is to be effectively deployed. Therefore, it would appear logical that the industry should support technological development of geologic sequestration through various means, including in-situ, prototype investigations utilizing its resource base. Taking it one step further, a logical strategy for the coal industry would be to use its mineral exploration activities (i.e., core drilling) as a mechanism for collecting and analyzing information that will be useful in characterizing subsurface geology under its control for potential usage in carbon sequestration.

Ms. Barbara Altizer
Executive Director
Eastern Coal Council

European Coal Producer response

Carbon sequestration is already well advanced, with the immediate driver being the storage of CO₂ stripped from produced natural gas from fields with a high CO₂ content. For example, at Statoil’s Sleipner project in the North Sea, one million tonnes of CO₂ per year are being re-injected into a deep saline aquifer to avoid atmospheric emissions that would have been subject to a Norwegian carbon tax. Another significant project, nearing its final investment decision, is the Gorgon LNG project off the north-west coast of Australia. The proposal here is to re-inject 129 million tonnes of CO₂, stripped from the produced gas over the life of the project (over six times more than at Sleipner), again into a deep saline aquifer.

With CO₂ storage advancing quickly, the issue for the coal industry lies with CO₂ capture. This is not well developed for coal combustion, although uniquely, in the case of coal gasification, technologies are well proven at a scale relevant for power generation. There is a need for a more co-ordinated, international effort to develop CO₂ capture technologies that meet the needs of coal users. A demonstration of capture at a commercial-scale integrated gasification combined cycle power station could go ahead today and would give confidence to electricity utilities that new, coal-fired power stations using this technology are a viable response to the greenhouse gas issue. Beyond that, co-ordinated R&D work on the options available to capture CO₂ at conventional PC plants is needed. There are pockets of activity around the world, but it is important to have some large-scale demonstrations that focus the attention of engineers and provide a foundation for commercial designs.

It is not only the coal industry that needs to see the commercialisation of CO₂ capture technologies. The oil and gas industry faces the same issues, yet its response to date has been cautious, perhaps because reducing CO₂ emissions through fuel switching from coal to gas is of more immediate, commercial interest. The principal oil industry initiative is the BP-led Carbon Capture Project. This has a budget of USD 25 million, half of which is public funded with the remainder coming from a consortium of oil companies. It examines many aspects of CO₂ capture, although excludes coal. With a turnover of around USD 900 billion at the top five oil companies, this is a very small investment in a technology area that could be fundamental to the oil industry’s future. The coal industry is much smaller, but has been instrumental in funding and promoting
R&D initiatives, particularly in the USA, Canada and Australia. The major coal-fired utilities have also supported R&D programmes in these countries and elsewhere, such as Japan and the European Union. However, finding the R&D funds necessary to establish CO₂ capture and storage (CCS) as a viable, commercially-proven technology would be a challenge for the coal industry acting alone, but perhaps feasible if funded jointly with others, such as electricity utilities and equipment suppliers. The difficulty is that competition in liberalised electricity markets around the world has resulted in low margins and significant cuts in R&D spend, such that few companies are in a position to fund long-term R&D.

A solution would be for governments to support the necessary R&D. This can be justified because of the failure of the market to deliver the “deep cuts” in emissions that will be needed to stabilise atmospheric CO₂ concentration. The coal industry can promote a greater understanding of the science behind global warming and climate change to demonstrate why CCS is not a technology alternative, but a technology necessity if UN objectives are to be met. Fuel switching from gas to coal does not achieve these objectives and renewable sources cannot deliver in the timescale required. CCS is a viable, large-scale option and a wider public debate is needed that should result in an outcome which justifies government support. The coal industry’s role is to promote this debate and respond to the outcome.

In this respect, it is encouraging that the US has taken a lead by establishing the Carbon Sequestration Leadership Forum. This international body has the potential to shape political thinking and to create a favourable climate for CCS projects to succeed.

Mr. Gordon McPhie  
former Chief Executive  
UK Coal plc

South African coal producer response

Successful carbon capture and sequestration associated with coal gasification, liquefaction and ultimately the production of hydrogen are collectively the keys to the long-term future for coal as an environmentally acceptable fuel. A fundamental barrier to success in this area is the significant research and cost barrier that must be overcome at a scale sufficient to make a difference. To address these issues, the following actions are recommended:

- Join, promote, support and enlarge international research and development alliances, in particular the Carbon Sequestration Leadership Forum (CSLF).
- Ensure within such alliance(s) that policy, legal, technical and social acceptability issues receive appropriate attention.
- Ensure such alliance(s) are inclusive of the widespread participation of developing countries as it is in the developing and ‘non-participant in Kyoto’ countries that the risk of unchecked emissions growth is highest (e.g. China).
- Recommend to, and lobby for, national governments to support both research and pilot project participation in developed and developing countries.
- Pursue international and national policy interventions, premised on environmental sustainability, to build the case for government support through tax, research and other incentives.
• Build strategic alliances with the power generating, gas, oil and chemical industries which will be at the forefront of technological advancement and implementation.

• Motivate for the adaptation of mechanisms available under the Kyoto Protocol, and/or any successor protocol, to further advance research in the area of carbon capture and sequestration.

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<thead>
<tr>
<th>Mr. Roger Wicks</th>
<th>Executive VP - Global Strategy, Marketing and Sustainable Development</th>
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<td>Anglo Coal, South Africa</td>
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**Asia-Pacific coal consumer response**

According to future scenarios in the third assessment report of the IPCC “Climate Change 2001”, it is estimated that a further degree of CO$_2$ reduction must be introduced to attain the commonly accepted “stability level” of 550ppm by 2100 or later. To meet this goal, the CO$_2$ emission level should be reduced to 20% below the “moderate case” (also known as “B2 scenario”: world population in 2100 = 10 billion, intermediate levels of economic development, slow but diverse technological change) in 2050 and 80% below it in 2100, which is 40% less than the 2000 level. Various approaches must be taken for substantial reduction of CO$_2$, e.g. improvement of energy efficiency, renewable energy, nuclear energy, capture & sequestration of CO$_2$, and so on. To minimize impacts of CO$_2$ reductions on the global economy, it is important not only to utilize Kyoto Mechanisms (emission trading, Joint Implementation, and Clean Development Mechanisms), but also to give priority to lower-cost mitigation technology in order to decrease the marginal cost of CO$_2$ reduction.

As a short-term measure to mitigate CO$_2$ emissions from coal use, further efficiency improvements in conventional pulverized coal-fired plant would have priority over everything else. In addition to this, it is also important to curtail CO$_2$ emissions per kWh economically, using offset mechanisms such as emission trading.

As a medium-term measure, power generation with coal gasification technology that enables efficient CO$_2$ capture has a fair degree of potential for CO$_2$ sequestration, which is expected to become widespread in the mid 21st century. In terms of CO$_2$ mitigation, IGCC or IGFC technology, using oxygen as the gasifying agent, would be an effective measure, allowing high efficiency of power generation and CO$_2$ capture at the same time.

CO$_2$ capture and sequestration is the only way to cancel CO$_2$ emissions, which inevitably accompany fossil fuel consumption. As long as we use huge amounts of fossil fuel, it will be an indispensable technology. In Japan, there are few oil and natural gas fields that could be potential CO$_2$ sequestration sites. Also, Japan’s restricted land space may limit available aquifers for sequestration. On the other hand, as a maritime country, Japan has high potential for ocean sequestration provided that the problems of high cost and public acceptance can be solved. For the future, it is necessary to investigate and develop CO$_2$ sequestration technologies as well as to create favourable public opinion for the acceptance of ocean sequestration in particular.

Unlike general air pollutants such as NO$_x$ or SO$_x$, CO$_2$ will have an impact on the global climate when the accumulated CO$_2$ concentration exceeds a specific threshold. Therefore, decades should be dedicated to
intensive R&D on CO₂ capture and sequestration until evidence of significant climate change appears. Then, after examining possible technologies, we can adopt reliable and proven ones. That could be the most economical way of mitigating CO₂ emissions.

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**Asia-Pacific coal consumer response**

The term “carbon capture and sequestration” has different implications. One is an attempt to reduce CO₂ emissions at generation units, such as FutureGen. This is certainly contributing to CO₂ reductions. Others include enhanced oil/gas recovery schemes that inject CO₂ underground or into aquifers. I wonder if these are CO₂ reductions in a real sense. Various incentives including taxation, R&D, financing and others should be given to “real CO₂ reduction projects”. We have to clearly separate these two.

“Carbon capture and sequestration” schemes are too expensive for private sector companies to underwrite. They are long-term solutions and will not address issues at present. Just focusing resources on carbon capture and sequestration will kill coal-fired electricity generation because generators will switch from coal to gas.

Political support for “real CO₂ reduction projects” needs to be given in order to let coal survive in the short and medium term. In this regard, real CO₂ reduction projects include CCTs (efficiency improvements).

It is hoped that international consensus (including IEA) will be built in regard to future coal/carbon policies that will place equal weight on medium term CCT and long-term carbon capture and sequestration. With political support and favourable financial terms and conditions, generators will be inclined to invest in coal.

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**European coal consumer response**

The coal industry can promote further advances in carbon capture and sequestration simply by sponsoring and financing research and pilot projects. When faced with carbon emission charges, power generators will be receptive to such initiatives, for example testing new technology at their power plants, if the projects are sponsored by the coal (production) industry.
Responses submitted by:

- Mr. Greg Boyce, President and Chief Operating Officer, Peabody Energy
- Mr. Steven Leer, President and Chief Executive Officer, Arch Coal Inc.
- Dr. Gert Maichel, President and CEO, RWE Power AG & Executive Vice President, RWE
- Mr. Michael J. Mudd, Program Manager, Generation Technologies, Corporate Technology Development, American Electric Power
- Mr. Seppo Ruohonen, Managing Director, Helsinki Energy
- Mr. Ömer Ünver, Head of Project Studies, Turkish Coal Enterprises
- Mr. John Hanson, Chairman, President and Chief Executive Officer, Joy Global Inc.
- Mr. Vít Kastovsky, Head of Mining Administration, Ministry of Industry & Trade, Czech Republic

**North American coal producer response**

For countries with indigenous coal reserves, coal can greatly reduce energy import demand. Coal's multiple uses: electricity generation, metallurgical feedstock, gasification, liquefaction and home heating make it a desirable fuel to hedge against reliance on foreign supplies of energy. In many cases indigenous coal reserves lead to low-cost electricity, which, in turn, allows these countries to increase their competitiveness and the standard of living of their citizens.

Countries without indigenous coal reserves or other extensive indigenous energy resources should make coal a major portion of their energy imports. By using coal, instead of exclusively relying on oil or natural gas imports, net energy importers can diversify the countries they depend upon for delivery of energy resources. According to the BP Statistical Review of World Energy, June 2003, the following countries held the top ten reserve positions in the respective fuel types:

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<tr>
<th>Coal</th>
<th>Oil</th>
<th>Natural Gas</th>
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<tr>
<td>1. United States (25.4%)</td>
<td>1. Saudi Arabia (25.0%)</td>
<td>1. Russia (30.5%)</td>
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<tr>
<td>2. Russia (15.9%)</td>
<td>2. Iraq (10.7%)</td>
<td>2. Iran (14.8%)</td>
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<tr>
<td>3. China (11.6%)</td>
<td>3. United Arab Emirates (9.3%)</td>
<td>3. Qatar (9.2%)</td>
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<td>4. India (8.6%)</td>
<td>4. Kuwait (9.2%)</td>
<td>4. Saudi Arabia (4.1%)</td>
</tr>
<tr>
<td>5. Australia (8.3%)</td>
<td>5. Iran (8.6%)</td>
<td>5. Syria (3.9%)</td>
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<td>6. Germany (6.7%)</td>
<td>6. Venezuela (7.4%)</td>
<td>6. United States (3.3%)</td>
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<tr>
<td>7. South Africa (5.0%)</td>
<td>7. Russia (5.7%)</td>
<td>7. Algeria (2.9%)</td>
</tr>
<tr>
<td>8. Ukraine (3.5%)</td>
<td>8. United States (2.9%)</td>
<td>8. Venezuela (2.7%)</td>
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<td>9. Kazakhstan (3.5%)</td>
<td>9. Libya (2.8%)</td>
<td>9. Nigeria (2.3%)</td>
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<tr>
<td>10. Poland (2.3%)</td>
<td>10. Nigeria (2.3%)</td>
<td>10. Iraq (2.0%)</td>
</tr>
<tr>
<td>Rest of World (9.2%)</td>
<td>Rest of World (16.1%)</td>
<td>Rest of World (24.3%)</td>
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The number in parenthesis is the percentage of the world's total proven reserves attributed to that country. It is important to note that countries with oil and natural gas reserves are in similar regions of the world. As world markets begin to rely on importing liquefied natural gas (LNG), each country will have to be concerned with security of supply as many of the supplying nations are in politically unstable areas. Having a diverse set of energy supplying countries and types of imported fuel, especially including coal, helps an importing nation's ability to sustain its energy needs through supply disruptions and price volatility.

**Mr. Greg Boyce**
**President and Chief Operating Officer**
**Peabody Energy**

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**North American coal producer response**

Coal is the most abundant and widely dispersed hydrocarbon resource on the planet. Significant coal reserves can be found within the borders of many different nations across the globe - including some of the world’s most populous. Just as notably, many of these nations - including China and India - have limited reserves of petroleum and natural gas. Clearly, every country needs abundant, cost-effective and secure sources of energy to fuel their economies. Coal can and should play a central role in meeting those needs.

Given the volatile nature of global energy markets, significant domestic energy reserves can prove invaluable to a nation’s economic stability and well-being. By encouraging and supporting the development of such reserves, nations can greatly mitigate the risks associated with shortages and disruptions in global energy markets, including the extreme swings in pricing that can undermine economic growth.

This beneficial market insulation is even more pronounced when the energy resource being discussed is coal. As a highly capital intensive business with relatively predictable production costs, coal has traditionally been sold under long-term contracts that serve to insulate coal consumers from swings in pricing. At the same time, coal is easy to manage and store, which means that coal consumers are often in a position to build significant inventories that can further dampen the impacts of price volatility.

The recent run up in world oil markets is a case in point. While spot coal prices have indeed climbed in recent months in response to higher prices for other forms of energy, coal is still a bargain compared to other hydrocarbons. Furthermore, most coal consumers are continuing to receive much of their coal supply under pre-existing, multi-year contracts - at fixed pricing determined in less uncertain times.

But resource-rich nations are not the only ones that can benefit from increased reliance on coal. Development of the world’s coal reserves can also benefit countries with little or no indigenous coal resources within their borders. First, significant reliance on coal throughout the world reduces the stresses placed on petroleum and natural gas markets - particularly during periods of high demand. Second, nations without indigenous coal reserves can still benefit from diversifying their energy portfolios, particularly when that means increased coal use. Not only are world coal markets generally less volatile than the markets for other hydrocarbons, but the world’s coal reserves are also more evenly dispersed across the globe. That wide dispersion greatly reduces the likelihood of regional disruptions related to conflicts or other issues. Finally, and perhaps most importantly, coal remains inexpensive on an energy-equivalent basis throughout much of the world - and low-cost energy is a cornerstone of economic success.
Diversification is almost always an effective way to mitigate risk. The fact is that coal use can act to stimulate economic growth and dampen the negative impacts of energy market volatility for nations with indigenous coal reserves, and even those without.

Mr. Steven Leer  
President and Chief Executive Officer  
Arch Coal Inc.

European coal producer/consumer response

Europe has a relatively low level of energy reserves, so that the continent is highly dependent on energy imports. Today already, the E.U. is one of the world’s biggest net importers of energy. Dependence on suppliers outside the European Community will increase even further in the future - estimates by the European Commission indicate a rise of as much as 70% over the next 20 to 30 years. The Commission attached particular importance to the subject of supply security in its Green Paper on a joint European energy strategy.

Hard coal and lignite are the main energy sources in Central Europe’s electricity sector. In the enlarged European Community, coal’s significance to power generation will grow. 27% of the power generated in the EU-15 is based on coal. But coal plays an even greater role in the E.U. Accession Countries where 67% of the power generated is based on coal. Altogether, 32% of the power generated in the EU-25 is coal-based. Additionally, the steel and base material industries are highly dependent on coal.

Domestic fuels, like hard coal and lignite, must not be placed at a disadvantage relative to imported energy. This is the only way that these fuels can make the politically-desired stable contribution to future energy supply and associated long-term investments are not jeopardized.

Coal remains important and is part of a balanced energy portfolio. The considerable contribution of coal should form the basis of long-term energy strategies, which will have to be developed under the heading “reliable, cost-efficient and environmentally sound”. The high-quality supply of domestic and imported coal must be communicated more strongly and positively. Policy-makers and the public should:

- acknowledge coal as a part of a balanced energy portfolio; and
- recognise that low-cost energy from coal is independent of political risks.

Dr. Gert Maichel  
President and CEO  
Executive Vice President  
RWE Power AG  
RWE

North American coal consumer response

The United States has the largest coal reserve in the world, and America has more coal than any other single energy resource found in any nation. Coal makes up 85% of the fossil fuel reserves of the United States, and
coal provides the fuel for over half of our nation’s electricity. At current consumption rates, these coal reserves are estimated to be able to serve energy needs for at least 250 years. This reserve provides the opportunity for long-term energy independence and security within the United States.

However, market conditions and environmental constraints have led to an abundance of new combined cycle gas turbine installations in the past decade to feed the growing demand for electricity in the United States. As a result, the price of natural gas is now at record high levels. The high cost of natural gas in the United States is due to an imbalance between supply and demand. It has been suggested by many economists that LNG can (and must) be imported to stabilize natural gas prices. There are numerous concerns about the environmental and security impacts of erecting LNG terminals to allow the import of large supplies of LNG. More importantly, there are concerns that the United States will forego its coal - an abundant, indigenous fuel - in favour of imported energy. This reliance on imported natural gas will be detrimental to the US trade deficit and to the goal of energy security and independence.

On the other hand, new technology can enable coal to be used to generate electricity with minimal emissions - comparable to the emissions from burning natural gas. Policies that encourage the use of coal will enable the United States to use its abundant, indigenous fuel in favour of imported fuels, without the risk of market and supply disruptions as are now seen for petroleum.

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Mr. Michael J. Mudd  
Program Manager, Generation Technologies, Corporate Technology Development  
American Electric Power

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**European coal consumer response**

Diversifying the energy mix is a sound strategy to reduce market and supply disruption risks. The most sustainable energy system is a combination of emission-free sources, such as nuclear power, hydropower, biomass, etc. and fossil fuels, like coal. Although the trend is towards reducing the role of fossil fuels, coal remains an important factor and one that strengthens the security of supply. Coal has well-known benefits as one of the base fuels: it is available from a wide range of sources; it is safe to transport; and, it is easy to store. It is also affordable, although recent price developments seem to threaten this argument.

The overall efficiency of coal-fired production in Finland is the highest in the world thanks to the large share of combined heat and power generation (CHP). During warm seasons absorber energy could be obtained from the excess district heat, which is the way to achieve better efficiency in CHP production in summer. In addition to this, environmentally harmful freons used in conventional cooling can be replaced by clean water.

Hydropower is the capacity adjuster in the Nordic power markets. During low water levels, the use of coal-fired capacity to compensate for the shortfall in hydropower output is essential. The spot market prices of electricity are, in fact, largely determined by coal-fired power, which will be heavily affected by the burden of emission allowances.

**CO₂ reduction strategy should be based on opting for technical efficiency enhancement.** Unfortunately, emission trading policies can divert attention away from technology that could offer the tools for reducing emissions. In particular, the E.U. emission trading scheme will promote replacement of coal with natural gas and that will lead to higher dependence on a few supply sources and increased gas prices. Instead of that,
policies should encourage a mix of technologies and competition between them, in fuels and generating modes. Efficient power generation will ensure long-term price and supply stability.

Globally, utilization of currently available technology could eliminate a remarkable share of the CO₂ emissions from coal-fired production. The construction of new, coal-fired power plants to replace the old ones, particularly in developing countries, should be encouraged as a cost-efficient way of reducing emissions.

Mr. Seppo Ruohonen
Managing Director
Helsinki Energy

European coal producer response

It is evident that countries with indigenous coal reserves are less susceptible to the risk of oil and gas supply disruptions than countries without such coal reserves. However, countries without coal reserves can also overcome or minimize the risk of dependence on oil or gas by adopting a development policy of electricity generation based on coal.

Mr. Ömer Ünver
Head of Project Studies
Turkish Coal Enterprises

North American/European mining equipment manufacturer response

Low-cost energy is the common denominator for economic growth everywhere in the world. It is not the only requirement, but it is a basic one. When comparing the relative costs of competing fuels, carbon or otherwise, over the past decades, coal consistently provides the lowest cost per kilowatt hour. Future liquefaction and gasification projects, and clean coal technology implementation, are all secure, safe, low-cost ways to produce environmentally-sound energy.

The major growth in energy demand in the future will come from two countries: China and India. Both of these countries have huge, mineable coal reserves. Coal is planned to remain the major energy source in both and forecasts in coal production reflect this fact. There is every chance that China will achieve the coal production goals, whilst in India, unless there is a major change, they will fall short.

In 2003, 11% of the world’s coal exports came from China (85 Mt). This number is expected to shrink dramatically in 2004, to the extent that it is likely that China will become a net importer of coal by early 2005. This change is being driven by the inability of the coal producers in China to keep pace with the growth in energy demand created by the rapid growth in GDP. This reduction in export coal is one of the largest contributing factors to the recent sharp increase in world coal prices. However, it is the intention of the Chinese government to return to being a net exporter of coal in the long term, and so, two
complementary policies are in place. Firstly, the regime is implementing a series of economic measures to cool the growth rate of the economy and, secondly, there is huge in investment in coal, nuclear and hydroelectric power generation.

The long-term plans for India suggest imports of 100 million tonnes annually by 2015 against a background of a huge increase in domestically-produced coal. If the energy demand forecast is achieved, then this import requirement could be understated.

In the USA, more than 50% of electrical power is generated from coal. It has, in the past, and remains the fuel of choice for the utilities generating base load. All other fuels provide the balance, all are more expensive. Fuel is the largest cost component of power generated.

South Africa has coal reserves, but no oil or natural gas, hence the development of the Sasol project, which now produces approx. 36% of South Africa’s petroleum fuel requirements. Similar projects are being planned in the US and China. Whilst it is an expensive process, it does provide independence from external energy sources.

Russia has huge coal reserves, but coal forms a relatively small proportion of energy production, behind natural gas and oil. The major, economically-viable reserves are in Siberia and the far east of the country. Transportation costs are high for both the domestic and export markets. Whilst the government has talked for some time about a bigger role for coal and preserving the reserves of natural gas, little has been achieved to date.

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Mr. John Hanson  
Chairman, President and Chief Executive Officer  
Joy Global Inc.

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**European government response**

Regarding the reality existing in the world - above all in Europe - coal use is a must. Present energy dependence is high in many countries and coal use in those countries with their own reserves is rational, provided that production is economically acceptable and does not displace another domestic fuel source, and that the country is willing to invest in a coal combustion process to decrease the negative environmental impact.

The use of coal must contribute in the given country to:

- reducing dependence on foreign energy resources, in particular from high risk regions of the world;
- elimination of unreliable supplies from foreign sources; and,
- economic and social development of the country.

Reliable and affordable energy from coal promotes the economic development and standard of living in the given country and contributes to sustainable development.

Recognising this, the Czech Republic will, in the long term, increase use of its own coal resources.

Coal accounts for about 56% of electricity production and about 47% of primary energy supply. Nuclear energy and renewable resources will compensate for the decrease in these shares.

For those countries without their own coal resources, coal use is an interesting option, especially if their
current import business relies on energy resources from the so-called high-risk territories (for example, oil from the Middle East). Supply difficulties or risks result from an unbalanced energy mix.

The European Union, or at least some E.U. countries, should quite logically promote the use of coal resources (mainly brown coal) in the new Member States, either in the form of coal import or the import of electrical energy produced in these countries using their own resources.

Mr. Vit Kastovsky  
Head of Mining Administration  
Ministry of Industry and Trade, Czech Republic

Responses to Question 8

How quickly can the coal industry respond to resolve energy security problems that may occur in the future because of failures in energy supply, for example from increased reliance on natural gas?

Responses submitted by:
- Mr. J. Brett Harvey, President and CEO, CONSOL Energy
- Mr. Steven Leer, President and Chief Executive Officer, Arch Coal Inc.
- Dr. Jürgen W Stadelhofer, President and CEO, RAG Coal International
- Mr. Eric Ford, Chief Executive Officer, Anglo Coal Australia Pty Ltd.
- Mr. Shiro Okada, Executive Officer and General Manager, Industrial Energy Department, Idemitsu Kosan Co. Ltd.
- Dr. Steve Lennon, Executive Director, Resources & Strategy, ESKOM
- Mr. Angel L. Vivar Rodriguez, Director of Energy Resources and Environment, UNESA

North American coal producer response

Despite the ability of U.S. coal producers to take action quickly, regulatory impediments and development lead times for major capacity increases limit the industry’s ability to increase supply to replace large volumes of alternative fuels. While some small punch mines in the east can be developed quickly (within a year), the potential increases would not be sufficient to address energy supply failures. Large-scale deployment of capital into major underground mines in the east and surface mines in the west would be required. Development times for these sources exceed three years (five years in the east), and are compounded by regulatory hurdles (permits, auctions, etc.) that may add up to five years or more.

Across the spectrum of carbon-based fuels, the effects of supply decreases appear much quicker than the effects of a responsive supply increase. For example, available natural gas supply from the lower 48 states in
the USA can decline quickly if drill rig count drops, if we experience cold winters or hot summers, or if productive basins begin to deplete. One obvious response to this is increasing coal production. But bringing on new mines and increasing the supply of coal will take much longer than the corresponding decline in natural gas supply, the reasons for which I will discuss in the following points.

- Power generators may be reluctant to commit to long-term contracts with coal suppliers. Without long-term commitments, the project risk for the coal suppliers is increased significantly. The reasons for the reluctance of the power generator to commit sooner rather than later are varied, but the biggest reasons are (a) uncertainty regarding future environmental regulations (b) uncertainty in long-term alternate fuel prices, and (c) limited capital available if environmental control technology or fuel blending capability is needed to utilize the new source of coal supply.

- Sufficient resources may not be allocated to development of clean coal technologies. Just as power generators have limited capital to commit to environmental control technology at existing plants, we are faced with a similar problem regarding development of new, more efficient generation technologies. Efficient development of these technologies will require the joint participation of power generators, coal suppliers, equipment vendors, and government. Time marches on: the need and challenge facing new technology development only increases as our generation fleet becomes older.

- Decisions to develop new sources of coal supply require an increasing level of input from a broad range of stakeholders. The number of stakeholders that are consulted with prior to development of new coal supply sources has increased significantly over the last 20 years. In addition, these stakeholders continue to grow their influence over the decision making process. In the long term, I believe this can be a positive development. However, one needs to recognize that an effect of this expanded stakeholder base can be longer lead times for project development. Today, we are looking at greater than 5 years for development of new mines in the USA.

The above factors demonstrate that coal supply has a longer response time to changing market conditions when compared to the response times associated with decreasing supply from other fuel sources such as natural gas. One of the most important things to help address this challenge is for regulators to streamline the process of developing the energy value chain from coal mines to power plants. Another important consideration will be the ability of the coal and power industries to collaborate on the issues above. If these can occur, I am confident that the coal industry will respond to the call.

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**Mr. J. Brett Harvey**
President and CEO
CONSOL Energy

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**North American coal producer response**

The world’s coal reserves are incredibly vast. At present rates of consumption, those reserves are projected to last for at least 200 years. In fact, the world’s coal reserves are significantly greater than its petroleum and natural gas reserves combined. Moreover, proven reserves of coal have risen by nearly 50% over the past two decades, and further gains are possible.

While capable of supporting substantially higher levels of production, the world’s coal reserves are not a convenient source of quick and easy-to-tap capacity. On the contrary, developing coal reserves requires significant and sustained investment over an extended period of time. Moreover, when the coal-producing capabilities of a region or country are allowed to atrophy, it is very difficult to reverse course. After all, mining
is an extractive industry. Coal producers must continuously invest in the development of new reserve areas in advance of the depletion of existing reserves. Without such investment, producers will confront declining productivity, rising costs and falling output - until ultimately the reserve base is exhausted and mining ends.

Consider these challenges to the rapid development of a nation’s coal reserves:

- Regulatory, legal and political - In most countries, there is a time-consuming and lengthy process required prior to initiating mining activity.
- Financing - Starting or re-starting a new mining complex requires a tremendous level of initial investment. Securing the necessary financing and providing the necessary assurances is a lengthy and challenging process.
- Labor - Mining requires highly skilled individuals - including mining engineers, equipment operators, explosives experts and electricians - who have experience with the unique challenges of the mine environment.
- Development - Developing a new mine or expanding an existing one can take many months or even years before a significant amount of production comes on line.

Given this lengthy critical path for new mine development, it is crucial that investment in the coal sector continues at a robust pace - and even increases, given current pressures on other fuels. Of course, investment in coal production alone is not sufficient. Nations must also take steps to upgrade and maintain rail systems, ports, and other aspects of the transportation infrastructure. Furthermore, existing power plants must continue to receive sustaining capital - and new generating facilities must be built. The newest technologies, including gasification and liquefaction processes, require even higher levels of investment. In each instance, long lead times - often constituting many years - must be built into the planning process.

Moreover, steps must be taken to ensure that policies aimed at constraining global carbon emissions do not slow investment in coal. Carbon constraints are almost certain to lead to price spikes and shortages in natural gas markets. World governments should not expect coal to provide a quick solution in such an environment. Coal must be part of the long-range planning process for satisfying the global demand for energy. Without sustaining investment, it simply will not be available as a safety net when other fuel sources fail to meet requirements.

Emerging clean coal technologies carry the promise of near-zero emission coal plants within two decades. If these technologies are to realize their full potential for increasing energy security and standards of living around the world, then investment in coal production - as well as the associated transportation and generation infrastructure - must remain strong until such technologies become economically viable.

**Mr. Steven Leer**  
President and Chief Executive Officer  
Arch Coal Inc.

**European coal producer response**

The answer to the question of the speed with which the coal industry can adjust itself swiftly to meet a potential rising demand depends on the structure of electricity generation in the national economy in question, and additionally on the expected dimension and lengths of potential failures in energy supply e.g. of natural gas. The question about the ease of substituting natural gas by coal impinges in particular on
power generation. To answer the question it is assumed that, in the energy industry of the country, coal-fired power stations do exist already. The question of the time required to build new power stations will not be dealt with in the following considerations.

**Scenario I: Short-term failures in natural gas supply**

In this scenario, the flexibility of coal-fired power stations to meet suddenly rising demand depends on the existing reserve electricity capacity and a sufficient coal supply. Given the fact that the coal-fired power stations are not operating at base load, electricity production can be expanded. Any existing stocks of coal enable the power stations to raise electricity generation rapidly.

In the case of additional coal demand, there are two options for power producers. First, to buy coal from the world market or else by means of increased coal supplies from the domestic coal industry. In this case, the increase of production depends on the current degree of capacity use at the mines. However, the rise in output is constrained by the mines’ currently operative capacities. Ideally, the mines are operating at capacity. Existing reserve capacities do allow the production to be expanded swiftly.

Additionally, the coal price is an important factor for both sides of the market, the power producers and the coal industry. An abrupt shift in coal demand normally goes along with a price increase, which however is modest, compared to the price volatility of other fossil fuels. But differences between domestic and international coal prices could be significant for the power producers’ procurement decision.

**Scenario II: Long-term failures in natural gas supply**

A sustainable increase of coal-based electricity generation, and accordingly of coal demand, will have an impact on long-term investment policies for both sides of the coal market. Investments into new mines and investments to expand capacities of existing mines will become inevitable. (Alternative investments in the import structure are not considered below). These types of investment require co-operation between the power producers and the mining industry based on long-term contracts in order to limit the investment risks for the coal companies. The time required for such investments depends on different assumptions concerning the type of coal production.

The time required to develop a new opencast mine is normally one to two years (assuming no official and political problems in the legal approval procedure). Three years are needed to expand the capacity of an underground mine, although the expansion of room and pillar mining can normally be arranged faster than longwall mining expansion. Here, it must be mentioned that investments are necessary not only in the face section but possibly also in the underground and surface infrastructure. A period of approximately five years is estimated for the development of a new underground mine.

**Asia-Pacific coal producer response**

In recent years, energy supply security has moved to the top of the energy policy agenda. Global energy trade has increased levels of mutual dependence among nations and led to intensifying concerns about the world’s vulnerability to energy supply disruptions. Credible threats to energy supply security range over a broad
CIAB MEMBERS’ RESPONSES TO INVESTMENT QUESTIONS

Spectrum: lower-than-expected rates of discovery of new oil and gas resources may constrain the contribution of those resources to future supply; a serious accident at a nuclear power plant could further erode public confidence in the safety of nuclear generation leading to additional freezes on new nuclear projects and the decommissioning of existing plant; acts of war or terrorism impacting on critical LNG production, transportation or storage facilities could significantly disrupt international trade in natural gas. Many other examples could be described.

Coal is the most reliable, robust and resilient energy source available: it is abundant; deposits are geographically dispersed; supply chains are diversified; costs of production, transportation and delivery are low compared to other forms of energy. Historically, coal prices have been much more stable than oil and gas prices. For these reasons, coal has a key role to play in enhancing the security of global energy supply and in responding to supply disruptions.

Coal is the most abundant and widely distributed conventional fuel on earth. At the end of 2002, proven coal reserves worldwide stood at some 984 billion tonnes, equal to about 200 years supply at current rates of production.3 The abundance and diversity of coal sources and transportation pathways makes it the least susceptible fuel to major supply disruptions. Moreover, if disruptions do occur, diversity of supply means that alternative sources can be mobilised quickly. Local production capacity can be quickly ramped up to meet supply deficiencies internationally. This “swing supplier” role traditionally filled by the United States in international trade is increasingly being taken over by countries such as China. Domestic energy shortfalls in countries as diverse as the USA and China are also being chiefly met by coal.

The critical determinant of the response time of the coal industry to supply disruptions will be the lead time required to develop new mines, expand existing operations and provide the supporting logistics infrastructure, whether on-shore in the form of railways and ports, or off-shore in the form of an adequately sized shipping fleet. While many mines do have latent capacity or can provide additional capacity through relatively minor capital expenditure, there is a limit to such tonnage in the short term. The response time will depend upon the location of the resource and the surrounding infrastructure available to get the product to market.

The coal industry’s capacity to respond to disruptions in the supply of other fuels may be limited in the short run by substitution considerations. It is clearly not possible, for example, to substitute coal directly for nuclear fuel in a power station. However, in the longer run, coal offers a secure and economical fuel supply alternative to meet shortfalls in availability of other fuels.

To the extent that future greenhouse gas abatement policies constrain the use of coal, the industry’s capacity to underpin secure energy supply may be diminished. Such policies may see a shift in coal production to developing countries that are not bound by emission reduction targets, while at the same time posing obstacles to the use of coal in developed countries. A deliberative shift away from coal in the global energy supply mix will necessarily see increased reliance on fuels that are inherently less secure and reliable than coal. Further investment in the development and deployment of clean coal technologies and carbon sequestration will contribute to long-term security of energy supply by maintaining levels of coal utilisation while at the same time addressing problems associated with greenhouse gas emissions.

Mr. Eric Ford
Chief Executive Officer
Anglo Coal Australia Pty Ltd.

Asia-Pacific Coal Supplier and Marketer response

Energy security is a very important issue to most of the countries in the world, especially to those countries who rely on imported fossil fuel energy sources from other countries.

Among the fossil fuel energy sources, coal is the most abundant and geographically widely distributed fossil fuel in the world. Due to these facts, coal is the most inexpensive fossil fuel on a unit calorie basis and considered as one of the most reliable fossil energy sources.

These are the main reasons why many countries have been using coal extensively as a primary energy source, particularly for power generation.

However, since coal is a solid fuel, the coal industry is a labour-intensive and equipment-intensive industry. Development of a new coal mine or expansion of coal production at a coal mine in operation will require the introduction of workforce and equipment based on a proper feasibility study to assess the required capital expenditure and the economics for such investment.

The coal industry will need more time to increase production levels than in the oil and gas industry due to the inherent characteristics of the coal industry as mentioned above. In the case of a new coal mine development, it takes at least a couple of years to conduct an exploration program and feasibility study for development and about two years to commence production at the mine after the decision to develop the coal mine is made.

Further, a total coal chain system has to be put in place in time to handle the coal produced by a new development or expansion.

Therefore, should energy security problems occur in the future because of failures in energy supply by other energy sources, it would take some time for the coal industry to respond to make up the shortfalls.

In this sense, it is quite important for the coal industry to watch the energy supply/demand situation closely so that it can take action quickly before any energy security problems occur.

South African coal consumer response

The question encompasses two different aspects, both of which refer to the availability of coal:

- How quickly can the coal industry respond to fill the energy supply gap should other resource supplies fail?
- How quickly can the coal industry reinstate supply options that have not been developed because other resources, including natural gas, were the fuel of choice and, as such, coal-based plant was either not developed or was prematurely shut down?

One of the difficulties of the electricity market is that the nature of the business is long term, with long-lead times for new plant and delivery infrastructure - especially coal-based plant.
Ways in which the coal industry can respond to energy security problems can include the following:

- Returning old coal plant to service (South Africa is currently returning plant which has been mothballed for more than 15 years).
- Identifying fast-track coal transport options where coal supply is a constraint to existing plant.
- Development of brownfield coal options - power stations as well as coal mines.
- Researching ways of increasing capacity and efficiency or extending the life of current plant. This will assist in avoiding long lead times. There are, however, constraints which the coal industry needs to address such as:
  - How to deal with changing environmental pressures and how to allow older plant to operate under these conditions (e.g. gaseous emissions such as SO₂ and CO₂)?
  - Reduction of operating and maintenance costs for ageing plant.
  - Technologies for the refurbishment of existing plant in a cost effective manner.
  - Re-powering or co-firing of existing plant.
  - Reducing plant outage time for planned and forced maintenance.
- Reduction in the lead time for new plant which could include:
  - Reducing the times required for environmental impact assessments by addressing some of the common challenges to coal, such as carbon and other emissions, and proactively undertaking EIAs.
  - Being proactive with regards to the design and engineering challenges for new plant, including having a list of action items for reducing the environmental impact of coal and investing in clean coal technologies and resourcing the material required for clean coal technologies up front.
  - Addressing financial risks, developing fast-track financing mechanisms, reducing up-front CAPEX requirements and maximising the flexibility of technologies - e.g. through modular approaches.
  - Keeping track of the status of current coal fields in production and understanding their full potential.
  - Pre-engineering new coal supplies.
  - Keeping track of greenfield coal resources and instigating environmental assessments to review any fatal flaws of developing those fields in the future.
  - Investigating new methods of extracting coal.
  - Investigating new methods of using the coal underground without having to first mine it, such as gasification and extracting Coal Bed Methane.
  - Increased utilization of coal fines and low grade coal, including multi-fuel technologies.
  - Better coal washing technologies to expand the usable coal resource.
- Increasing acceptance of coal as a longer-term fuel source including:
  - Advocacy programmes at the international level and the provision of statistics on how coal has improved its performance and reduced its environmental impact.

Dr. Steve Lennon
Executive Director, Resources & Strategy
ESKOM
European coal consumer trade association response

An exaggerated imbalance in the generating structure of electricity in favour of natural gas-fired plants can create severe problems in the event of supply disruption, price volatility or any other big change in the normal availability of this product.

Coal, the other major constituent of the power structure in many countries, can eventually mitigate the failures that may affect the natural gas supply chain. But, of course, the capacity of coal to offset the problems will depend on the percentage of electricity generated with this fuel and the ability of the coal producer to increase the supply quickly enough.

Coal is undoubtedly the fuel with largest reserves, which are widely distributed around the world in free market economy countries. On the other hand, most coal is consumed in the country where it is produced and only a rather small percentage is seaborne traded. Out of 3.8 billion tonnes of estimated hard coal production in 2002, only around 580 millions were seaborne traded. This ratio is changing due to closures of inefficient local mines in several developed countries and the replacement, in some cases, of indigenous coal by imported coal.

In answering the question “how quickly can the coal industry react to solve a possible natural gas disruption?”, several scenarios may be considered with different results for each case.

In the case of a natural gas disruption lasting a few days or weeks, the coal industry can do very little to solve the problem and only the availability of gas storage or well interconnected power grids between countries can avoid a major generation failure. Also, spare coal-fired capacity, together with adequate coal stocks or local production, can be utilized to replace gas generation.

In the case of a more structural disruption affecting a world region for a longer period, the coal chain and the associated infrastructure will show its weakness; big price increases and possible supply disruptions may initially occur. After some time, the coal industry will show its potential (large reserves, strong and flexible mining companies in free market countries etc.) and will satisfy the increase in demand. The present coal market situation is an example of what can happen in the event of a sudden large increase in coal demand, created not by an energy crisis but from an unexpected increase in economic growth in a large country. Local coal production, especially from open cast mines, will react much faster and with less impact than if the supply has to come from distant producers or the coal has to meet special quality requirements.

If the generating company has taken certain precautions to reduce the impact of an unplanned shortage of gas, problems that may occur could be minimized. These precautions are: maintain a good degree of diversification so that gas plants could be replaced by other ones; maintain, if possible at reasonable cost, sufficient supply of local coal; and, maintain strong relationships with reliable suppliers of imported coal, through long-term contracts or even ownership of coal mines.

In conclusion, it can be said that the coal industry has a large inertia to react to a sudden increase in demand for coal, in most cases due to a complicated coal supply chain that normally operates at full capacity and is costly to oversize.

Mr. Angel L. Vivar Rodriguez
Director of Energy
Resources and Environment
UNESA
North American coal transporter response

Much depends upon the severity of any proposed energy security problem and the resultant increase in demand that gets translated to the coal markets. A 25% reduction in gas net electric generation would amount to about 157.3 million MWh per year. Using eastern bituminous coal and a heat rate of 9,600 BTU/kWh, this would represent a marginal need for about 55 million tons of new coal burn (MTPY) to replace the lost gas generation. A 55 MTPY increase amounts to an increase in coal production of about 5% per annum. Clearly, a loss of 25% of the gas generation could be accommodated by the coal industry. This would require immediate cessation of net coal exports and dramatic increases in production, including of high sulphur coal.

In the electric generation market, coal generation can quickly replace natural gas, as coal-fired power plants generally have excess capacity during all but the hottest months and daytime hours. If combined with mandatory time-of-use pricing incentives, substantial daytime electric loads could be shifted to night hours when even more coal-fired generation capacity would be available.

Generally, the most excess generation capacity is available at coal plants east of the Mississippi where Appalachian coal supply is dominant. Western coal plants tend to be bigger and are base-loaded more often. As such, coal availability and rail carrying capacities would become the limiting factors in the east. Metallurgical coal exports to Europe would have to be diverted. Emergency orders that bypassed significant permitting requirements, combined with government backing for coal reclamation bonding, would enable coal companies to open new mines at a much more rapid pace. Certainly, in an emergency, the time required to achieve first production could be reduced from the current 2 to 3 years to less than 12 months.

In the west, it is likely that coal burn could be increased by some factor, but the limit would be set by available coal-burn generation capacity. Lead times to open new coal plants would be on the order of 4-6 years. As such, the western states, where gas generation is already higher, may have significantly more difficulty replacing lost gas generation with coal than in the east. Eastern generation could possibly have to be increased by a factor greater than the local need, in order to free up additional gas supplies for use in the west. Gas deliveries are more easily diverted east to west than are electrons.

Coal carrying capacity of the eastern Class I railroads would be challenged with a 15% increase in current loadings. Assuming eastern coal would need to increase by 21 million tons or 70% of the 30 MTPY marginal demand need, then rail companies would have to make incremental capital investments in locomotives, track capacity and cars; a process that could be ramped up over the course of a year. Most excess electricity generation capacity is available at rail-served, coal-fired power plants because barge units usually dispatch ahead of rail-served units.

Western coal production in the Powder River Basin (PRB) could increase faster than at eastern mines because the large surface mines are more amenable to incremental production gains. In order to use more PRB coal in eastern plants, investments in coal handling and boiler modifications would be needed. While these investments could take place within 3-6 months, if focused, the de-rating of the boilers and the tightness of western rail capacity would be troubling. Western rail infrastructure investments would be needed depending upon when, in the rail capacity upgrade cycle of the western rail carriers, the natural gas shortage occurred. Loan guarantees in the fashion of the recent airline loans, post 9/11, could encourage faster infrastructure investments by railroads and coal mines.

Mr. David R. Goode
Chairman, President and CEO
Norfolk Southern Corporation

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**European government response**

The speed with which energy security problems are solved will depend on the implementation of sophisticated fuel and energy policies by individual States. From this point of view, the States must safeguard the readiness of equipment for using coal as an energy source.

The speed of the solution depends on the foresight and preparedness of the coal industry to solve these problems.

We perceive energy security in this sense to be adequate supply, i.e. sufficient and regular supply of energy resources at an affordable price. We must respect the growing world energy consumption in the future, above all the growing electricity consumption.

Fossil fuels will henceforward be crucial for meeting this consumption increase. It is desirable to maintain their balanced structure and not to diminish the present coal share, which is about 38% in the world and about 28% in the EU.

Supporting this, is the fact that coal is more evenly spread across the world than resources of natural gas and crude oil. Coal reserves have a much longer economic life and the price level is more stable. The willingness to invest, not only in new resource deposits but also in clean coal technologies, is crucial for the promptness of the solution to energy security.

Less favourable spatial distribution of natural gas, its more demanding exploitation in the future and its longer transport routes all point to a quicker increase in prices.

Increased use of coal also means a transfer of such technologies to less advanced countries and a coal industry capability to execute its development projects in a way to match the ever-growing environmental requirements.

The higher use of coal must respect the demands of climate protection and the environment in general. The quantities of SO₂, NOₓ, CO₂ and solids arising from coal consumption will be constantly supervised and monitored.

Coal as a source of energy, with the latest combustion technologies, is able to maintain security and prevent energy supply breakdown.

To fulfil this long-term strategy, apart from the willingness to invest in innovative programmes, a political will to follow this logical path to energy security and not to succumb to arguments from the gas lobby is important.

The speed of response to energy security challenges also depends on the ability of the coal industry to convince the public, through the media, about the necessity of this approach: in other words to handle, on a highly professional level in the media, the question: “How does the use of coal achieve sustainable development?”.

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**Mr. Vit Kastovsky**  
Head of Mining Administration  
Ministry of Industry and Trade, Czech Republic
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- Mr. Shiro Okada, Executive Officer and General Manager, Industrial Energy Department, Idemitsu Kosan Co. Ltd.
- Mr. Roger Wicks, Executive VP - Global Strategy, Marketing and Sustainable Development, Anglo Coal, South Africa
- Mr. Gerhard Hirth, Managing Director, SCHWENK Zement KG
- Mr. Aad Atteveld, General Manager, Production Department, Essent Energy
- Mr. John Hanson, Chairman, President and Chief Executive Officer, Joy Global Inc.
- Mr. Seppo Ruohonen, Managing Director, Helsinki Energy
- Mr. Vít Kastovsky, Head of Mining Administration, Ministry of Industry & Trade, Czech Republic

North American coal producer response

Three critical issues drive diversity of supply within our changing industry economics: (a) demand forecasts for coal, (b) future environmental regulations, and (c) coal supply response time.

Obviously, growing demand helps nurture diversity of supply. For example, over the foreseeable future coal will continue to fuel over 50% of U.S. power generation. But coal’s share could be substantially higher. What are the economic alternatives to coal? In the U.S., natural gas prices would need to decline by half to be competitive with coal for electric power generation. The nuclear option is problematic in most western countries, regardless of economics. Hydro generation faces significant environmental hurdles and renewables are not competitive at current costs. The indigenous supply of coal in the world’s largest economy (U.S.) and fastest growing economies (China and India) makes coal not only an economically competitive fuel source but also a secure fuel source for a significant segment of the world’s economy. These factors suggest that the demand forecast for coal is significantly higher than those currently quoted in the public sector.

A second driver that has an impact on diversity of supply is additional environmental regulations. More specifically, not whether we have new regulations (which we surely will), but what the specific rules of the game will be across a range of regulated emissions such as SO₂, NOₓ, particulate, mercury, and CO₂. A generator will not be willing to commit billions of dollars for new coal generation or environmental control technology at current coal plants without some assurance that they will be in compliance with environmental regulations once the investment is made. The same effect cascades down to investment in coal supply. Funding commitments will be delayed or not committed if there is material uncertainty regarding whether the customers (i.e. power generators) will be able to utilize your product. Think of the standard sequence of events for new mine investments. Assume a coal producer has a reserve that could be developed economically at current market prices. However, increasing the supply by making the new investment creates a risk that those prices will not be available. Often, the coal producer will negotiate a term contract that would reduce the risk associated with committing the investment. If the power generator is not sure as to whether it can
utilize the new production source due to potential environmental regulations, the term contract will not be secured and the coal producer will be less likely to commit to the now riskier investment.

Finally, there is the last driver affecting diversity of supply: coal supply response time. We all agree that there are incremental sources of coal supply out there, albeit at potentially higher extraction costs. However, many customers and regulators fail to account for the time needed to develop a green field coal mine from the engineering phase to full production. In some cases, this can take over five years, with major time allocations required for things like permitting and regulatory approvals. Financing needs to be secured along with related infrastructure to the mine such as preparation load out facilities and rail spurs. A number of stakeholders beyond shareholders need to be considered in the overall project concept. All of this takes time - a lot of it.

In conclusion, the three critical issues that must be addressed to secure adequate diversity of supply in the current economic environment are:

- realistic demand forecasts for coal that do not understate the potential market,
- clear environmental regulations that address current and foreseeable significant health and ecological risks of power plant emissions, and
- adequate lead times to ensure that incremental coal supply will be available when the demand develops.

Asia-Pacific coal producer response

Diversity of supply for the coal industry is a function of geography and geology, along with social and political requirements. Overall, the supply and use of coal must be economic within the context of the above parameters.

If the economics of coal production or consumption change then there is a risk to the business, which may be either positive or negative depending on the source of coal (e.g. local supply versus imports).

Because of the widespread availability of coal, any change in supply or subsequent change in economics will result in further diversity and competition. This process is maintained by continued investment in mining technology.

Other factors are:

- Continued exploration for new, lower-cost coal supplies.
- Improvements in operations to lower greenhouse emissions (ex-mine).
- Improving the quality of coal supplied (e.g. more washed coal, higher energy content, lower ash and lower sulphur).
- More alliances between buyers and suppliers to increase investment in mines and infrastructure (lowering the risk from economic change).
- Diversity of sources has always been a factor when security of supply is considered by buyers.
Asia-Pacific coal supplier and marketer response

According to IEA’s World Energy Outlook 2002, fossil fuels will remain the primary sources of energy, meeting nearly 90% of total world energy demand. While oil will remain the single largest fuel in the primary energy mix and demand for natural gas will grow fastest among fossil fuels, coal will continue to be a very important fossil energy source, accounting for about 25% of the total world primary energy supply/demand in 2030.

Coal demand is expected to increase most strongly in Asia, particularly in China and India, driven by economic growth and the associated need for more power generation.

China and India are, and will continue to be, major world coal-producing countries but most of the coals produced in the two countries are consumed domestically and this will also be the case in the future.

China’s energy demand has been accelerating with the high economic growth rate. In China, coal has been and will continue to be the largest primary energy source, accounting for about 60% of the total primary energy demand in 2030. Its domestic coal supply will increase to meet coal demand, mainly for power generation. It is expected that southern China will increase imports from overseas, particularly from Australia, some time in the future because imported coal will be more competitive than the coal transported from northern China.

In India, about 75% of the coal consumed is for power generation and this trend will continue towards 2030. It is expected that India will have to import a large amount of coal from overseas to fill the gap between coal demand and domestic coal supply capacity.

As world coal demand increases, particularly in developing countries like China and India, the coal-producing countries will have to expand coal production. In particular, Australia and Indonesia are geographically close to China and India and they are expected to be the main exporters for the two counties when they start to import substantial amounts of coal.

In addition, Russia will be a potential coal supplier for the Far East countries and China once the coal resources in the Eastern Siberian region are developed to meet future coal demand in the area.

Coal supply increases will require investment in coal supply chains. Investment for building and expanding these coal chains is the key to maintaining diversity of supply sources. In this connection, government support for investment is quite important.

South African coal producer response

This question is aimed, I assume, principally at the internationally traded coal market. It is inherently difficult to respond to in a world now almost entirely driven by market-based economics and one in which the deregulation of energy markets looks set to continue. If the recent price increases for fossil fuels are sustained across all fuels, the impact may merely translate into higher energy costs for everyone, coupled to
a drive for greater efficiency, but the world is rarely that simple. More importantly, it is what happens at the margin and the relationship between fuel prices that are becoming the primary drivers, allied to improvements on the part of power utilities to switch between alternative plants depending upon generation costs.

The impact of fundamental economic issues aside, coal’s ability to maintain supply source diversity will be assisted by historical accidents of geology and geography. The abundant and widespread availability of coal reserves with long life will underpin the availability of diverse supply sources. However, the last thirty five years of growing international trade in coal have demonstrated, in a more often over-supplied than under-supplied market, that economic and competitive pressures will drive productivity improvements and cost reductions, up to a point. Thereafter, the exploitation of reserves shifts to areas where either: the competitive pressure is less; market growth is expected; or, the conditions, the geography, the economics or some combination thereof, is more favourable. The initial dominance of the USA, the successive build up in Australia, South Africa, Indonesia, Colombia, other more minor players and, most recently, China, are evidence of this. So too are the rationalisation and globalisation phenomena that have changed the shape of major international coal companies. Also worth noting are the potentially negative impacts of processes, such as the World Bank Extractive Industries Review, which could reduce the potential of coal resources, especially in developing countries, to contribute positively to the alleviation of poverty, whilst simultaneously enhancing energy security.

In essence, market demand and inter-fuel competition will dictate price thresholds. Current producing areas will survive for as long as the reserves can be economically produced, having regard to anticipated price thresholds and overlain, no doubt, by environmental policy influences. Shifts in the pattern and range of producing countries will continue in response to these drivers. Coal’s uniqueness lies in the spread of the resource base which offers greater geographic diversity than is typically the case for other, especially fossil, fuels.

European coal consumer (cement producer) response

The world cement industry is very capital and energy intensive. The global investment in the cement industry may well come to over 60 billion EUR in the next five years. Worldwide, cement production required about 250 million tonnes of coal equivalent in 2003, corresponding to 6.5% of the global hard coal demand, and over 200TWh of electricity. Cement production is also environmentally sensitive throughout its production chain, from the extraction of raw materials via the processing to the dispatch of finished cement. Therefore, as a major coal and electricity customer, it is important to the cement industry that these industries address sustainable development issues. Continuing coal supply diversity requires new investment in coal production, and the coal industry must consider sustainable development issues when making these investments.

The cement industry is aware of its responsibility for sustainable development. The global players are therefore involved in the Cement Sustainability Initiative of the World Business Council for Sustainable
Development. Corresponding activities are also being followed at national levels. One example is the Initiative for Sustainability in the German cement industry that is supported by companies, associations and trade unions. One central aim is to increase resource productivity still further and to reduce CO₂ emissions.

In addition, the activities of other basic industries, including the coal and power industries, play an important part for the cement industry. In the long term, this also includes the option of CO₂ capture and storage. However, industry needs a well-balanced strategy for energy supply, which includes security, cost-efficiency and environmental compatibility as equal targets. Otherwise, there would be an extremely negative impact on the cement industry as a major consumer of fuels and electricity. The cement industry is therefore backing a diversified mix of energy sources for power generation.

Whatever is valid for energy supply also applies to sustainable development as a whole: economic, social and ecological demands should be carefully balanced. The climate protection instruments, including the European emissions trading scheme in which the cement industry will take part from 2005, must be judged against this. One-sided and exaggerated objectives, in countries where sustainable success in climate protection has already been achieved, make no sense. They just tend to cause a shift in capital investment and industrial production. Demand will then increasingly be covered by imports, resulting in negative effects on domestic employment and higher transport emissions.

To avoid counter-productive “leakage” effects, it is important to make progress with climate protection in the world regions where massive potential for the reduction of CO₂ and other greenhouse gas emissions can be developed cost-efficiently. Utilisation of the project-oriented instruments of the Kyoto Protocol (Clean Development Mechanism and Joint Implementation), that is as comprehensive and unbureaucratic as possible, can contribute to this. Sustainable investment conditions can only be achieved through international cooperation. If this knowledge is implemented consistently, then there are good future prospects in Europe not only for cement production, but also for coal as an indispensable material for power generation and industry.

Mr. Gerhard Hirth
Managing Director
SCHWENK Zement KG

European coal consumer response

The industry can maintain diversity by adjusting its investment behaviour to ensure long-term diversification. It should make sure production is well spread across the global regions. The advantages of this include diversity of coal types (e.g. in terms of quality) and, more importantly, reduced vulnerability to specific local conditions (e.g. port congestion etc.). In fact, it would increase security of supply to customers.

Diversity might be achieved at the expense of short-term profits, but it is up to the coal industry to cope with this. Security of supply arguments will be helpful in increasing customer support for diversification strategies. A practical example is South Korea, which is currently actively diversifying its sources of coal to become less dependent on China as its main supplier.

Mr. Aad Atteveld
General Manager, Production Department
Essent Energy
North American/European mining equipment manufacturer response

The major drivers of the coal industry maintaining its diversity of supply sources are the availability of economically-viable reserves, cost of production, preparation, transport and burn, as well as safety and environmental issues. There is an abundance of economically-viable reserves in many countries of the world. Environmental issues are discussed elsewhere. To optimise cost of production needs investment in the latest mining technology, in terms of equipment and infrastructure.

In China, 95% of current production comes from underground mines. Recent government projections anticipate this ratio remaining fairly stable in the foreseeable future. These projections also state that, in order to support growth in China’s GDP of 8-10% per year for the next 10 years, coal production will need to grow from 1.7 to 2.7 billion tonnes per year. To meet this demand, the industry is going through a period of rapid consolidation. The small, locally owned, notoriously unsafe mines are being closed down. These mines have traditionally produced some 50% of China’s total output. The focus is now on the current, centrally-controlled coal bureaux and the development of new capacity. The majority of production will come from a few large coal companies, perhaps 8 to 10, each producing in excess of 100 million tonnes annually. These companies will initially be state owned entities, but the likelihood is that, over time, they will attract private equity through IPOs and bond issues. It is also likely that vertical integration with power generation companies and/or steel makers will happen. Mines are being developed in non-traditional mining areas to ease transportation difficulties. Investment will be made in latest-technology mining equipment as confidence builds, following the world-class achievements of Shenhua in the Shendong coalfield. The known reserves of extractable coal in China are massive and so this is not expected to be an issue. Substantial investment is also taking place in rail and port infrastructure, which will prevent supply bottlenecks.

The US is driven predominantly by fundamental and free-market policies. Competing markets around the US experience success or failure by the most basic drivers, primarily price. Total price being determined by the cost to mine, prepare, transport and burn the fuel. In addition, all fuels are competing beneath a set of environmental regulations that demand compliance to a federally-mandated level. These fundamentals provide a level playing field that can be used by utilities to plan for fuel purchase. Recent history shows a trend for the import of some steaming coals from South America. This will probably continue as long as pricing supports the freight cost. Even so, only coastal utilities can presently justify the imported product because of freight and handling.

India is second only to China in the forecast growth for energy and hence coal demand. At the moment, the future growth in demand will be met from both indigenous and imported sources. The current indigenous coal production comes very largely from surface mining, approx 75%. The future growth of indigenous supply is planned to come also from surface production, with underground production remaining static, as it has been indeed for the past 20 years. Environmental pressures are growing and doubts must be expressed about the ability of surface mined coal to meet the targets. There is an abundant supply of economically-viable underground coal which is of much better quality than that mined on the surface. Mining techniques are now proven in India so that underground coal can be mined very competitively compared with both indigenously-mined surface coal and certainly imported coal. Investment is needed in mining technology to make this happen.

Equipment suppliers have a major role to play globally to ensure that coal production costs are optimised. Highly productive, reliable equipment, fully supported throughout its life cycle must be made available to all potential markets of the world.

Mr. John Hanson Chairman, President and Chief Executive Officer Joy Global Inc.
**European coal consumer response**

Consolidation of the global coal industry has improved productivity and probably also increased the security of supply, but on the other hand it has been one factor which has led to bullish price increases. Consolidation has not been able to prevent today’s huge price volatility, which will not encourage investments in coal-fired electricity production.

Coal is a significant indigenous energy source in the EU-25 and it could guarantee a certain degree of independence in energy policy. From this point of view, any EU restructuring program should also include investments in the best coal production areas.

If energy policy is favourable to investments in coal-fired electricity production capacity, that will also encourage the coal industry to make investment decisions to improve productivity in mines, open new mines, secure rail transport from mines to ports, etc.

Generators own decisions could be a major influence if they equip new power plants with technology that allows the use of a variety of fuels.

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**Mr. Seppo Ruohonen**
Managing Director
Helsinki Energy

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**European government response**

Countries with varied economies (less developed, developing and transition countries) have many good reasons, particularly economic and social reasons, for using coal. Countries with sufficient coal resources have an advantage, while the others that are dependent on coal imports have to look for supplies at a reasonable price and with appropriate forms of financing. Countries with coal resources that have not yet been exploited should be granted investment incentives or subsidies to start coal mining. Changing economic policies, aimed at the open market business environment, might become more vulnerable to increasing prices of natural gas and oil by increasing their dependency on energy imports.

In view of the fact that the major worldwide coal mining companies in highly developed countries intend to increase coal production and its worldwide transport, and as they are backed with a strong economy, there are excellent opportunities for the coal industry in transition countries to contribute by enhancing and diversifying the exploitation of their own resources. As a matter of fact, practically all areas of the world are rich in coal resources, which are mostly used for the production of electricity, in some cases as a key resource. The grounds for this are its reliability and cost efficiency in the long run. The Central and East European countries have extensive lignite resources and any conversion to other energy resources would involve considerable financial costs.

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**Mr. Vít Kastovsky**
Head of Mining Administration
Ministry of Industry and Trade, Czech Republic
Responses submitted by:

- Mr. Steven Leer, President and Chief Executive Officer, Arch Coal Inc.
- Mr. Peter Coates, Managing Director & Chief Executive Officer, Xstrata Coal
- Mr. Eric Ford, Chief Executive Officer, Anglo Coal Australia Pty Ltd.
- Mr. Shiro Okada, Executive Officer and General Manager, Industrial Energy Department, Idemitsu Kosan Co. Ltd.
- Mr. Michael J. Mudd, Program Manager, Generation Technologies, Corporate Technology Development, American Electric Power
- Mr. Gerhard Hirth, Managing Director, SCHWENK Zement KG
- Mr. Ömer Ünver, Head of Project Studies, Turkish Coal Enterprises
- Mr. David R. Goode, Chairman, President & CEO, Norfolk Southern Corporation

**North American coal producer response**

Throughout the course of the past three decades, global energy markets have experienced a high degree of volatility. Often, such volatility has had pervasive and adverse implications for the global economy. Geopolitics has often played a role in such volatility. The fact is that the world’s energy resources are concentrated in a handful of regions. Instability or other regional developments can have far-ranging implications for the world’s energy markets - and thus for the world’s broader economic condition.

Clearly, there is nothing that can be done to reapportion the world’s energy resources. Some countries are blessed with significant reserves of petroleum and natural gas, and others are not. However, we believe that robust levels of investment in developing the world’s largest hydrocarbon resource - coal - can act as a stabilizing force in international energy markets. Increasing reliance on coal raises the number of countries participating in world energy markets, enhances fuel diversity across the globe, and provides a crucial source of energy for many of the world’s fastest-growing economies; economies that would otherwise depend increasingly on already-strained, world supplies of petroleum and natural gas.

Consider the examples of China and India - two countries experiencing torrid rates of growth at present. Both countries have large indigenous reserves of coal that can serve as the foundation of their rapidly expanding energy infrastructures. Furthermore, with sufficient levels of investment, both countries have the capability to produce volumes of coal in excess of their internal requirements, should they choose to do so. In fact, China is already one of the world’s largest exporters of coal, having sold an estimated 90 million tonnes of coal into the international marketplace last year. Many other nations - including Russia, Indonesia, Australia, South Africa, Colombia, Venezuela and the United States - have the potential to significantly increase coal production to help meet the world’s growing demand for energy. Many of these nations are already seeking to expand production quickly and significantly.

The value of such a development is clear - both to the producing countries and those that seek to obtain coal via the international marketplace. A robust, global coal industry alleviates pressure on world oil markets. It
creates greater geopolitical supply diversity, reducing the likelihood that a disruption in one region affects the broader global marketplace. And it taps one of the world’s greatest energy resources.

The world’s coal reserves are extraordinarily vast and - compared with petroleum and natural gas - widely dispersed. Economically recoverable reserves are estimated at one trillion tonnes - a total that greatly exceeds the world’s combined reserves of petroleum and natural gas on an energy equivalent basis. At current rates of consumption, the world has an estimated 200 years of coal supply - and that number has been growing. Since 1980, the world’s proven coal reserves have increased by nearly 50%. Clearly, it makes sense for the nations of the world to find environmentally responsible ways to employ this tremendous energy resource. Emerging clean coal technologies carry the promise of near-zero emission coal plants within two decades. We must ensure that coal remains a viable option until such technology is available.

The inclusion of coal as a growing component of world energy supply is certain to have a stabilizing influence on world energy markets. That, in turn, should produce significant benefits for global economic growth, quality of life and the alleviation of poverty in both developed and developing nations for many decades to come.

**Asia-Pacific coal producer response**

Other energy sources are relatively more expensive than coal, which is abundant and widely distributed. Thus, more investment in coal will lower the overall cost of supplied energy.

Coal, as an energy source, has been historically less prone to wide fluctuations in price or availability when compared with other fossil fuels.

Investment and improvements in coal utilisation technology, especially in lesser-developed countries, leads to more stable energy markets.

Investment in alternative energy sources, such as nuclear or renewables, is unlikely to lead to stable energy markets in the near-term future (e.g. 10 years).

**Asia-Pacific coal producer response**

Coal has for many years underpinned the stability of global energy markets. Coal is the world’s most abundant and widely distributed energy source: proven reserves are ample to meet long-term supply; deposits are geographically dispersed; supply chains are diversified; and, costs of production, transportation and
delivery are low compared to other forms of energy. By contrast, most of the world’s hydrocarbons lie in politically unstable regions, with some 80% of proven reserves of both oil and gas located in the Middle East, Africa and the former USSR.4

Most of the world’s coal production is consumed locally and is therefore insulated from the supply risks associated with internationally traded fuels. Of the 4.3 billion tonnes of coal produced in year 2000, only around 18% was internationally traded. Coal has been the most price stable of the major fossil fuels. Over the 15 years to 2002, coal prices varied within a range of 22% to 42% around average levels, oil in a 76% to 80% range, LNG (Japan) 45% range and natural gas a 70% to 163% range.5 It remains to be seen whether the price volatility experienced by all fossil fuels this year represents a structural shift or a relatively short-term phenomenon.

If coal is to continue to provide stability in global energy markets, ongoing capital investment will be needed. Such investment will provide the additional mine capacity, logistics infrastructure and coal-fired electricity generation plant required to meet demand growth as well as replacing depleted resources and obsolete facilities. While the required level of capital investment is substantial - some USD 1.9 trillion to year 2030 according to recent IEA analysis6 - it represents only around 12% of the USD 16 trillion that will be needed in total for energy supply infrastructure over the period. This highlights the low capital intensity of investment in the coal chain - six times less than that for gas - which is an important factor when considering the challenges of financing investment on this scale.

The investment that will be required to enable coal to continue to underpin stable global energy markets cannot be taken for granted. Energy market reforms in many developed countries and rapid energy sector expansion in transition economies and developing countries have increased the risks faced by investors. In order to ensure the levels of private sector investment that will be needed for energy supply infrastructure generally, and coal in particular, governments need to create the right enabling conditions.

One area of particular concern relates to environmental policy. The mooted introduction of tradeable emission rights or other abatement measures is directionally unfavourable for coal, and therefore adds to investment risk. However, it is not the threat of abatement measures per se, but rather the lack of clarity surrounding the policy parameters that currently poses the greatest barrier to investment. Continued research into clean coal technologies and carbon sequestration offers the potential for improved environmental performance of coal-fired power plants, and mitigation of the risk to investment, but again, funding of these critical areas needs to be underpinned by clear, soundly constructed policies which offer incentives. Clarification of these matters is a critical precondition to addressing the joint objectives of stable energy supply, third-world economic advancement and environmental sustainability.

Mr. Eric Ford
Chief Executive Officer
Anglo Coal Australia Pty Ltd.

Asia-Pacific Coal Supplier & Marketer response

According to the IEA’s World Energy Outlook 2002, fossil fuels will remain the primary sources of energy, meeting nearly 90% of total world energy demand. While oil will remain the single largest fuel in the primary energy mix and demand for natural gas will grow fastest among fossil fuels, coal will continue to be a very important fossil energy source, accounting for about 25% of world total primary energy supply/demand in 2030.

As recoverable reserves at operating coal mines deplete with time, new coal mines and the associated transport infrastructure need to be developed. From a supply-side point of view, coal chain investment comprising coal mine construction and/or rail and port upgrading is essential for maintaining stable coal supply, which in turn will contribute to more stable world energy markets. In light of this, government support in coal-producing countries for coal chain investment would be very helpful.

From the perspective of coal utilization, coal has more carbon content than other fossil fuels and more impact on global warming. Therefore, the clean and efficient use of coal and CO₂ sequestration and storage are quite important.

As development of clean coal technology (CCT) advances, demand for coal will increase further mainly in the power generation sector, because coal will remain more competitive than oil or gas on a unit calorific value basis.

Since it takes time and cost to develop CCT such as IGCC and IGFC and to develop CO₂ sequestration and storage technology, the role of governments is very important in terms of financial support for these technology developments.

Therefore, investment in the coal chain and in CCT development will enhance the position of coal in the future energy market, and coal will continue to contribute to energy market stability and sustainable development.

North American coal consumer response

Coal is an important source of electricity for the United States. It currently provides in excess of 50% of the electricity generated in the United States. The use of coal in generating electricity has provided stable electricity prices for those regions of the country that use coal. On the other hand, regions of the country that rely on natural gas for the majority of their electric generation have seen significant increases in the cost of electricity. The use of coal to fuel the existing and proposed power plants of the world depends on the abundance of low-cost coal. If investments are not made to maintain and increase the production of coal, then coal will see increases in both prices and volatility.

For example, in the United States, an imbalance between the supply and demand of Central Appalachian coal is beginning to be reflected in higher prices and volatility for coal from certain portions of the
Appalachian region. This imbalance is because the demand is beginning to exceed the supply. The imbalance came about because most new power plants built in the last decade used natural gas, which depressed the market price of coal. Therefore, the coal suppliers did not receive market signals to encourage investment in new mines. Now, the demand for coal has increased because of high natural gas prices. However, the lead time to develop new mines or expand existing mines is several years. This precludes the ability to increase supply rapidly. Because of this, the market focus has been on attempts to procure lower-cost coal from other regions of the country. This situation has placed a premium on sub bituminous coal from areas of the United States such as the Powder River Basin; however, transportation constraints limit the supply of that coal to some markets. This situation could have been eased by a more strategic position with respect to planned robust investment in coal.

Therefore, continued robust coal investment in R&D, technology, and infrastructure will ensure that coal continues to be an abundant, stable, and low-cost source of energy for the economies of the world.

Mr. Michael J. Mudd
Program Manager, Generation Technologies, Corporate Technology Development
American Electric Power

European coal customer (cement producer) response

This response describes the importance to the cement industry of raising energy efficiency and optimizing the fuel mix - similar challenges to those faced by electricity generators - and highlights the importance of stable energy markets to making effective cement industry investment decisions.

Because of the high proportion of energy costs in the total manufacturing cost, the European cement industry has significantly reduced its specific energy requirements through technological change and investment. Primary energy requirements, equivalent to approximately 11 million metric tonnes per year of coal, have thus been saved since the 1970s through some 30% reduction of the specific energy consumption for the production of cement clinker in the 25 CEMBUREAU (European Cement Association) countries. The European cement industry is now close to the limit of what can be achieved through such technical improvements.

Optimisation of the fuel mix therefore plays an important part as a further strategy. Many cement plants today can flexibly use solid, liquid and gaseous fuels. The cost of the heat - alongside the logistical and handling costs - is of decisive importance in the choice of fuels. After the negative experience with the oil price crises in the 1970s, the traditionally dominant position of coal is, and will remain, established. At the same time, it must face up to the competition by other fuels such as pet coke - an option that is gaining in importance in view of the current price of coal.

The use of alternative fuels is increasing - largely independently of the fluctuations in the prices on the markets for primary fuels. Different types of waste are burnt in cement kilns: used tyres, paper waste, waste oils, waste wood, sewage and animal meal residues to name but a few. The benefit to the cement industry is fairly obvious. Even if it often needs to be treated and made sufficiently homogeneous to be used, and despite the process investment which this may require, waste is usually cheaper than primary fossil fuels; in certain cases, alternative fuels may even be a negative cost item. Actual cost varies, of course, with each type of waste and each set of local conditions.
The use of waste in cement kilns also presents environmental benefits. First of all, the use of waste as an alternative fuel in cement production benefits the environment by preserving non-renewable fossil fuels. The equivalent of 2.5 million tonnes of coal is already being saved in this manner every year by the cement industry in Europe. Secondly, the use of waste in cement kilns contributes to lower overall CO₂ emissions by replacing fossil fuels and their CO₂ emissions by waste materials that would otherwise have to be incinerated or landfilled with corresponding greenhouse gases emissions.

In 1990, the overall rate of substitution of traditional fossil fuels by alternative fuels in Europe was only 3%. Today, it stands at 12%. If a level of substitution of 17% is achieved by 2010, this would result in a reduction of 9.7 million tonnes of CO₂ emissions each year. However, the effects on coal as a primary fuel will remain limited for the foreseeable future. This is because alternative fuels are not yet available in the requisite quality in many countries. At the same time, progress to lower the specific energy consumption in the newly-industrializing countries is not leading to a corresponding drop in absolute energy consumption, because of a simultaneous increase in cement production.

Hard coal and lignite accounted for about 35% of European cement industry fuel requirements in 2001 and will continue to be a significant part of the energy mix. Government and coal industry action on investment to promote more stable global energy markets is therefore very important.

**European coal producer response**

If development plans for coal are adopted by developing economies as well as developed economies, dependence on oil and gas will be minimized and this will result in more stable oil and gas markets which will eventually lead to more stable development of global energy markets.

**North American coal transporter response**

With the advanced combustion boiler technology existing today, the installation of clean coal technology could eliminate using natural gas for electricity generation. This would reduce gas demand and stabilize world gas markets. Accordingly, gas supplies could be used in other sectors such as agriculture, chemical and residential heating where substitution is impossible and the consequences to the U.S. economy are significant if these industries locate offshore. In order to accomplish this, strategy and policy must be developed for uniform emission regulation in order to provide certainty for financing of new coal-fired power plant construction.
Coal gasification is a viable process that can be used to operate combined cycle power plants with low emissions. Gasification technology is not new. Eastman Chemical’s U.S gasification operation in Tennessee is 20 years old, and the Terre Haute plant, which provides fuel for a Cinergy power plant, has been fully operational since November 1995. A gasification plant in Tampa, which uses Kentucky coal in its mix, has been producing coal gas since 1996.

The model for gasification is straightforward. Take coal or other carbon-containing material, inject oxygen and heat (with steam or hot water) until it breaks down into more elementary components. The process gives off a gas that is 85 percent hydrogen and carbon monoxide, along with smaller amounts of methane and carbon dioxide. The mix can be burned or converted into methanol and other chemicals used to make other products, including artificial sweeteners.

The tight natural gas supply, weak infrastructure and the resulting price risk to vital industries prohibits the use of natural gas for generating electricity in the United States. As petroleum and natural gas supplies dwindle and prices rise, the economics of producing gas from coal will continue to improve. It is also anticipated that the price of natural gas will stay well above USD 3.50/MMBTU, allowing coal gasification to become quite competitive. However, the gasification plants are quite capital intensive.

In the future, hydrogen could well be a replacement for gasoline and diesel fuels in the transportation sector. Hydrogen from coal can be economically produced through the gasification process. Since hydrogen is not an energy source, but only a chemical energy storage element (stores input energy used to create the pure hydrogen), it offers a convenient way of using coal energy sources for replacing gasoline/oil. Whether the economics can be made attractive will depend solely on oil supply/prices. As a replacement for oil, coal through hydrogen conversion could offer the world a much more stable energy market; at least until coal supply begins to dwindle. It is believed by some futurists that nuclear fusion could be ready by that time to eliminate carbon-based fuels entirely.
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