INTERNATIONAL ENERGY AGENCY
COAL INDUSTRY ADVISORY BOARD

CIAB

30th PLENARY MEETING

DISCUSSION REPORT

IEA Coal Industry Advisory Board plenary meeting
IEA Headquarters in Paris, 6/7 November 2008

IEA – 9, rue de la Fédération – 75739 Paris Cedex 15

PROGRAMME – Thursday, 6 and Friday, 7 November 2008

SESSION 1: Coal – Challenges in Developed and Developing Economies
Chaired by Mr Steven F Leer, Chairman and Chief Executive Officer, Arch Coal Inc, US and CIAB Chairman

Coal in Japan
Mr Yoshihiko Nakagaki, President, J-Power, Japan

Coal Sector in Russia: Challenges and SUEK's Response
Ms Anna Belova, Vice CEO for Strategy and Corporate Development, SUEK – Siberian Coal Energy Company, Russia

Coal in China
Mr Yong (Richard) ZHANG, Deputy Director – Foreign Affairs, China Shenhua Coal to Liquid and Chemical Co Ltd

Current Developments in Power Generation and the Coal Industry in Indonesia
Mr Bob Kamandanu, President Director, PT Berau Coal, Indonesia

Discussion

SESSION 2: Coal's Contribution to Energy Security
Chaired by Mr Preston Chiaro, Chief Executive – Energy, Rio Tinto plc, UK

Security and Cost of Future Coal Supply
Mr Joost van Dijk, Director – Board of Management, E.ON Benelux nv, The Netherlands

Coal Delivery Infrastructure Developments
Mr Pierre Guérin, General Director, ATIC Services SA, France

Electricity Shortages in South Africa: Impacts and the Response
Dr Steve J Lennon, Managing Director – Corporate Services, Eskom, South Africa

Gas-Coal Interplay in Spain
Mr Angel L Vivar, Director of Energy Resources & Environment, Asociación Española de la Industria Electrica - UNESA, Spain

Discussion

SESSION 3: Coal's Role in Mitigating Climate Change
Chaired by Dr Don Elder, Chief Executive Officer, Solid Energy New Zealand Ltd

From Analysis to Action on CO_2 Capture and Storage
Mr Henry A Courtright, Senior Vice President, EPRI – Electric Power Research Institute, US

GreenGen: Changing the Colour of Coal
Mr Fredrick D Palmer, Senior Vice President – Government Relations, Peabody Energy Corp, US

G8 Heiligendamm Process
Mr Andreas Schaal, Senior Policy Analyst – Heiligendamm Process Support Unit, OECD

CCS: Who Pays? – The Role of Government-Industry Partnerships
Mr Roger Wicks, Head of Energy, Anglo American plc, South Africa

Discussion

Introduction

These notes describe the discussion sessions held on the afternoon of 6 November 2008 and the morning of 7 November 2008 during the 30th CIAB Plenary Meeting. The aim of the sessions was to engage CIAB Members in a debate on the major issues affecting not only the coal industry, but also the wider community that depends on coal, largely indirectly, for its electricity, steel and cement needs. These issues, including energy security and efforts to mitigate climate change, affect both developed and developing countries.

Presentations used during the sessions are available to CIAB Members and Associates at: www.iea.org/ciab/docs.

SESSION 1: Coal – Challenges in Developed and Developing Economies

Mr Steven F Leer, Chairman and Chief Executive Officer, Arch Coal Inc, referred to earlier comments by Mr Nobuo Tanaka (IEA Executive Director) that had illustrated the enormous economic growth and associated demand for energy in emerging economies. Mr Leer said that energy and climate change challenges rarely respect national boundaries, and observed that development paths in the developed and developing worlds are diverging. Growth in coal use in the developed world is moderate, because there are alternatives, but the developing world is and will continue to use coal because it is affordable and available to fuel their seemingly exponential growth in energy needs as their economies develop. The world will continue to use coal, the only issue being how fast coal use will grow, so developing carbon dioxide capture and storage (CCS) technologies is not optional, he said, but essential.

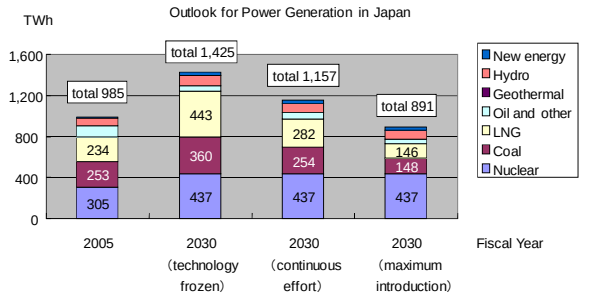
Coal in Japan

Mr Yoshihiko Nakagaki, President, J-Power, covered the outlook for long-term energy supply and demand in Japan, and coal's role and challenges, with particular emphasis on electric power supply.

"Outlook for Long-Term Energy Supply and Demand"

The latest edition of this study, a quantitative projection by the Japanese government, was published in May 2008. It outlines measures to mitigate the increase in CO_2 emissions, including targets to improve energy efficiency by 30% and increase the use of nuclear power in total electricity generation to 30-40% by 2030. Mr Nakagaki highlighted some of the uncertainties in achieving the efficiency and CO_2 mitigation targets, including technology development, environmental policy, power station development, infrastructure development in coal exporting countries and the availability of coal for export, all of which would affect coal-fired power generation.

1.3 Results about Power Generation



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Coal's Role in Electric Power Generation

Mr Nakagaki emphasised the need for Japan to maintain fuel flexibility in electricity generation, necessitating a sustainable role for coal. This would require the continuous expansion of coal supply capacity and transport infrastructure by exporting countries, particularly in the Asia-Pacific region. He added that the proposed replacement of the International Maritime Organisation's Code of Safe Practice for Solid Bulk Cargoes (BC Code) with an International Maritime Solid Bulk Cargoes Code (IMSBC Code) must avoid inappropriate and costly restrictions on coal shipping because of any lack of scientific verification on coal self heating.

CO_2 Leakage

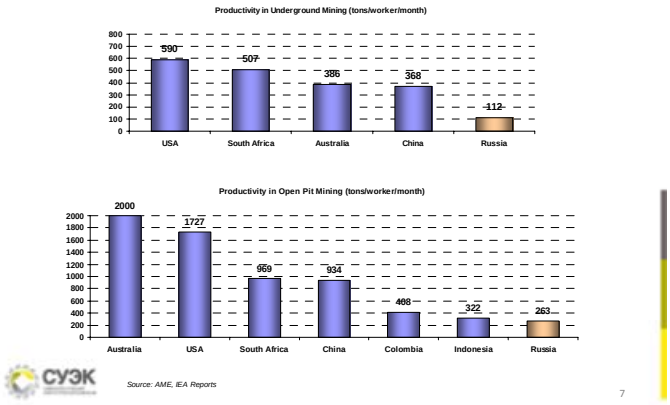
Mr Nakagaki added some personal observations regarding possible international migration of heavy industry to countries with less strict environmental regulations, a process that could result in CO_2 leakage and reduce the effectiveness of climate change mitigation measures. In his view:

- all countries must participate in the formulation of post-Kyoto emission regulations, taking into account each country's specific conditions;
- the main CO_2 mitigation process should involve the introduction of new technologies – other measures, such as the provision of incentives through market-based mechanisms, should be supplementary;
- emission trading schemes should be designed to avoid excessively high prices that, in turn, encourage migration of heavy industry;
- CDM/JI must be effective in stimulating technology transfer; and
- a sectoral approach, designed to work in a similar way to CDM/JI, would establish a rational pattern of sustainable CO_2 reductions across national boundaries.

Coal Sector in Russia: Challenges and SUEK's Response

Ms Anna Belova, Vice CEO for Strategy and Corporate Development, SUEK, illustrated the growing role of coal in world energy consumption and placed Russia as the second largest holder of coal reserves, with 17% of the world total. Its coal production is now over 300 million tonnes per year. She said that SUEK, the largest Russian coal producer, has nearly 6 billion tonnes of proven and probable coal reserves, extracts over 90 million tonnes of coal per year and exported 26 million tonnes in 2007 (compared to 5 million tonnes in 2003). SUEK also has stakes in three Russian power generation companies with a total installed capacity of about 13 GW. It is investing heavily in new mining and export infrastructure. She presented figures illustrating the low productivity in Russian coal mines,

Productivity Remains The Largest Issue For Russian Mining That Might Influence Global Competitiveness Of Russian Coal



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compared to other major producers, and said that this is the subject of a key strategic initiative by SUEK, whose mines are already among the most productive in Russia.

By Massive Investments In Expansion SUEK Is Going To Support Sales To Growing Export Market

Coal loading terminal at Muchka Bay will increase export capacity to Asian market

Capacity – 12 mtpa with opportunity to increase to 16 mtpa
Investments over 9 bln RUR ($340 mln)
Cape size vessel loading with 160K-170K dwt
First share of coal loaded in September 2008

Investment in Tugnui mine development and enrichment plant will support massive expansion to Asian market

Capacity – 8,5 mtpa of mined and 4,5 mtpa of enriched coal
Investments over 3,5 bln RUR ($130 mln)
Project to be completed in November 2008

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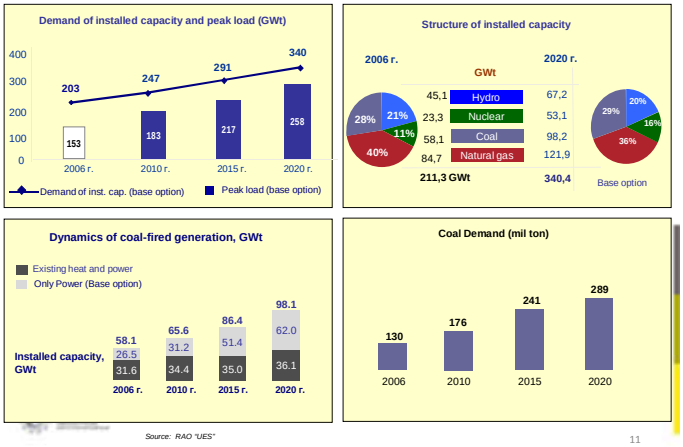
Ms Belova characterised the domestic energy market as being dominated by natural gas (49% of total energy demand and 69% of power generation in 2007), with coal taking a smaller share (19% of total and 28% of power generation). She highlighted a new energy strategy, due for its first government reading in December 2008, which will see the shares of coal and nuclear power in electricity generation grow. The government has developed a road map for the location of new electricity generating capacity, which is projected to increase to 340 GW by 2020, with coal-fired plant capacity increasing from its present 58 GW to 98 GW by that date.

According To Power Sector Strategy Adopted By Russian Government Share Of Coal In Power Generation Should Be Increased Thus Driving Demand For Coal



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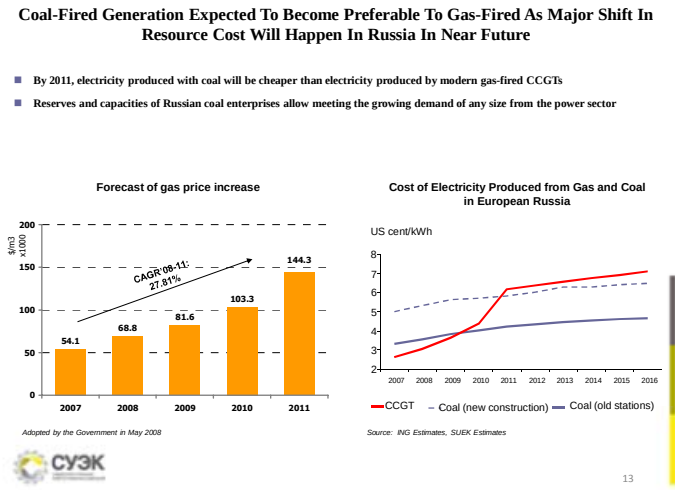
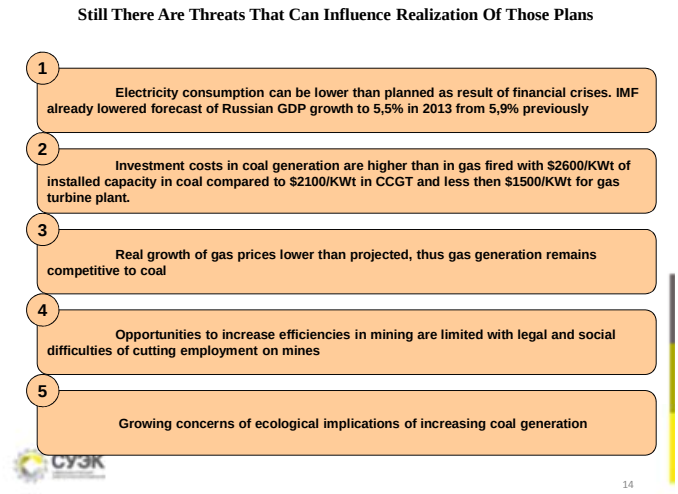
She said that gas prices in Russia will continue to increase substantially to 2011, reflecting the fuel's future resource cost and making new coal-fired electricity generating capacity competitive.



She highlighted several risks to the achievement of Russia's investment plans and made two specific points regarding recent world economic developments:

- Coal investment will be slowed by the economic recession over the next 3-5 years. The resulting lower energy prices may consign CCS to the position of an intellectual exercise, although she saw the need for a CCS demonstration project in Russia.
- The latest financial and economic changes, including lower GDP growth in Russia (IMF has revised this down from 5.9% in 2013 to 5.5%), may drive down investment costs.



Coal in China

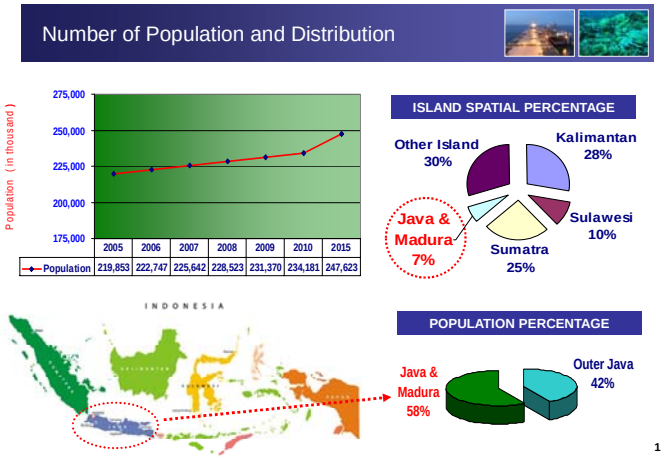
Mr Richard Zhang, Deputy Director – Foreign Affairs, China Shenhua Coal to Liquid and Chemical Co Ltd, said that Shenhua is the leading coal producer in China with sales of over 200 million tonnes per year. Since China became a net oil importer in 1993, and with oil demand projected to rise above 450 Mtoe when imports might account for 60% of supply, coal has become even more important to the country's energy security and to its economy. He recognised the need to face the environmental implications of coal use by deploying clean coal technologies (CCTs), at least until a time when renewables can take a greater share of energy supply.

He expressed a view that the supply-demand imbalances on world oil markets will get worse and that coal liquefaction will be an important component of China's energy security. However, the National Development and Reform Commission (NDRC) had called a halt on new coal-to-liquids (CTL) project development in light of the cost of this technology, soaring coal prices and technology risk.

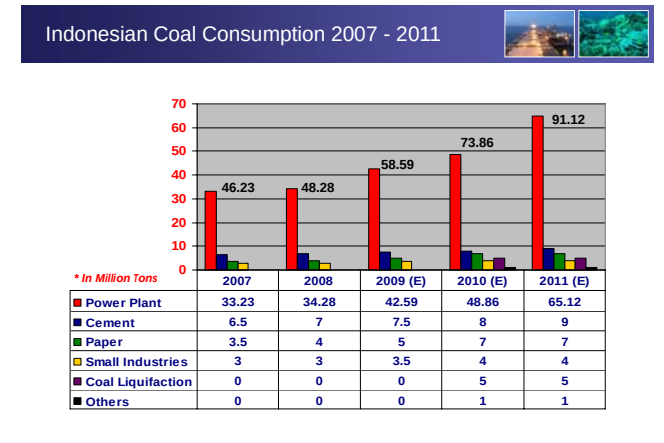
Mr Zhang said that Shenhua has its own power plants, mines and coal transport infrastructure, and is proceeding with a CTL demonstration project. Its direct coal liquefaction programme was launched in 2004 with a 6 tpd pilot plant, and is now at the industrial demonstration phase. Construction of the 1 Mtpa plant is complete and preparations for commissioning are being made. A CCS feasibility study for the plant has already started, with support from the US DOE.

Current Developments in Power Generation and the Coal Industry in Indonesia

Mr Bob Kamandanu, President Director, PT Berau Coal, explained that half of Indonesia's 230 million people live on Java island (7% of Indonesia's land mass), and that the country has a low electrification rate of just 61%.



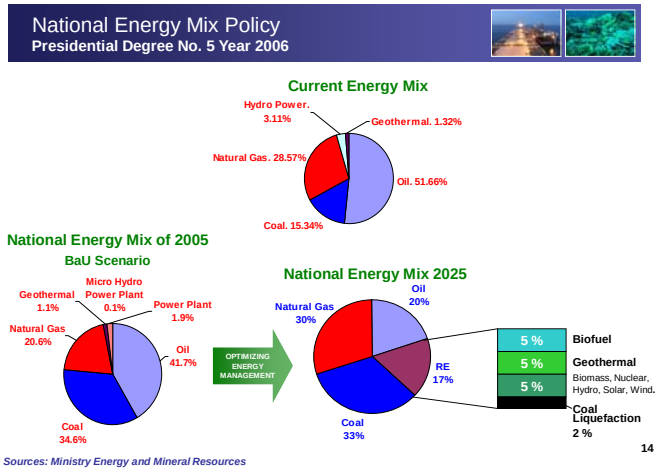
Power plant reserve margins are low and installed capacity in Indonesia was projected, by the State Electricity Company in 2007, to increase from 25 GW in 2008 to 36 GW by 2011. The projections include coal-fired plant capacity increasing from 9.8 GW to 18.8 GW and annual coal consumption increasing from 34 million tonnes to 83 million tonnes over the three years. He said that actual growth will be lower than projected, possibly reaching 65 million tonnes of coal by 2011.



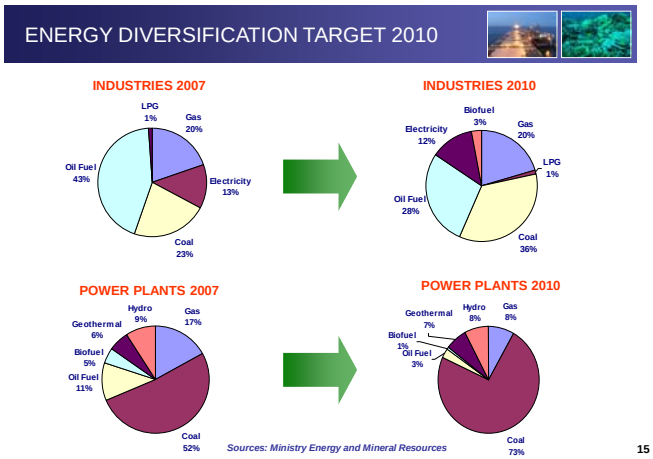
Turning to Indonesian coal resources, Mr Kamandanu said that over 90% of these resources, totalling 93 billion tonnes, are to be found in Kalimantan and Sumatra, and that most are low- or mid-volatile coal (*i.e.* below 6 100 kcal/kg). Coal production is projected by the government to increase from 213 million tonnes in 2007 to 280 million tonnes in 2011, with a small increase in

exports to 185 million tonnes over the period (industry anticipates greater export growth).

He said that Indonesia currently relies on oil for 51% of its energy requirements and that the national energy policy aims to increase the proportion of coal in the mix from its current 15% to 33% by 2025, using more coal in industry and for electricity generation.



Summarising the current coal production challenges, he said that Indonesia is still struggling with low electrification rates, social issues and poverty. As coal production sites are often located near villages, discontent among locals can lead to disruptions to coal production: corporate social responsibility issues will need to be addressed if coal production targets are to be met. Development and deployment of CCTs would be important, including those conversion technologies that can add value to Indonesia's coal products.



Session 1 Discussion

Mr Lennon (Eskom, South Africa) remarked that the presentations all emphasised the importance of low-emission technologies and the need for enormous investment, but questioned whether such investment would be forthcoming.

Mr Nakagaki said that J-Power uses 21 million tonnes of coal each year, a quarter of all thermal coal use in Japan. Before coal prices escalated, half of J-Power's purchases were based on annual contracts and the company had made upstream (*i.e.* coal production) investments based on long-term contracts. In the last 2-3 years, some coal supply had been lost through production *force majeures* and coal procurement had become more difficult. He said that J-Power would like to make further upstream investments, but that the company could not achieve this alone. It needs partners for these investments and would value Japanese government support to find these.

Ms Belova said that the level of investment over the next few years is a key issue: SUEK has already reduced its investment programme and will be reconsidering it again since the forecast 2.7% annual growth of global electricity demand may not be reached. She remarked, however, that world demand for energy will not decrease in the medium to long term, so energy prices will eventually increase and encourage investment.

Mr Kamandanu offered Indonesia's USD 60 billion investment programme as an indication of the need for new energy supplies to achieve 100% electrification. He said that help from developed countries would be needed to achieve this growth.

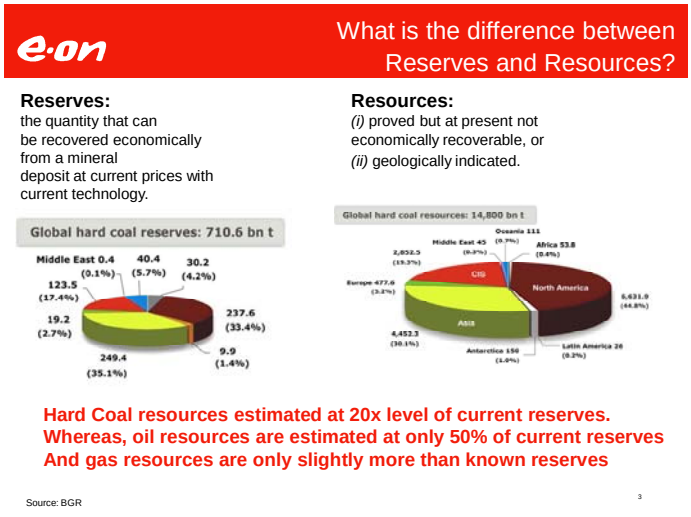
Mr Leer concluded that a period of low investment could start a cycle of recession and growth which may hamper the development of CCS.

SESSION 2: Coal's Contribution to Energy Security

Mr Preston Chiaro, Chief Executive – Energy, Rio Tinto plc, introduced the session by referring to coal's energy security attributes, including abundant and secure supply and relatively stable prices. However, he balanced this against two current issues: the adequacy of production, transport and power station infrastructure and a tendency towards "resource nationalism". He wondered whether increasing competition for coal for other uses, including coal liquefaction, gasification and use as a chemical feedstock, would affect the advantages that coal has as a fuel for power generation. Two other challenges to coal's energy security role include the question of whether CCS can be developed in time to address climate challenge mitigation requirements, and whether a new "dash for gas" would limit investment in coal supply.

Security and Cost of Future Coal Supply

Mr Joost van Dijk, Director – Board of Management, E.ON Benelux nv, explained that, following a request from the IEA, the CIAB Energy Security Working Group had prepared a paper on coal resources as input to a forthcoming IEA report, Resources to Reserves, which would include, for the first time, a section on coal resources. He set out the main conclusions from this CIAB work, including estimates of coal reserves, their development costs and a position on recent suggestions that the world is approaching "peak coal" production.

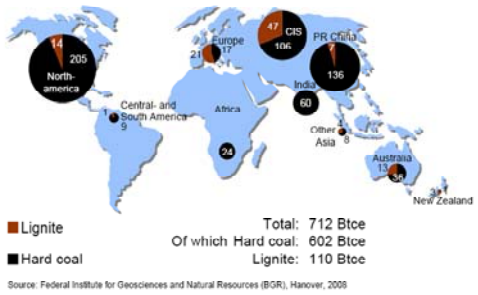


He explained that the working group had drawn on recent work by the German Federal Institute for Geosciences and Natural Resources (BGR) to show that coal resources are estimated to be twenty times greater than economically recoverable reserves, in contrast to oil (1.5 times) and natural gas (with

resources only slightly higher than reserves). Coal reserves are sufficient to cover 134 years (hard coal) and 322 years (lignite) of current global demand and are widely distributed geographically.

Global Coal Reserves: abundant and widely distributed

Unlike oil & gas deposits, location of reserves far more geographically diverse located across North America, Asia, Europe and Australia.



Source: Federal Institute for Geosciences and Natural Resources (BGR), Hanover, 2008

Reserves estimated to be sufficient to cover 134 years (hard coal) & 322 years (lignite) of current global demand This is 3x-8x the level of oil

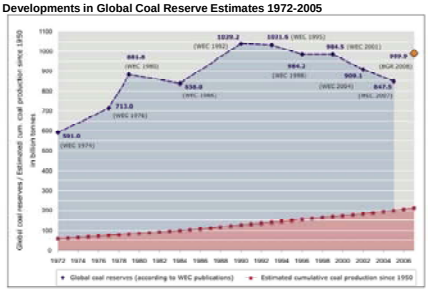
He admitted that the quality and frequency of data on coal reserves varies widely at the country level, but that there is no support for the hypothesis that coal production will peak by 2025. Indeed, the high level of known reserves in itself limits the interest of governments and private companies to frequently measure reserves.

Coal Data Under Fire? but still no „Peak Coal"

YES, the quality & frequency of updated coal data varies widely at the country level and this has led to regular adjustments in estimates of global reserve levels.

„Peak Coal theory" hypothesis states that the enormous rise in global coal demand and the uncertainty in actual reserve levels could cause prodution to peak in 2025.

Developments in Global Coal Reserve Estimates 1972-2005



On the contrary:

- High amount of known reserves, limits the interest of countries and private firms from measuring frequently reserve levels.
- Lack of information on excavation costs at individual sources.

Mr van Dijk presented estimates of mining costs for coal reserves that suggested that sufficient coal is available for the next 90 years, at current demand levels, at USD 33-175/tonne of coal equivalent, loaded on rail.

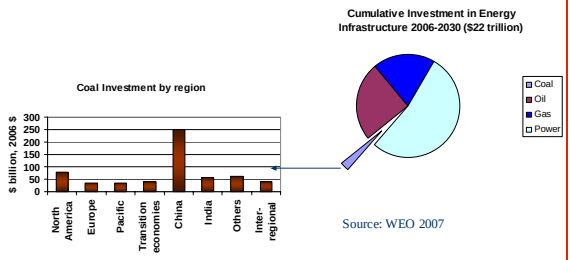
In summary, he said that:

- coal is a far more abundant and secure energy source than other fossil fuels;
- unlike oil and gas, where new resources need to be located, the conversion of coal resources into reserves is only dependent on economics and technology; and
- coal has the potential to substitute for oil as CTL conversion technology develops.

Coal Delivery Infrastructure Developments

Mr Pierre Guérin, General Director, ATIC Services SA, explained that ATIC Services was established in 1945 to manage coal imports into France, but is now a logistics services company with an annual turnover of EUR 300 million and nearly 1 200 employees. He provided examples of coal logistics constraints in 2008 that were due to weather or a lack of timely investment; these had affected coal shipments from Australia, China, Indonesia and Russia.

Required Investment

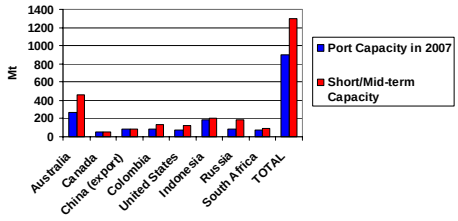


Source: WEO 2007

Cumulative investment: US$ 600 billion 2006-2030 (24 billion/year)
Mining investment represents the largest share (88%)
Shipping fleet 9%, Ports 3% – WEO 2003
Three countries dominate: China, United States and India

In the short term, the upswing in coal trade had brought forth investment in new bulk carriers to the extent that an anticipation of the world economic downturn had resulted in the collapse of freight shipping rates.

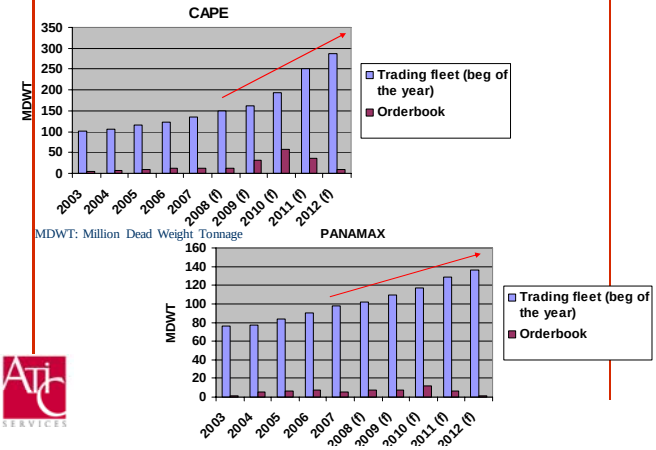
Global export capacity is growing (but slowly)



Export capacity was a bottleneck in Australia, Indonesia and Russia

He presented estimates of global coal export capacity growth in the short to medium term, showing slow growth. However, he said that the "missing link" in infrastructure development is often inland transport: rail transport capacity in Australia, South Africa and Russia, and barge transport capacity in mainland Europe.

Bulk carrier fleet is developing fast



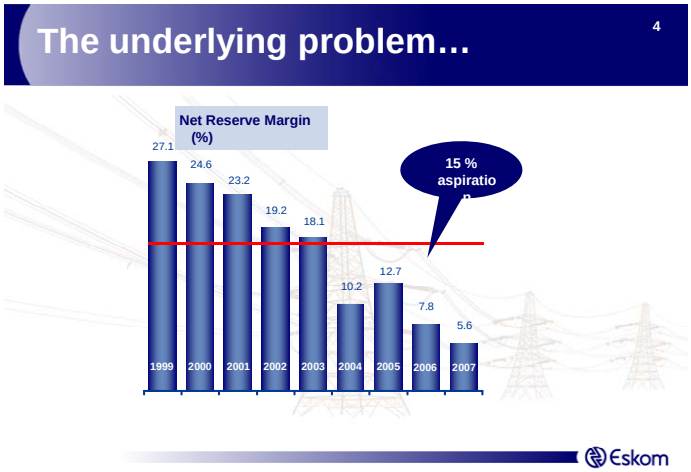
He expressed his view that the credit crunch will reduce infrastructure investment and that this may lead to future

bottlenecks as economies eventually start to grow again. Mr Guérin felt that governments could encourage investment and reduce investment risk by:

- long-term planning of the whole coal logistics chain;
- providing a stable investment framework;
- encouraging quick and effective project approval processes;
- providing more funding for environmental R&D projects and avoiding abrupt changes in environmental policies; and
- encouraging competition and working with private investors.

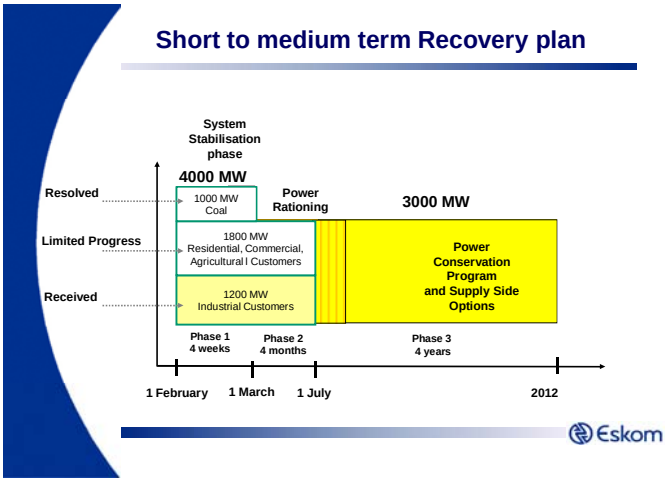
Electricity Shortages in South Africa: Impacts and the Response

Dr Steve Lennon, Managing Director – Corporate Services, Eskom, presented a review of the consequences of failing electricity supply security in South Africa, and the implications of a planned recovery strategy.

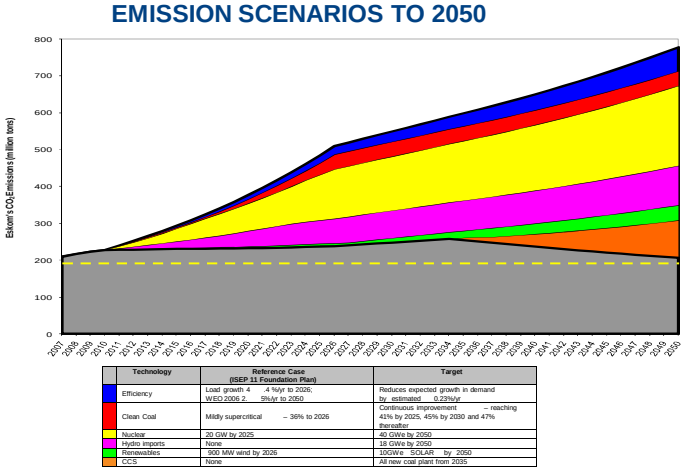


He described how electricity generation reserve margins had been steadily falling in South Africa since before 2000, and planned outages during the summer months meant even less flexibility. In addition, unplanned outages consistently exceeded 6%. As a consequence, ageing coal-fired plant had been called on to meet demand more frequently; this had increased operational problems including plant breakdowns and coal supply and quality issues at specific collieries supplying these power stations. Coal stockpiles at power stations had fallen from 35 days to 11 days in 2007. The electricity system therefore became more vulnerable and exceptionally high rainfall during late 2007 and early 2008 exacerbated coal supply, quality and handling issues, resulting in regular load shedding during January 2008 and an eventual electricity system emergency on 24 January. The South African mining industry ceased production for several days because safety could not be guaranteed during periods of intermittent electricity supply.

He said that the effect on society of these events was extreme. There were extended periods when residential customers suffered random 2-4 hour blackouts. At local government level, traffic management systems and essential water and sewage services suffered. More fundamentally, it was difficult to isolate essential services, such as healthcare facilities, from scheduled load shedding. General industry had to adjust to an average 10% loss in electricity supplies – sales of UPS and diesel gensets soared, while the energy-intensive sectors, such as mining and smelting, struggled to maintain production. The experience had showed that the cost of "unserved" electricity demand, including a loss of confidence in Eskom and the South African economy in general, to be much higher than previously estimated.



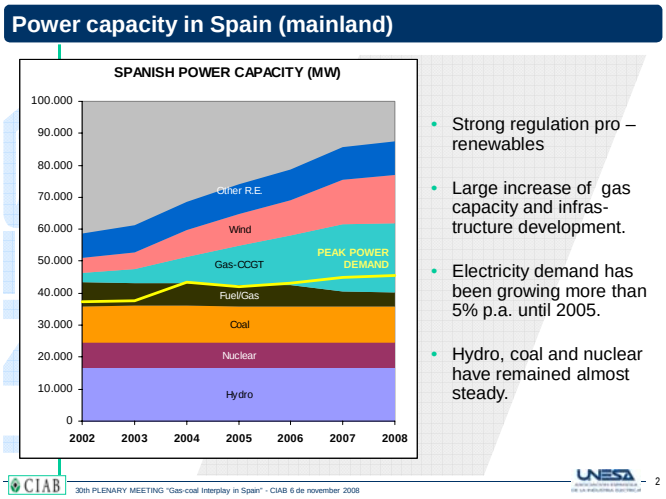
He said that the risk of electricity supply losses will continue until 2012. The recovery programme includes short-term power rationing and a USD 40 billion capacity expansion programme for electricity generation and transmission (9.6 GW of new coal-fired generation, 3.8 GW of old plant returned to service, 3 GW of nuclear, 2.1 GW of open-cycle gas turbine, 1.3 GW of pumped storage and 100 MW of wind turbines). Demand-side management and energy efficiency programmes are targeted at achieving a 3 GW reduction in the need for electricity generating capacity by 2013 and 8 GW by 2025. He said that the longer-term recovery programme will require major commitments at the policy, regulation, production, delivery and end-user levels, together with substantial increases in electricity prices to incentivise efficiency and fund new capacity construction.



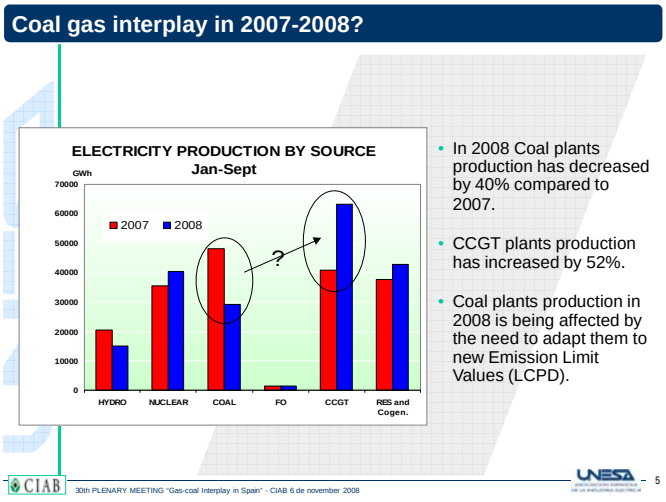
Dr Lennon said that the investment programme, driven by electricity supply security concerns, also has the potential to address South Africa's CO_2 emissions growth. Its major elements to 2025 are energy efficiency, new nuclear plant construction (28 GW), renewables (1.6 GW) and a gradual increase in the efficiency of coal-fired generating plant; while, towards 2050, CCS and solar power will also make significant contributions. In the meantime, definitions of "CCS-ready" are being discussed with the South African government. He said that there are many technology options to address CO_2 emissions in the longer term, including underground coal gasification which has great worldwide potential and lends itself to CCS.

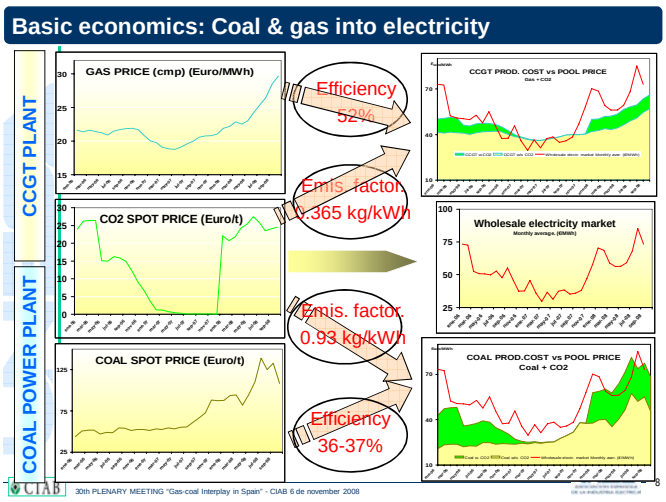
Gas-Coal Interplay in Spain

Mr Angel L Vivar, Director of Energy Resources and Environment, UNESA – Asociación Española de la Industria Electrica, described recent developments in the Spanish electricity sector.

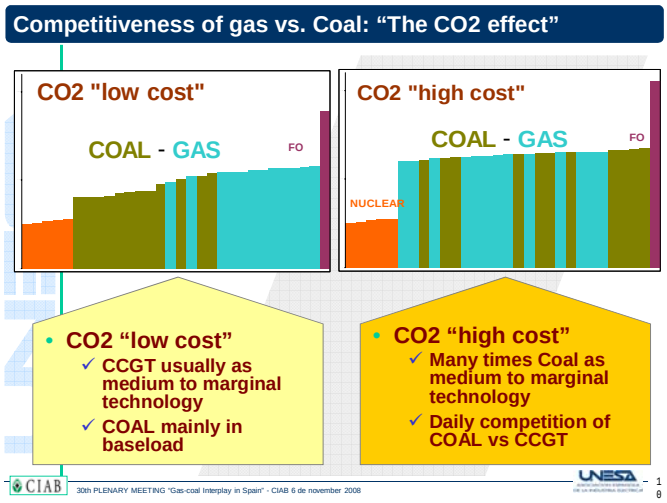


While coal-fired, hydro-electric and nuclear generation capacities had remained stable, there has been rapid increases in natural gas-fired and wind energy capacities, the latter being driven by strong pro-renewable energy regulation. Between 2002 and 2008, CCGT generating capacity had increased from 3 GW to 21.4 GW, accompanied by gas pipeline developments and six LNG re-gasification terminals. Wind energy capacity is now 15 GW and, being very variable, has a large impact on electricity pool prices and creates a large requirement for back-up generating capacity. Algeria now accounts for more than a third of Spain's natural gas supply, imported by pipeline and LNG tankers.





He said that electricity generating capacity in Spain, after an expansion to meet increasing demand and the back-up requirement for intermittent power sources, is now twice maximum demand and is very diversified, allowing great flexibility in fuel use. Comparing 2008 with 2007, electricity production from coal-fired electricity generating plants had declined by 40% while CCGT plant use had increased by 52%. This had been partly due to the need for coal plant to meet new emission limit values under the EU Large Combustion Plants Directive and partly a commercial response to electricity market prices and relative gas, coal and CO_2 permit costs. During 2008, high CO_2 permit prices and high coal prices had favoured the use of gas.



Session 2 Discussion

Mr Chiaro asked delegates for views on the role of governments in addressing energy security.

In ***Dr Lennon's*** view, governments have important roles in providing stable, effective and predictable regulatory frameworks and in ensuring that incentives for long-term investment are in place. For example, electricity pricing needs to support long-term capacity investment and this is equally as important for coal mining investment. South Africa needs USD 10 billion of investment in coal mining over the next 5-10 years, including investment in prospecting. Dr Lennon explained that Eskom's increasing coal requirements are unlikely to materially affect coal exports because Eskom's plants are not designed to burn high-quality export-grade coal. Although there is a slight quality overlap at the margin, the main constraint on coal exports is transport capacity, but he anticipated that the Richards Bay coal terminal expansion would be serviced.

Mr Crocker (SUEK, UK) observed that running coal-fired plants at the margin added to their operating costs. He asked if this was sensible, or even viable, in other countries, such as the US. ***Mr Courtright*** (EPRI, US) provided an example of government involvement in the US, where state regulators have required that coal-fired plant developers include efficiency or wind power programmes in a package that makes the permitting of new coal-fired plants more politically attractive. ***Mr Gentile*** (Leonardo Technologies, US) said that public policy could usefully be added to the list of factors affecting investment decisions in coal supply.

Mr Vivar noted that the introduction of new regulations in Spain had been accompanied by an increase in average electricity pool prices and that gas-coal switching had resulted from arbitrage opportunities at the margin. He added that, in the longer term (>15 years) CCS will be required to maintain the flexibility of coal and gas in electricity generation. Mr Vivar said that Spain has a 10-year electricity and gas transmission investment plan, developed by government after industry consultation. He explained that the regulatory framework required that the generation balance should take account of

market prices, but not the full life-cycle cost of CO_2 emissions from coal, natural gas and LNG. ***Mr Palmer*** (Peabody Energy, US) said that the position is similar in the US and that the CIAB might consider presenting a comparison of the full life-cycle CO_2 emissions from coal and LNG (citing a Carnegie Mellon University study[1]). Drawing on previous experience with such analysis, ***Dr Topper*** (IEA Clean Coal Centre) cautioned that the complexity makes it very difficult to draw definitive conclusions, especially given the widely varying volumes of methane released during coal mining.

Dr Lennon observed that energy pricing varies substantially between countries and called for energy decisions to be based on correct pricing signals. On a separate point, he remarked that the climate change debate typically concentrates on the mitigation of CO_2 emissions to limit global temperature increases. The recent experience in South Africa had highlighted the need to also consider how we need to adapt to climate change. He said that Eskom is taking steps to improve the handleability of coal on its stocks during episodes of extreme wet weather. He concluded that the effect of climate change on mining operations and transport infrastructure will also affect security of supply.

Mr Houssin (IEA) remarked that the speakers and the subsequent discussion had usefully highlighted several energy security interactions and reinforced the need to look at energy security in a global context, involving all fuels.

SESSION 3: Coal's Role in Mitigating Climate Change

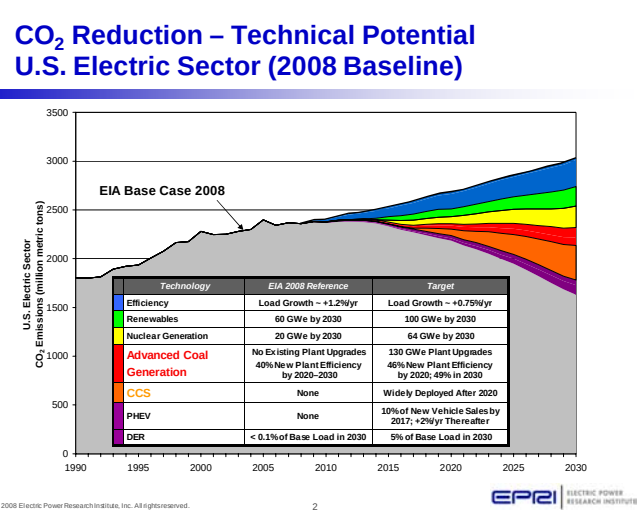
Dr Don Elder, Chief Executive Officer, Solid Energy New Zealand Ltd, introduced the session by describing CCS as the most pressing issue for the coal industry and governments, while warning that the current financial crisis must not be allowed to divert attention away from CCS and the major financial issues associated with its development. He noted that there are many CCS initiatives and meetings, with many people working on the subject, but estimated that the world was spending an insufficient USD 500 million per year on only four CCS projects of the type and scale needed.

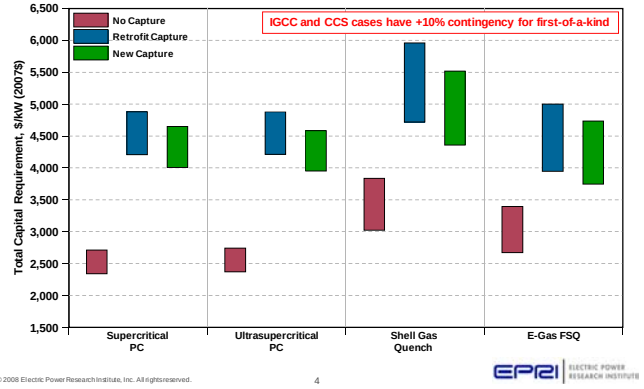
He described the so-called "valley of death", or perhaps more descriptively the "mountain of death", as an issue of financing the transition from initial research on CCS technologies to their commercial availability. He suggested that setting a price for carbon could encourage industry to take the technology "off the shelf" and deploy it, but that pricing carbon would not put it "on the shelf" in the first place. He observed that industry is often seen as the financier for initially proving CCS technologies, but he viewed this as wrong, given the public-good nature of CCS. The common objective is to reduce the cost of CCS, making it available for commercial deployment, and so helping to set the market price of carbon at an affordable level. Failure to achieve this transition would have an enormous impact on world growth by restricting the ability to use fossil fuels.

From Analysis to Action on CO_2 Capture and Storage

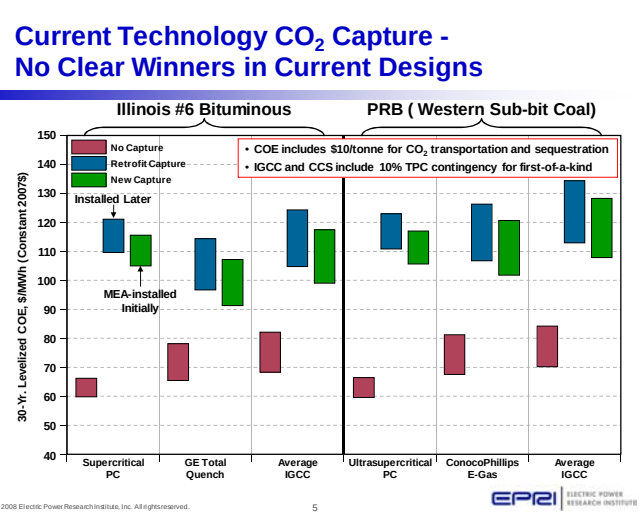
Mr Henry A Courtright, Senior Vice President, EPRI – Electric Power Research Institute, referenced EPRI work on the potential for reducing CO_2 emissions in the US electricity sector to 1990 levels by 2030, which included a "prism" chart illustrating the technical potential for different components of this reduction. Power plant efficiency improvements and CCS account for 40% of the required CO_2 emission reductions.

He said that applying the full range of mitigation technologies, which also includes a major expansion of nuclear generation capacity together with some renewable energy and demand reductions through end-user efficiency improvements, would increase the cost of electricity by 50-80%. EPRI is looking at the potential for reducing this increase to 25%. Conversely, if nuclear plant and CCS-equipped coal-fired plant are not developed, then the cost of electricity would need to increase by 250% to achieve similar CO_2 emission reductions.





He described progress with current CCS projects in the US, covering a chilled ammonia pilot plant at We Energies, chilled ammonia capture at AEP and a competing capture process led by Southern Company Services, three integrated gasification combined cycle (IGCC) CCS projects and a pre-commercial oxygen separation demonstration plant using ion transport membranes led by Air Products and the US DOE. He also listed planned CCS demonstrations, commercial IGCC/CCS projects and oxy-fuel demonstrations worldwide. He observed that there are currently no clear "winning" CCS technologies and hence there is a need to share experience as projects progress.

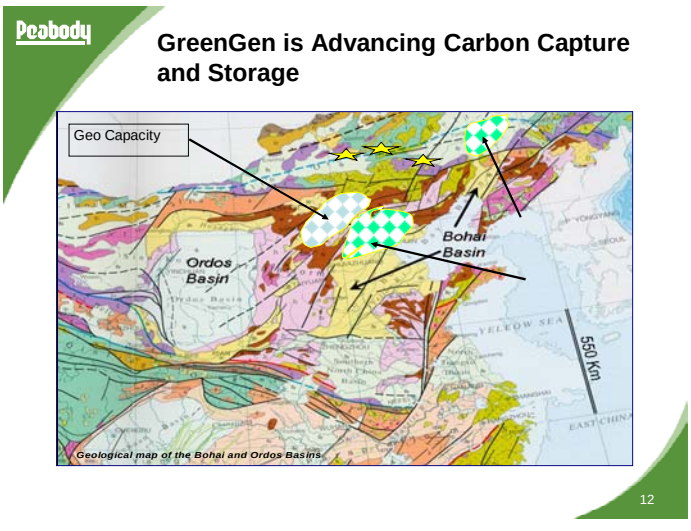


GreenGen: Changing the Colour of Coal

Mr Fredrick D Palmer, Senior Vice President – Government Relations, Peabody Energy, referred to Peabody Energy's involvement with the Australian COAL21 programme and the FutureGen project in the US, adding that the company had joined the GreenGen project in December 2007 as the only non-Chinese company involved in the partnership.

He explained that the restricted global availability of oil required China to use coal to support industrialisation and lift the Chinese population out of poverty. The GreenGen project is China's centrepiece carbon reduction initiative and will allow the greater use of coal on a sustainable basis. He described the IGCC / polygeneration project located at Tianjin near the Dagang oilfield and designed to demonstrate hydrogen production, hydrogen power generation and CO_2 storage systems. He said that permitting is nearing completion and that the project has strong government support from NDRC and the new Ministry of Environmental Protection.

Mr Palmer quoted US DOE Energy Information Administration projections showing world coal consumption growing by 65% over the 25 years from 2005. He said that this growth results from the need to bring more of the world's population out of poverty and that it is not dependent on the deployment of CCS. However, he regarded CCS as necessary to manage the resulting carbon emissions and he was proud to be associated with international projects that responded to this need.



G8 Heiligendamm Process

Mr Andreas Schaal, Senior Policy Analyst – OECD DAF/INV and Heiligendamm Process Support Unit, briefly explained that, at the G8 Heiligendamm Summit in 2007, leaders had agreed to further co-operation of the G8 with the major emerging economies (China, India, Brazil, Mexico and South Africa) within a 2-year topic-driven policy dialogue on the world economy. The four main topics are:

- freedom of investment and investment conditions, including responsible business conduct;
- innovation – promoting it and protecting it through intellectual property rights;
- development – for example, the current energy situation in Africa; and
- energy – with a particular focus on energy security issues and improving energy efficiency – for example, through sustainable buildings and retrofitting coal-fired power plants.

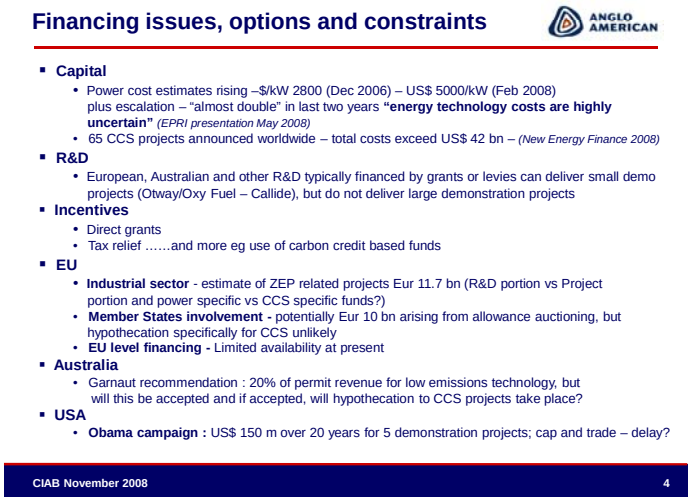
He said that IEA estimates had suggested the potential for retrofitting 200 GW of coal-fired power plants to achieve an overall efficiency improvement of over 2 percentage points. The Heiligendamm Process will consider financing strategies for supporting such retrofits, examine the technology options and encourage a retrofit project.

CCS: Who Pays? – The Role of Government-Industry Partnerships

Mr Roger Wicks, Head of Energy, Anglo American, presented a list of CCS recommendations that had been warmly welcomed at the July 2008 G8 leaders summit:

- demonstrating CCS, including a commitment by 2010 to twenty >1 Mtpa demonstration projects and wide deployment by 2020;
- taking concerted international action, including financial support from governments;
- addressing the financial gap of up to USD 20 billion in CCS funding (or a EUR 25-55/tCO_2 gap according to a recent study by McKinsey[2]), which will not be closed by the market alone;
- establishing legal and regulatory frameworks; and
- raising public education and awareness.

He spoke to a detailed presentation on CCS, covering: private versus public funding; financing issues, options and constraints; public and investor perceptions; examples of projects; and key ingredients for progress.



Representing the private sector, he recognised the need for CCS, but noted that companies are driven by shareholder imperatives which are becoming ever more acute as the implications of the financial crisis develop. Opposing views of CCS are: that it is a global public good benefitting all and an essential climate change mitigation technology; or that it is, in the eyes of some NGOs, a private industry façade to protect coal company interests. He characterised investor concerns

over the early mover risks on CCS, including technology risk, regulatory uncertainty and the inability to demonstrate acceptable financial returns or manage credit risks.

Investor Perspectives *(ERM May 2008 – pipeline focus)*

- **Significant risks for early movers – made worse by recent developments**
- **Altering funding approaches can reduce costs of service and risk**
  - Government funding vs private banks vs multilateral agencies
- **Government funding**
  - A necessary commitment to support climate change policy achievement
- **Private banks**
  - Too early to consider; too many unknowns – market, technological efficacy, regulatory environment
  - Project Finance depts have project finance drivers (**Debt** repayment resulting from cash flows) and would apply standard project finance metrics (NPV)
  - Commodities depts would be driven by availability of **Carbon Credits** which could underwrite **Debt** and/or **Equity**
- **Multilateral Lenders**
  - CCS and related infrastructure seen as vehicles that support implementation of government policy objectives (eg EU commitments)
  - Broader economic assessment leads to different perspective on project appraisal
  - **Debt** (soft loans), **Carbon Funds, Guarantees, Technical Support**
- **Credit risk criteria loom large in the aftermath of recent market developments**

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Mr Wicks discussed factors that could narrow and then bridge the financing gap, summarising these in a list of key ingredients to achieve progress with CCS deployment. His conclusion was that, if governments want to achieve climate change objectives while providing secure and affordable energy, then they will have to contribute very substantial funding to launch CCS demonstration and deployment projects.

Narrowing and bridging the financing gap for power sector CCS

- **To narrow the gap and reduce costs :**
  - International collaboration to develop robust commercial-scale projects
  - Minimise duplication, spread costs and focus on projects with commercial potential
  - Partnerships : equip manufact., power generators, fuel producers and governments
  - Prioritise projects
  - Recognise competitive and political limitations of multi-national projects
- **To bridge the gap and secure sufficient funding**
  - Public funding of upwards of $1 billion per project will still be required
  - Direct government funding being contemplated in Australia, US, Canada, Norway
  - Government development of initial pipeline infrastructure – Canada, Australia?
  - Tax credits and new administration measures - US
  - Share of revenue from sale of emissions permits will be essential - Europe & Australia
  - Trusts based on power generation or fuel production levies - Australia, US?
  - Might the idea of bonus emissions trading permits be possible - Europe?

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Key ingredients for CCS progress in tough economic times

- **Maintain commitment to the G8 agenda of early industrial-scale CCS demonstrations**
- **Acknowledge and embrace the major contribution that non-power projects can make to the demonstration and financing of CCS**
- **Narrow the financing gap for power projects by supporting international collaboration to minimise duplication and spread costs**
- **Maximise public funding opportunities from emissions permitting**
- **Emphasize the global benefits of CCS in engagement with governments and the wider community**
- **Accept that industry must play a driving role in the development of industrial-scale projects, and be prepared to join forces with other industries that provide skills and technologies, and with governments who provide funding and incentives**

Even before the recent credit crisis, the inescapable conclusion, now even more applicable, is that if governments want to achieve climate change objectives while providing secure and affordable sources of energy, they are going to have to contribute very substantial funding to launch CCS demonstration and deployment projects

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He referred to the South African energy market developments, outlined by Dr Lennon, remarking that he had seen assessments suggesting that many other countries are showing similar signs of imminent stress, such that energy security is a very real and global concern.

Session 3 Discussion

Dr Elder queried whether CO_2 mitigation targets in the US could be met without CCS, especially if insufficient natural gas were available to achieve EPRI's alternative, higher-cost mitigation scenario. He wondered how close the US was to the type of electricity supply crisis seen in South Africa.

Mr Courtright responded that EPRI had based its analysis on US government CO_2 reduction scenarios. He expected a decade to pass before clear technology preferences emerged and said that the key message was not to close any technology options that could reduce CO_2 emissions. While the EPRI model had allowed a great dependence on LNG, this may not be available at the price assumed. In the last year, progress has been made with 15 GW of new coal-fired electricity generation projects, but another 15 GW had been cancelled. He expected slow development of new nuclear plant and low electricity capacity margins, bringing supply risks during the first years of the next decade in the US.

Dr Elder asked whether China is likely to roll out further CCS projects after GreenGen: he had heard that project development may cease if economic growth in China falls below 9% per annum.

Mr Palmer replied that, in his view, China was sincere about developing sustainable coal use: NDRC had made statements on the necessity of energy supply to bring people out of poverty and on addressing climate issues. He thought that, once energy is widely available and affordable, China will concentrate on making it more sustainable. He had no doubt about China's determination to achieve these objectives and expected China's economy to continue to grow in the medium to long term.

Mr Zhang agreed, saying that NDRC is looking for the right technical route by supporting demonstration plants. He said that the global financial crisis has affected China and expressed concern about its possible effects on the Chinese economy, which would then affect economic growth throughout the world.

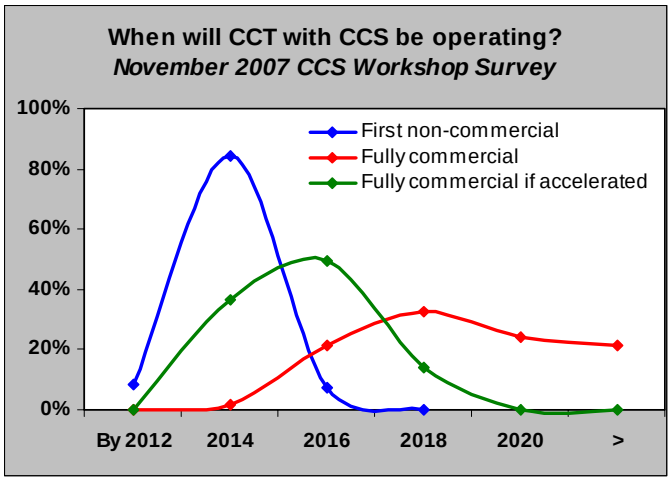
Dr Elder reminded the meeting of the three questions that he had posed at the CIAB workshop on CCS held in November 2007:

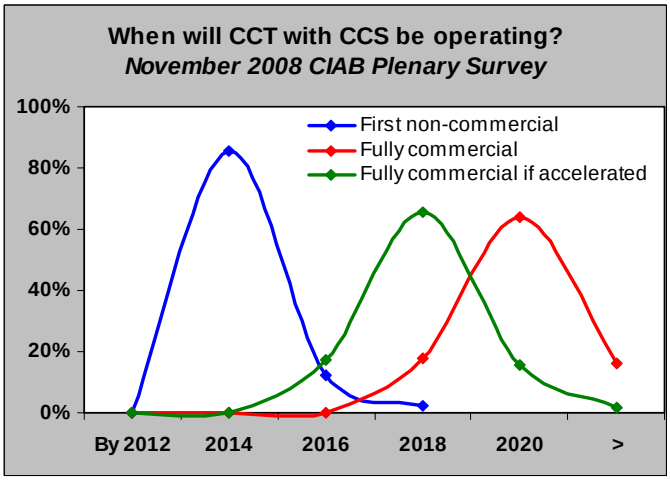
- When will large-scale coal-fired generation with >50% CCS be successfully commissioned and operating, or available to operate on a non-commercial basis?

- When will large-scale coal-fired generation with >50% CCS be successfully commissioned and operating on a fully commercial basis (knowing what we know today about all the drivers for this and the uncertainties, risks and challenges)?

- If governments, international organisations, industry and research organisations all worked together with the common objective to accelerate global availability, affordability, economic viability and deployment of CCT with CCS by the earliest possible date, with the removal of all unnecessary barriers, the mitigation of risks and other facilitation steps (technical, regulatory, economic, public acceptability, *etc.*), when will large-scale coal-fired generation with >50% CCS be successfully commissioned and operating on a fully commercial basis?

He invited a new show of hands in response to these questions, which showed the following results compared with those from the November 2007 workshop:





In summary, the consensus on the first stage of CCS development remains 2014, although no respondents now see this as being possible by 2012. Views on the date for deployment of fully commercial CCS, whether accelerated or not, have slipped by about two years and there is now greater consensus on the dates than previously.

Dr Elder summarised the messages to the IEA from this session by saying that CCS is not just about climate change, but that it is also about energy security and economic growth. The issue is no longer about balancing these objectives because CCS is required for all three. The conclusion had been that CCS is a public good and must be funded by governments sooner rather than later – in another five years it may be too late.

***

Notes

[1] Jaramillo, P., W. M. Griffin and H. S. Matthews (2008), "Comparative Analysis of the Production Costs and Life-Cycle GHG Emissions of FT-Liquid Fuels from Coal and Natural Gas", *Environmental Science and Technology*, 42 (20), pp. 7559–7565.

[2] McKinsey (2008), *Carbon Capture and Storage: Assessing the Economics*, McKinsey and Company, 22 September, www.mckinsey.com/clientservice/ccsi/pdf/CCS_Assessing_the_Economics.pdf.

Annex – Plenary Meeting Participants

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Mr	C Wick	MOORMAN	Chairman, President & CEO, Norfolk Southern Corporation	USA
Mr	Michael J	MUDD	Chief Executive Officer, FutureGen Alliance Inc	USA
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Mr	Michael J	SUTHERLIN	President & CEO, Joy Global Inc	USA
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Mr	Angel L	VIVAR RODRIGUEZ	Director of Energy Resources & Environment, UNESA	ESP
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Ms	Alison	BROWN	General Counsel & Company Secretary, Solid Energy New Zealand Ltd	NZL
Mr	Antonio	CANSECO	President, Fuelec SL	ESP
Ms	Sylvie	CORNOT-GANDOLPHE	Energy Advisor to Chairman, ATIC Services SA	FRA
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Mr	Yong (Richard)	ZHANG	Deputy Director, China Shenhua Coal to Liquid and Chemical Co Ltd	CHN
Dr	Carl	ZIPPER	Associate Professor, Virginia Polytechnic Institute & State University	USA

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Mr	Pierre	GUÉRIN	General Director , ATIC Services SA	FRA
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Coal Industry Advisory Board

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