INTERNATIONAL ENERGY AGENCY
COAL INDUSTRY ADVISORY BOARD

CIAB

34th PLENARY MEETING

DISCUSSION REPORT

IEA Coal Industry Advisory Board Plenary Meeting
IEA Offices, Paris, 15/16 November 2012

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

PROGRAMME – Thursday 15th and Friday 16th November 2012

SESSION 1: "An Inconvenient Reality – the continuing role of coal to 2050 in the energy mix and the need for low emission coal technology"
Chaired by Mr Peter Freyberg, Chief Executive, Xstrata Coal Pty Ltd., Australia

Coal Outlook to 2050
Mr. Jeff Watkins, Chairman of Coal, Wood Mackenzie, USA

Evolving Trading Patterns for Coal and Supporting Investments
Mr. Ernie Thrasher, CEO, Xcoal, USA

Energy Technology Perspectives
Dr Markus Wråke, Head, Energy Supply Technology Unit, IEA

CCS: From Vision to Action
Dr. Wolf Heidug, Carbon Capture and Storage Technology Unit, IEA

Discussion

SESSION 2: "21st Century Coal: Advanced Technology and Global Energy Solution"
Chaired by Mr. Gregory Boyce, Chairman and CEO, Peabody Energy Co. Inc., USA

This session comprised discussion of a *"21st Century Coal: Advanced Technology and Global Energy Solution"* report draft. The report represents the results of the CIAB's 2012 Work Programme and was prepared for the CIAB by the Electric Power Research Institute, Inc. (EPRI) with direct support from Advanced Resources International, Inc., (ARI), CONSOL Energy, Peabody Energy, and RWE. Dr. Andrew Maxson of EPRI introduced the draft report, which was later published in March 2013 as an "IEA Insights" report on the IEA website.

Chapter 5: Case Study on the Flexible Use of Conventional Power Plants in Germany
Dr. Hans-Wilhelm Schiffer, Head of General Economic Policy and Science, RWE AG, Germany

SESSION 3: A Way Forward
Chaired by Mr. Doug Ritchie, Group Executive Strategy, Rio Tinto plc, Australia

The Role of Energy Literacy in Energy and Climate Policy Formulation
Dr. Nikki Williams, Chief Executive Officer, Australian Coal Association, Australia

Getting Carbon Capture & Storage Back on Track
Dr. Chris Greig, Professor of Energy Strategy & Director of the University of Queensland Energy Initiative, Australia

An Industry Perspective on Enhanced Oil Recovery
Mr. Craig McPherson, Senior Vice President, Chief Operating Officer, Denbury Resources Inc., USA

Discussion

Introduction

The aims of the sessions were to engage the IEA Secretariat, CIAB Members including consumers (particularly the electricity industry) producers and infrastructure/transportation providers, and invited guests, in a debate on major issues affecting the coal industry. These issues include the continuing role of coal to 2050 in the energy mix; the role of efficiency, Carbon Capture and Storage and other clean coal technologies in mitigating greenhouse gas emissions; and ways to promote understanding of the need to accommodate emerging energy demand and energy poverty alleviation as well as climate issues.

SESSION 1: An Inconvenient Reality – the continuing role of coal to 2050 in the energy mix and the need for low emission coal technology

Session Chaired by Mr. Peter Freyberg, Chief Executive, Xstrata Coal Pty Ltd., Australia

Introducing the session, ***Mr. Freyberg*** referenced Al Gore's film "An Inconvenient Truth" that focused on climate change and the contribution of fossil fuels, saying that there is also "an inconvenient reality" that the world does need energy and that coal is continuing to play a significant role in meeting that need. He said that without greater emphasis and investment on low emission coal technology and a greater injection of reality into energy mix forecasts, it is very likely that the key climate change policy objective of reducing greenhouse gases will simply be foregone.

He referenced a leading energy consultant's forecast and recent coal demand growth in China and India to reinforce the energy and coal growth trends; while commenting that OECD policy makers are focused on the IEA 2 Degree Scenario (2DS) and see it as the "most likely" forecast without necessarily understanding the policies or economic resources required globally to see it achieved. He welcomed the key recommendations made to global energy Ministers in *"Energy Technology Perspectives 2012"*, including the need for a level playing field for clean energy technologies, and IEA recognition of the vital role that CCS needs to play; but highlighted the reality that progress has been much too slow.

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Coal Outlook to 2050

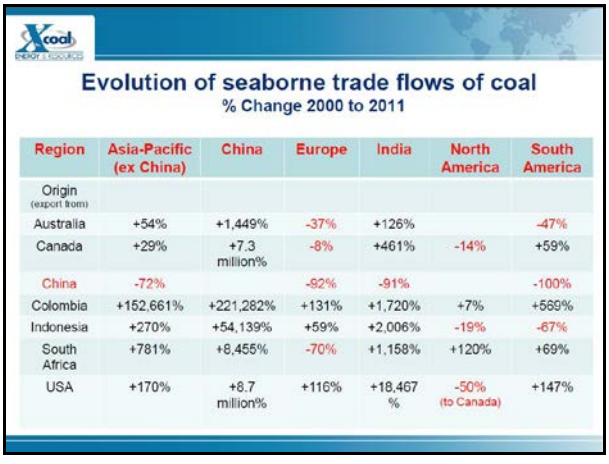
Mr. Watkins presented a brief comparison between Wood Mackenzie forecasts of world energy and coal demand growth (Not for Publication) and the IEA WEO2011 New Policy and Current Policy scenarios. He highlighted coal demand in China and India as being very significant influences on projections of world energy demand growth.

He said that Wood Mackenzie draws on the expertise of many coal analysts worldwide as it formulates its energy forecasts. He pointed out that the Chinese economy has historically been significantly more electricity intensive than other major manufacturing economies; and that coal is expected to remain the lowest cost fuel for electricity generation in China. He recognised that electricity intensity in China will decline over time, but suggested that it will be some years before this significantly impacts coal demand. He saw the continuing installation of significant quantities of electricity generation capacity in the coming decade, over half of which could be coal-fired.

He further pointed out that assumptions on greenhouse gas emissions policies, including carbon pricing, in various regions of the world will have significant effects on global coal demand projections.

Evolving Trading Patterns for Coal and Supporting Investments

Mr. Thrasher said that although coal's contribution to the energy mix in mature economies may be declining, coal consumption in emerging economies is growing rapidly. He explained that this had caused a major shift in seaborne coal trade patterns in the last decade, with exports from China almost entirely ceasing and exports from other countries to China and India expanding rapidly.

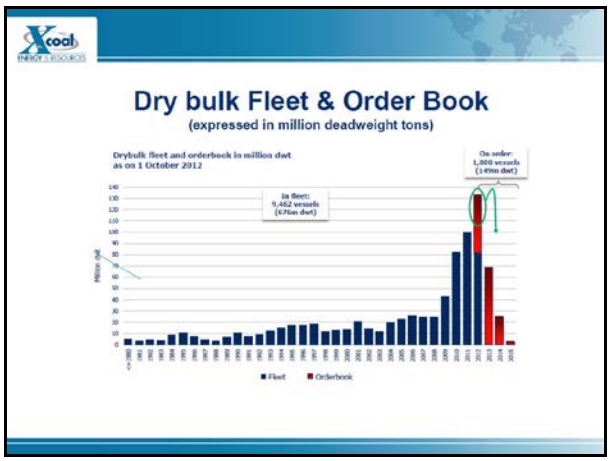


Region	Asia-Pacific (ex China)	China	Europe	India	North America	South America
Origin (export from)						
Australia	+54%	+1,449%	-37%	+126%		-47%
Canada	+29%	+7.3 million%	-8%	+461%	-14%	+59%
China	-72%		-92%	-91%		-100%
Colombia	+152,661%	+221,282%	+131%	+1,720%	+7%	+569%
Indonesia	+270%	+54,139%	+59%	+2,006%	-19%	-67%
South Africa	+781%	+8,455%	-70%	+1,158%	+120%	+69%
USA	+170%	+8.7 million%	+116%	+18,467 %	-50% (to Canada)	+147%

In particular, he highlighted the growth in Australian coal exports in response to demand

from China and India and to replace Chinese coal formerly exported to other regions of the world.

He explained how private industry is responding to the market changes, for example with increased export infrastructure capacity and orders for new dry bulk carrier ships to handle increased seaborne coal shipping requirements.

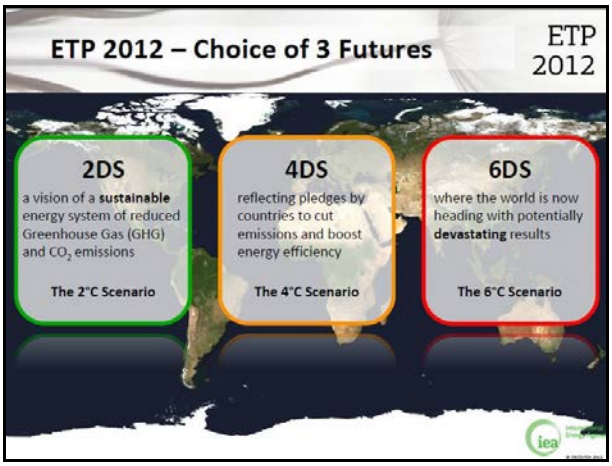


He estimated that annual global coal export capacity is currently over 1,100 million tonnes and that this could expand to nearly 1,900 million tonnes, adding that over half of this potential is in Australia.

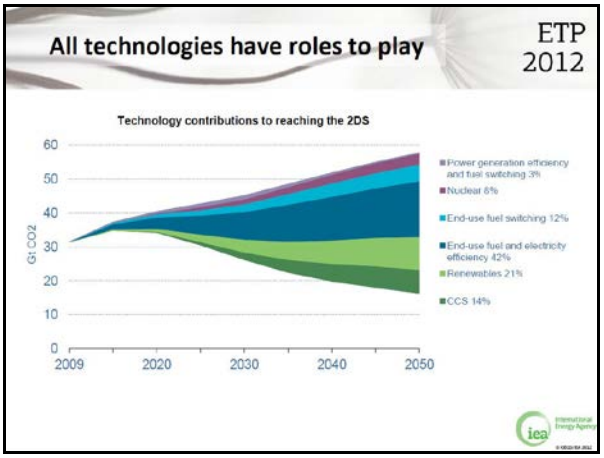
In summary, he said that economies utilizing coal exhibit above average growth; global coal consumption continues to increase, reflecting its competitive cost in relation to other energy sources; and that capital is being allocated to develop the rail, port and other transport infrastructure necessary to meet the growth in coal demand and trade.

Energy Technology Perspectives

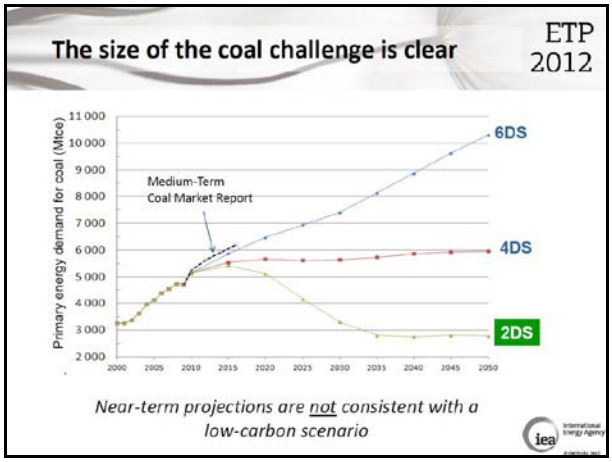
Dr. Wråke explained that the recently published IEA book *"Energy Technology Perspectives 2012"* explores possible scenarios based on 2°C, 4°C and 6°C global temperature increases (2DS, 4DS and 6DS) and the technology development paths required to reach those outcomes at lowest cost by the year 2050.



He explored in particular the implications for electricity generation in the 2DS, which will require the development of a portfolio of technologies. He said that the ageing electricity generating infrastructure and future electricity growth provide the opportunity to deploy the required technologies - efficiency, nuclear power, renewable energy and carbon capture and storage (CCS) - but that progress remains too slow.



He explained that large investments in clean energy, including cleaner coal technologies are required, but that the cost of these investments will be outweighed by the resulting fuel savings. He pointed to the fact that a large proportion of new coal-fired power plant installations still use proven but less efficient technology, highlighting the challenge for coal.

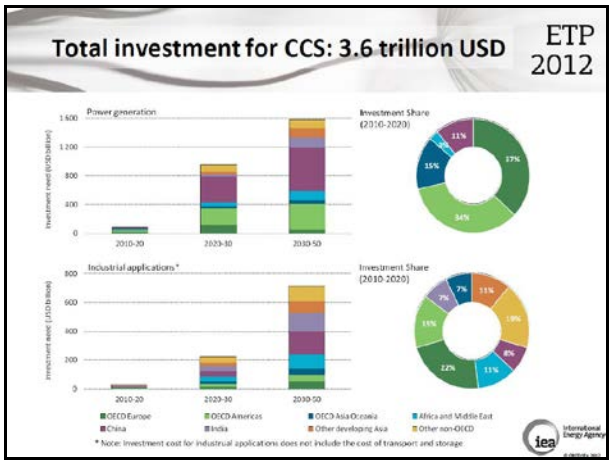


The IEA medium term projection of coal demand to 2017 lies above the 6DS; while a moderation of coal demand and reductions from 2020 onwards would be necessary to meet the 2DS trajectory. He saw natural gas as a "transitional" fuel, itself becoming part of the "problem" by 2025-30 and reinforcing the requirement for the rapid development of CCS.

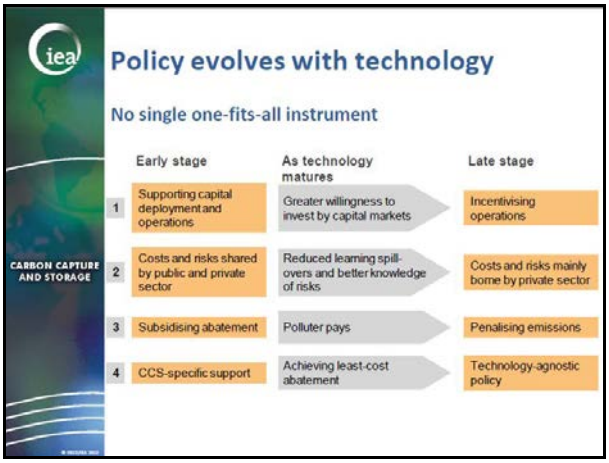
Summarising, he highlighted the consistent decline in energy RD&D as a proportion of total RD&D since the late 1980s and said the message that technology development is too slow applies across almost all clean energy technologies. The positive exceptions are onshore wind and solar PV, which are progressing well, and there is also encouraging growth in new vehicle technologies, albeit from low levels.

CCS: From Vision to Action

Dr. Heidug reinforced the role of CCS in meeting the 2DS and highlighted some necessary near-term policy actions. He emphasised that the deployment of CCS is needed in power generation as well as in other industrial applications and detailed the regional investment pattern included in the 2DS.



He said that the total CCS investment requirement between 2010 and 2050 is US$3.6 trillion (2010 dollars), occurring almost entirely from 2020 onwards and with China playing a significant role; that this investment is 10% of the total incremental clean energy investments required to reach the 2DS scenario, and will deliver 14% of the CO_2 reductions; and that the type of policy support for clean energy investments will need to change as the technologies develop and mature.

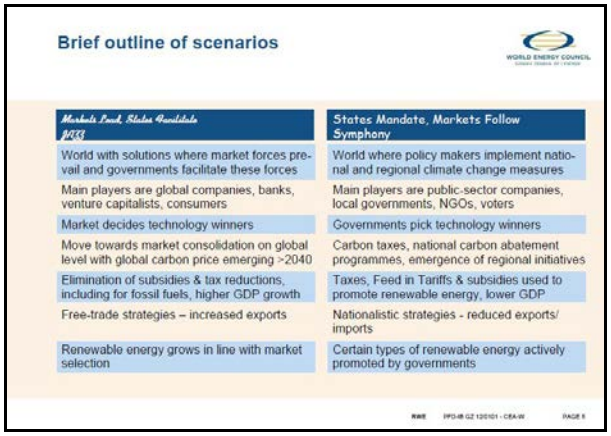


While accepting the urgent need to pursue the development of appropriate laws and regulations, assessment of CO_2 storage capacity, infrastructure development and engaging the public, he highlighted some necessary near-term CCS policy actions:

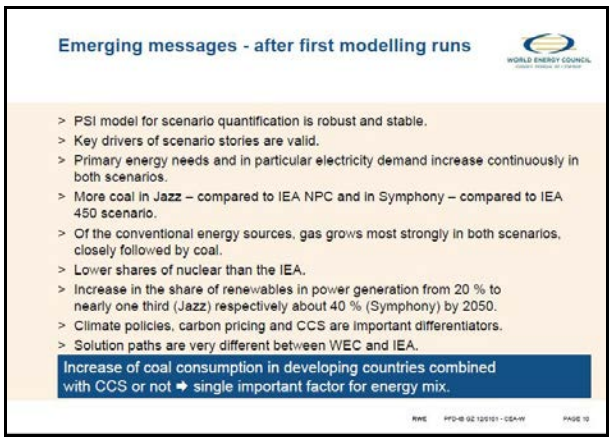
- Governments to assess the role of CCS in their country's energy strategy;
- Governments to design and implement appropriate policy; and
- Governments and industry to strengthen efforts to demonstrate CCS.

Session 1 Discussion

Reinforcing the prospect of continuing growth in coal demand, ***Dr. Schiffer*** referenced work in progress on the development of two World Energy Council scenarios for energy growth to 2050, one government-led and one market-led.



Each scenario has different economic growth and energy policy objectives; while an emerging message is that both exhibit important future roles for fossil fuels, with strong growth in natural gas demand closely followed by coal. While preliminary, the modelling results indicate greater coal demand than is shown in equivalent IEA scenarios, he added.



Mr. Freyberg remarked that the speed of introduction of all clean coal technologies is slowing, asking how the IEA informs governments on investment choices including CCS.

Dr. Wråke said that the IEA explains the future roles of the different clean energy technologies. CCS is very capital intensive and returns are longer term so there is a need to emphasise that investment levels are not prohibitive and to reduce investment risk by facilitating access to governments' lower cost capital, he added.

Mr. Catelin suggested that the greater value of CCS relative to other options as a greenhouse gas reduction technology should be emphasised more, and asked whether 2DS remains a realistic scenario in light of the low level of investment in clean energy technologies. ***Dr. Wråke*** responded that the IEA scenario work is done in response to IEA member country priorities and that removal of 2DS as a primary focus would risk softening commitment to climate change mitigation.

Mr. Varro added that coal is no longer seen as important to Europe, being characterised as a fuel of the industrial revolution, so in its discussions with member governments the IEA emphasises the global picture, including electricity supply security aspects for which coal and CCS have advantages.

Dr. Lennon raised some challenges for coal-fired power generation and CCS that need to be addressed if these technologies are to move forward:

- The risks of investing in coal-fired power generation have increased markedly since greenhouse gas emissions have moved up the policy agenda and are now less easily quantified, but how do these compare with the risks of alternatives such as nuclear power?
- Identifying mechanisms to build more flexibility into coal-fired power generation investment, for example through smaller, shorter life, coal-fired power stations.
- Recognising that the implications of CCS for power plant operation, which include increased water usage, loss of MW capacity and restricted operational flexibility are factors that will reduce the appetite of developing economies for CCS investment; suggesting a need for an international agreement to provide an incentive.

Mr. Freyberg emphasised the need to "get to grips" with improving the efficiency of coal power plant.

The discussion turned to the future use of coal and CCS, particularly in China. ***Mr. Watkins*** expressed the view that realistic assumptions on power plant investment in China could support significantly higher coal demand than shown in IEA scenarios. He said that over 271GW of new coal-fired power plant is at various stages of planning in China today, that growth in electricity demand will moderate as it starts to shift away from industry towards the commercial and residential sectors, and that in his view China is unlikely to adopt carbon pricing.

Recognising that coal-fired power plant with CCS is a competitive option for greenhouse gas reduction, ***Dr. Schiffer*** questioned why it does not feature more prominently in IEA scenarios. ***Mr. Wråke*** explained that in IEA modelling CCS deployment is constrained by construction

capacity, that there is a need for gas-fired power plant fitted with CCS in later years, and that this limits the growth of CCs on coal-fired plant. ***Mr. Varro*** added that China is developing alternative fuels to coal, including gas, hydro-electricity and wind power, as rapidly as possible. He explained that coal therefore becomes the balancing fuel and is affected more by differences in economic growth in the scenario projections; especially if growth in steel and cement production slows.

In conclusion, ***Mr. Freyberg*** observed that the public tends to see IEA scenarios as forecasts and therefore regards climate objectives as achievable; while they are actually projections of what is required to meet these objectives and carry other risks, for example in meeting future energy demand, that receive less consideration. He suggested that there is a role for the CIAB and the IEA to promote understanding of the real implications of meeting climate objectives.

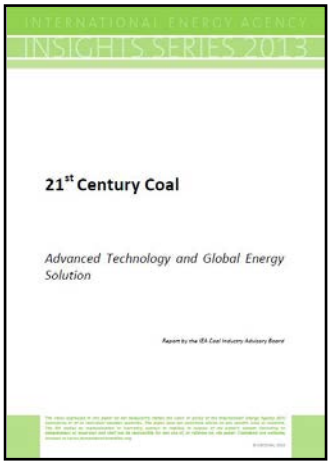
SESSION 2: 21st Century Coal: Advanced Technology and Global Energy Solution

Session Chaired by Mr. Gregory Boyce, Chairman and CEO, Peabody Energy Co. Inc., USA

Mr. Boyce explained that the *"21st Century Coal: Advanced Technology and Global Energy Solution"* report, made available in draft to the meeting, represents the results of the CIAB's 2012 Work Programme; and that this first draft had been prepared for the CIAB by the Electric Power Research Institute, Inc. (EPRI) with direct support from Advanced Resources International, Inc., (ARI), CONSOL Energy, Peabody Energy, and RWE.

He added that an editorial panel of CIAB Associates had guided the work and that the objective of this session is to secure the endorsement of CIAB Members for IEA publication of the report.

The draft was endorsed, subject to a limited number of editorial changes, and the report was published as an *IEA Insights* paper in March 2013. It can be downloaded from the IEA website at: http://www.iea.org/publications/insights/21stCenturyCoal_FINAL_WEB.pdf



He noted that the term "21st Century Coal" had been introduced by the governments of China and the USA in 2009 in the context of an international partnership to advance the development of clean energy solutions from coal; and that it now more broadly symbolises the future of coal in the world. He added that coal currently supplies 30% of world energy needs, 40% of electricity generation and will overtake oil as the world's largest energy source by 2015.

The report focuses on the technology path to near-zero emissions (NZE), addressing the progress of high efficiency and other advanced coal generation technologies, the promise associated with enhanced oil recovery in restoring momentum for carbon capture, and the dynamism of today's coal-fuelled power plants in ensuring stable electricity supply

It demonstrates the compelling reasons for confidence in coal's ability to provide a solution to the global objectives of economic sustainability, energy security, and NZE.

Report Coverage:

Coal and the CO_2 challenge: *d*iscusses the benefits of and the need for coal, issues associated with coal use especially related to carbon dioxide (CO_2) emissions, and roadmaps to improve coal use and continue on a path toward zero emissions.

Evaluation of advanced coal-fuelled electricity generation technologies: provides insights into groundbreaking technology innovations for advanced coal plants to improve efficiency and reduce emissions including CO_2.

Carbon capture, utilisation, and storage (CCUS): focuses on the exciting potential for enhanced oil recovery (EOR) to enable the economic viability of carbon capture and storage (CCS) together with the need for, and status of, CCUS demonstrations.

Flexibility of coal-fuelled power plants for dynamic operation and grid stability: assesses the essential features of fossil-fuelled power plants to operate dynamically on grids with intermittent wind and solar.

Key Messages:

Advanced Coal with CCS Is Essential: Any plan for reducing greenhouse gas (GHG) emissions significantly must include advanced coal generation with CCS. The time window for

technology investments to potentially reconcile the policy objectives of secure global energy supply and the mitigation of growth in GHG emissions is closing, requiring renewed focus on coal. In particular, significant efforts should be made to make certain that CCS demonstration projects move forward.

Higher Efficiency Is a Key First Step in Lowering CO_2 Emissions: An estimated 59Gtonnes (65Gtons) of reduced CO_2 emissions from coal power could have been achieved, had new coal units over the past 50 years used the highest efficiency technology available when built. This is a significant amount of CO_2, equivalent to the world not producing any CO_2 over the next two years, and illustrates the importance of efficiency gains in reducing CO_2 emissions.

Significant Advancements in Coal Technology: Multiple technologies are being developed for coal power designed to improve efficiency, lower emissions, and reduce both costs as well as the energy penalty associated with CCS. Current best-in-class efficiencies for coal power plants are over 40%. In the 2020 timeframe, efficiencies could be as high as 42% and by 2030 up to 46–48%. More advanced future coal-based power cycles could achieve efficiencies near 60%. Similarly advances in environmental controls for emissions and capture of CO_2 under development are providing a path toward NZE for future coal-fuelled power plants.

Game-Changing Promise of EOR: CCUS-EOR holds transformational potential in terms of both GHG emissions reductions and global energy security. Worldwide application of EOR could recover over one trillion additional barrels of oil, with associated permanent storage of 320 Gtonnes (350 Gtons) of CO_2. Furthermore, EOR needs CCUS and vice versa since: a) large-scale realisation of EOR needs CO_2 from power generation and b) revenues from the sale of CO_2 for EOR provide significant benefit to CCUS economics.

Coal Power Plants Are Highly Flexible: A case study on the German electricity market demonstrates that coal-fuelled units have considerable flexibility needed to follow dynamic grid operation caused when intermittent renewables are added to the electricity portfolio. This flexibility is critical to ensuring grid stability during extended use of intermittent wind and solar energy sources. Optimised coal-fuelled power plants are shown to be able to achieve part-load levels of less than 20% with ramp rates of approximately 3 percentage points per minute, allowing changes in the mode of operation between full and part load in under 30 minutes. These results indicate that coal units exhibit as much flexibility as other units in power systems, including natural gas combined cycle ones.

CIAB Recommendations:

- Coal will remain the cornerstone fuel in the global energy economy for decades to come. In 2013, the IEA should leverage its stature and undertake a special initiative to re-educate OECD leaders on this and other aspects of world energy. Such an initiative would be highly constructive by contributing to a greater understanding of crucial energy issues on the part of policymakers and the public they serve. In turn, such understanding would enhance prospects for consensus between developed and developing world leaders on balanced policy measures to achieve the dual benefits to human civilisation resulting from increased energy access and advanced emissions technology.

- World leaders should be guided by the history of technological development in approaching the issue of coal and the CO_2 challenge. The documented record of industry to overcome previous emissions challenges has rested squarely on the progression of new technologies, a fact which remains true today through continued advancements in coal-fueled generation technologies. The next generation of clean coal technologies – including CCUS – represents 21st Century Coal and now provides the path toward NZE, demonstrating coal's continuing role as a global energy solution.

- Energy Ministers from developed and developing countries that use coal should promote in earnest the building of more efficient supercritical and USC coal-fuelled generation. This approach is grounded in scientific and economic analyses that conclude that improved thermal efficiency is the essential first step in realising both meaningful and the lowest-cost reductions in GHG emissions, followed over time by the deployment of CCS technology. Efficiency improvements can deliver emission reductions of 20–30% followed by the application of CCS that can deliver emission reductions of 90%.

- Governments should collaborate with the petroleum industry to identify current and future demand for CO_2 for EOR and ensure that the opportunity to supply CO_2 for EOR is fully considered in strategies to support FOAK [first of a kind] commercial-scale CCS demonstrations. These will generally be the lowest-cost CCS demonstration projects. EOR has been profitable for 40 years in the United States and is a technology that holds transformational potential in

terms of GHG emissions reductions and global energy security. Likewise, the additional revenue stream associated with EOR provides integral financial support enabling the commercial viability of – and restored momentum for – CCS projects.

➢ Efforts should be made by all stakeholders to engage with China on CCS demonstrations and EOR. China possesses numerous EOR opportunities; however, information on the country's efforts in the field of CCS is not well-known outside China. Among the relevant stakeholders are private companies from the coal, power generation, and related industries, which can play a constructive role in broadening the extent of bilateral and multilateral cooperation with China through co-sponsorship with Chinese counterparts of joint scientific R&D initiatives relating to CCS and EOR. China is likely to be of vital importance in achieving cost reductions and other necessary progress to advance CCS deployment.

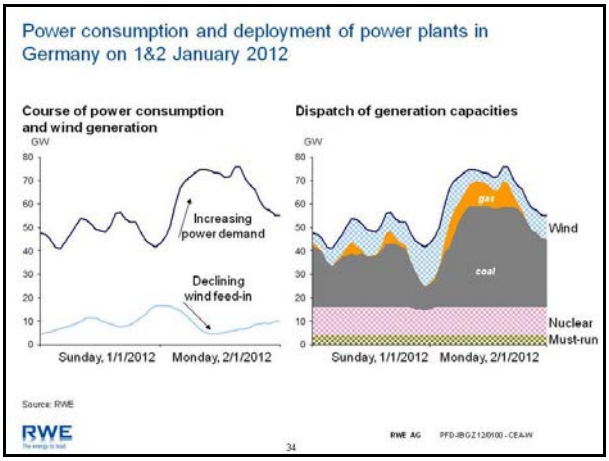
Chapter 5: Case Study on the Flexible Use of Conventional Power Plants in Germany

Dr. Schiffer illustrated the flexible operation of conventional power plants in the German electricity market, which is characterised by intermittent input from 65GW of renewable energy capacity benefitting from a subsidised feed-in tariff (total generating capacity on the market is 168GW, 103GW of which is conventional plant).

He said that since the year 2000 wind energy capacity has increased from 6GW to 30GW and photo-voltaic capacity has increased from 0.1GW to almost 30GW, resulting in fluctuations in renewable energy power feed-in to the electricity grid of up to 30GW within an 8 hour period; equal to the consumer demand fluctuation and set to become the dominant fluctuation within three years.

He said that market volatility caused by these fluctuations in 2012 had resulted in conventional power plants meeting as much as 75GW (>90%) of the peak load, and as little as 17GW when load was low and photo-voltaic input was high. He added that most of these plants date from the 1980s and 1990s, but that measures to improve flexibility have subsequently been implemented.

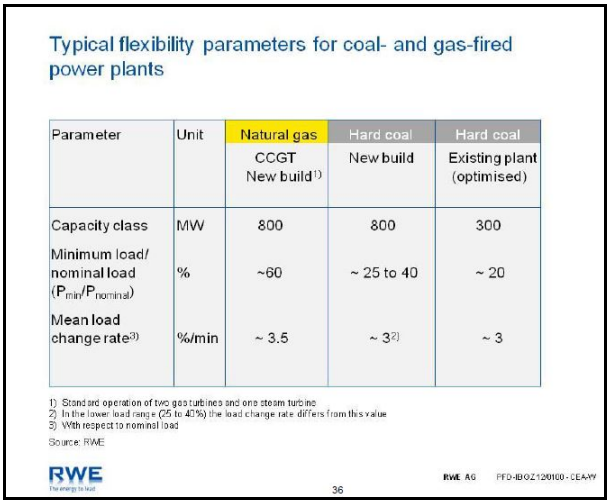
He described examples of how conventional power plant operation had responded to large fluctuations in wind energy availability on 1-2 January 2012.



He said that in the regular configuration of two gas turbines and one steam turbine, the minimum load of a new CCGT plant is typically around 60% of its installed capacity. A lower minimum load is achievable by switching off one gas turbine, but this reduces efficiency substantially and this mode of operation is rarely used, he added.

In contrast, he said a new coal-fired power plant has a lower minimum load capability of some 40%, with further potential to reduce this to 20–25%. The reason for a coal plant having greater flexibility is that the output of the coal boiler is controlled directly via fuel combustion, while the output of the CCGT steam boiler is indirectly controlled via the gas turbine.

He said that, at existing power plants in Germany, the minimum load can be reduced by optimising the boiler-turbine system using modern control systems and that coal-fired power plants are nowadays able to achieve a part-load level of less than 20%. He added that load can be changed at all plants at the rate of approximately 3 percentage points per minute, allowing a change from part-load to full load in less than half an hour.



Questioning the erroneous perception that coal-fired power plants have limited capability to respond dynamically, he concluded that:

- the increased need for flexibility in the German power market is fulfilled just as well by coal-fired as by gas-fired power plants;
- new coal-fired plants are specifically designed for flexible operation and pure base-load power plants are no longer being built; and
- existing coal-fired power plants can be optimised and made flexible to meet the new requirements, avoiding the need for early replacement.

SESSION 3: A Way Forward

Session Chaired by Mr. Doug Ritchie, Group Executive, Strategy, Rio Tinto plc, Australia.

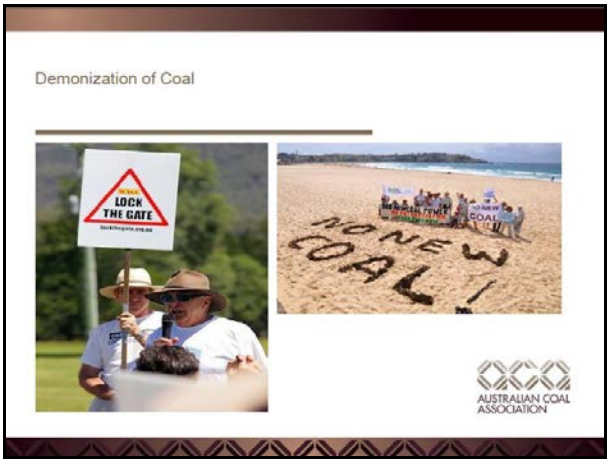
Mr. Ritchie expressed a strong view that the world community is failing to address the challenge of emerging global energy demand and alleviation of energy poverty in a manner that also addresses the need to mitigate greenhouse gas emissions growth. He endorsed the view that under any realistic scenario the world will continue to use coal in significant quantities; and that without the necessary investment there is no chance of limiting the global GHG concentration to 450ppm. He contrasted the $1 trillion already locked in to support until the early 2030s renewables-based electricity capacity installed by 2011 with the $21 billion currently available to support CCS projects.

Identifying a clear need to urgently increase investment in CCS, he observed that communities do not understand the need for such investment and that its rising costs are a concern for governments. He offered CIAB support to the IEA in the task of closing this reality gap and explained that this discussion session will address the issues of energy literacy, refocusing on the challenges for CCS and the potential for enhanced oil recovery (EOR) to play a part in supporting CCS demonstration projects.

The Role of Energy Literacy in Energy and Climate Policy Formulation

Dr. Williams explored the role for energy literacy by reference to the public energy debate in Australia, explaining that after 20 years of almost unchecked economic growth based largely on the country's generous mineral resource endowment, the public debate on the coal industry is now at a crossroads; and there is poor understanding of the real issues, illustrated by some recent developments:

- The Australian Government has released its Energy White Paper that confirms its commitment to market efficiency, the creation of a stable regulatory environment and the appropriate development of Australia's vast energy resources. It highlights, amongst others, the need for CCS to play a key role in the future energy mix.
- A carbon tax of Aus$23/tonne of CO_2 came into effect on 1 July 2012, being the highest such tax in the world and imposing punitive costs on the coal industry by including fugitive emissions from mining, in contrast to any similar taxes in other coal exporting countries.
- A Renewable Energy Target of 20% by 2020 for electricity generation, which is likely to be exceeded due to a slowdown in demand growth and will therefore impose unnecessary additional costs on the economy.
- The development of an organised, well-funded specific anti-coal movement.



She said that coal is being characterised as the incumbent player protecting the status quo, while promoters of renewable energy and gas have assumed the moral high ground as proponents of change. She emphasised the need for a long term strategy to improve energy literacy and raise awareness of issues resulting from policies designed to change Australia's energy mix including capital investment cost, impacts on electricity prices and energy security. She added that the Australian Coal Association is currently formulating such a strategy which will include preparation of factual, credible information presented in a style tailored to differentiated target audiences as well as identification of the most efficient communication channels.

She called for consistency in treatment of all fuels in the energy debate and expressed the hope that rationalising the debate and understanding the role of coal will increase the probability of

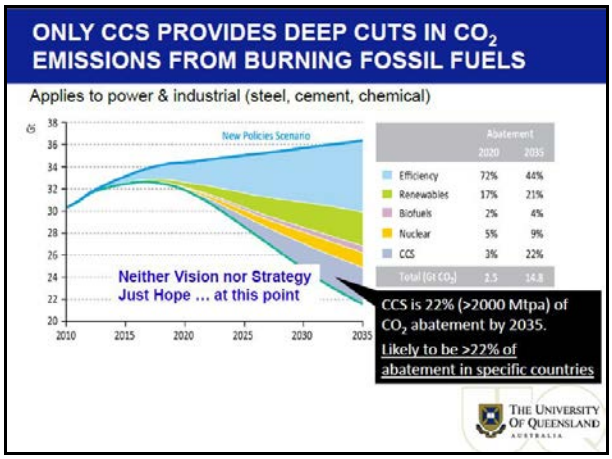
achieving the level of low emissions investment required to actually deliver greenhouse gas emissions mitigation at lowest cost.

She expressed shock at the figures quoted by Mr. Ritchie highlighting that government financial support for CCS is less than 2% of already committed renewable electricity subsidies; adding that CCS must be developed rapidly because if there is no deployable technical solution to mitigating emissions from increasing coal and gas use then there is no solution to the climate change challenge.

She called on the IEA to exercise its global authority and leadership role to promote genuine understanding of the true costs of our energy choices.

Getting Carbon Capture & Storage Back on Track

Professor Greig reinforced the crucial role that CCS must play in facilitating the future use of coal and gas, remarking that its contribution assumed in IEA scenarios by 2035 is currently just a hope rather than a vision or strategy.

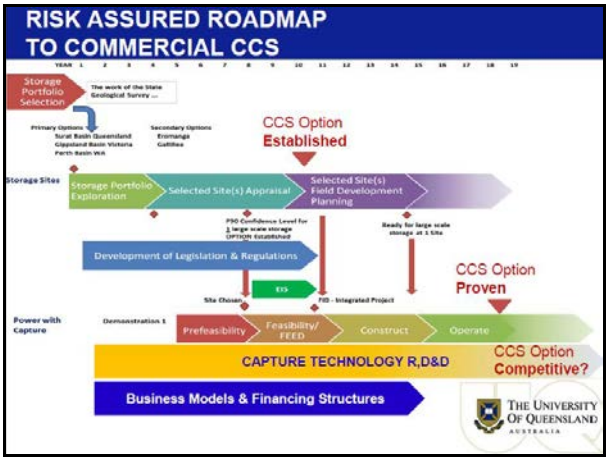


He said that, while CCS strategy needs to be designed at a national level and co-ordinated globally, much of the effort to date has concentrated at the operational level; adding that even after significant expenditure in Australia, USA, Europe and Asia over the last decade we are still unable to determine whether CCS is a real option.

He said that the challenge of achieving CCS deployment at large scale is initially one of storage, on which expenditure is currently insufficient. He estimated that exploration and appraisal costs are in the order of >$200 million for each commercial storage basin in Australia, equivalent to about $20 million for 1 million tonnes per annum of CO_2 storage. He added that the IEA 450 scenario will require over 2,000 million tonnes p.a. of CO_2 storage by 2035 – about the scale of current global natural gas production – and called for more exploration and appraisal expenditure.

He also said that carbon capture costs are too high and there is a need for further demonstration plants to confirm that capture costs can be lowered for "nth of a kind" installations, remarking that CO_2 storage potential is a national issue while capture should initially be demonstrated where project economics are most beneficial.

Putting all these points into context, he emphasised that the challenge for global deployment is significant and front-end investment is high; set out a schematic road map to establish and prove the CCS option; and highlighted some relevant key points.

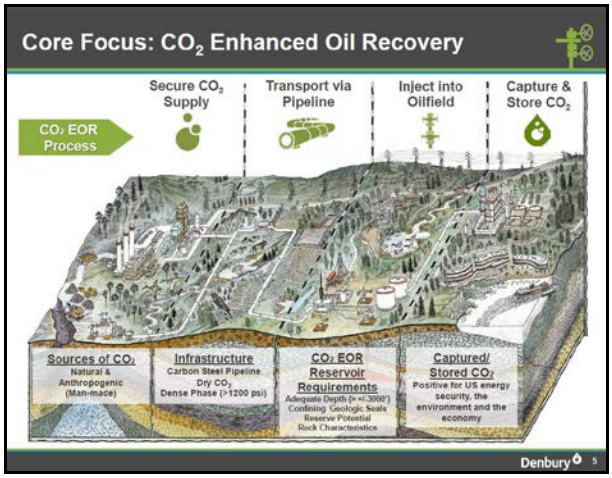


- CO_2 storage resource evaluation and development must come first and needs more pragmatic leadership.
- To deliver IEA targets of >2 billion tonnes a year of CO_2 mitigation from CCS requires investment of over $30 billion in exploration and appraisal globally by 2030.
- Scientific and engineering R&D and demonstrations must deliver a significant reduction in the cost of electricity by 2025.
- Business and finance models are required because there is currently no incentive for early mover projects.
- Do we need government to government agreements to deploy the technology of others (e.g. USA, Japan, Germany, China), similar to nuclear?

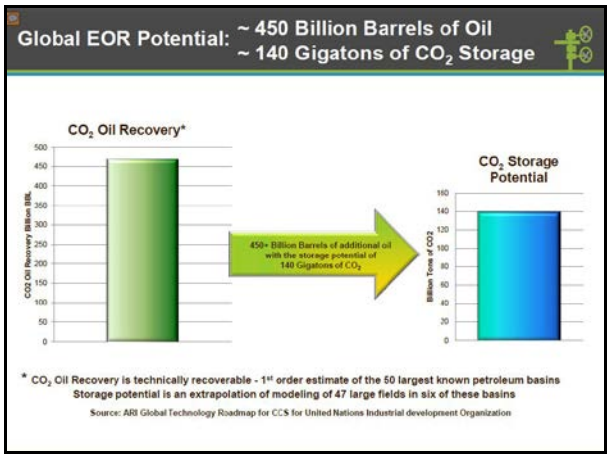
An Industry Perspective on Enhanced Oil Recovery

Mr. McPherson said that Denbury Resources Inc. uses enhanced oil recovery (EOR) to extract additional oil from mature oil fields by injecting CO_2.

He explained that this process involves a CO_2 source, collection and transportation, injection into a mature oil field and capture/storage after use, that proximity of these process elements is desirable, and that the technology was proved in the USA between the 1960s and the 1980s.



He detailed elements of the EOR process including; the need for a dedicated CO_2 pipeline to the mature oil field; the limited availability of new natural CO_2 sources in the USA; the abundance of mature oil fields with EOR potential, many with well-head infrastructure already in place; and the operational process involving CO_2 injection, recovery of oil and CO_2 through a production well, and recovery, separation and re-use of CO_2 over several production cycles.



He highlighted the strategic benefits of EOR, including the production of additional oil and the long term storage of CO_2, estimating a global potential to produce 450 billion barrels of oil and store 140 billion tones of CO_2.

He added that the development of anthropogenic rather than natural sources of CO_2 will be necessary to facilitate this future potential and that this fits well with the need to reduce CO_2 emissions from coal-fired power plants. He saw the current barriers to future growth as uncertain policy on carbon capture, utilization and storage, education on the benefits of EOR, and cost.

On cost, he said that EOR is feasible using natural sources of CO_2 but that it sometimes struggles to support the higher costs of capture from man-made sources such as power plants. However, he saw a brighter future for EOR if this gap could be lessened by improved capture technology, increased EOR efficiency and government incentives.

Session 3 Discussion

Dr. Williams saw a role for the CIAB to support the IEA in pulling together information on CCS for policy makers, commenting that the IEA has a tremendous amount of data, but that it is contained in detailed reports and needs to be succinctly summarised for policy makers. While suggesting that the CIAB should share its expertise with the IEA, she recognised that all fossil fuel industries will have a role in the development and deployment of CCS.

Dr. Lennon agreed that it is difficult to change perceptions but recommended that the coal industry should highlight how it can contribute through improving mining efficiency and educating customers on means of using coal more efficiently, promoting a more positive image for the industry. He also suggested that the coal industry should itself use more renewable energy, for example photo-voltaic, and should consider whether it would be appropriate to sell coal with emissions credits.

Dr. Williams remarked that the Australian coal industry does not oppose renewable energy, but that the full cost of using it needs to be explored. She said that the lack of a direct interface between the coal industry and electricity consumers has encouraged conservatism and reinforced the need for the coal industry to highlight the overall benefits of coal use rather than just the economic and social benefits of individual development projects.

Mr. Boyce suggested that coal companies should partner with CO_2 customers – a step that can be taken now.

Responding to a question on the case for subsidies for specific technologies, ***Professor Greig*** emphasised that carbon storage appraisal constitutes about 80% of CCS pre-investment decision costs and that these front-end costs are very difficult to finance. In the absence of a near-term global commitment to a price on carbon emissions, he suggested that all low emissions technologies including CCS will require incentives or subsidies. The investment by governments in such incentives can help secure an option for CCS and contribute to reducing the cost of the technology such that commercial deployment is enabled if and when the cost of carbon emissions is high enough to provide a business case for investors. He also argued that if incentives are to be provided, all low emissions technologies need to be eligible.

In response to a question from ***Mr. Gentile*** on the future suitability of shale formations for EOR, ***Mr. McPherson*** said that cycling CO_2 through the deposits will be difficult because of the characteristics of the shale formations, but expressed confidence that there will be some potential if new technology can deliver a solution by enabling injection and recovery through the same small well.

Mr. Freyberg referenced the perceived lack of leadership on coal and CCS that had emerged during the Plenary discussion sessions; emphasising that this highlights an opportunity for the IEA to exercise its strong leadership role by encouraging focus on the role that coal will continue to play in global energy markets and on the recommendations that emerged from the CIAB's *"21st Century Coal: Advanced Technology and Global Energy Solution"* publication.

Annex – Plenary Meeting Participants

CIAB MEMBERS:

Mr.	Mustafa	Aktaş	General Director and Chairman of Board of Directors, Turkish Coal Enterprises (TKI)	TUR
Mr.	Gregory H	Boyce	Chairman and Chief Executive Officer, Peabody Energy Co. Inc.	USA
Mr.	Milton	Catelin	Chief Executive, World Coal Association	GBR
Mr.	Andrea	Clavarino	Chairman, Assocarboni and Chief Executive Officer, Coeclerici Logistics	ITA
Prof.	Jósef	Dubiński	General Director, Central Mining Institute (GIG)	POL
Mr.	Greg	Everett	Chief Executive, Delta Electricity	AUS
Mr.	Peter	Freyberg	Chief Executive, Xstrata Coal Pty Ltd.	AUS
Mr.	Robert H	Gentile	President and CEO, Leonardo Technologies Inc.	USA
Mr.	Godfrey	Gomwe	Chief Executive of Thermal Coal, Anglo American	ZAF
Mr.	J Brett	Harvey	Chairman and Chief Executive Officer, CONSOL Energy Inc.	USA
Mr.	Bob	Kamandanu	Chairman, Indonesian Coal Mining Association	IDN
Mr.	Steven F	Leer	Chairman and Chief Executive Officer, Arch Coal Inc.	USA
Dr.	Steve	Lennon	Group Executive (Sustainability), Eskom Holdings Ltd.	ZAF
Dr.	Xolani	Mkhwanazi	Chairman, BHP Billiton South Africa Ltd.	ZAF
Mr.	Petr	Paukner	Chairman of the Board, Coal Energy Ltd.	CZE
Mr.	Doug	Ritchie	Group Executive, Strategy, Rio Tinto plc	AUS
Mr.	Yoshihiko	Sakanashi	Executive Vice-President, J-Power	JPN
Dr.	Nina	Skorupska	Chief Technical Officer, Essent NV	NLD
Mr.	Robert H	Stan	Chairman, Spruce Bluff Resources Ltd.	CAN
Mr.	Michael W	Sutherlin	President and Chief Executive Officer, Joy Global Inc.	USA
Mr.	Kosuke	Tsuji	Executive Officer and General Manager, Energy & Mineral Resources Dept., Idemitsu Kosan Co. Ltd.	JPN
Mr.	Joost	Van Dijk	Chief Operating Officer, Steam, E.ON Kraftwerke GmbH	DEU
Dr.	Nikki	Williams	Chief Executive Officer, Australian Coal Association Ltd.	AUS
Mr.	Fernando L	Zancan	President, Brazilian Coal Association	BRA

CIAB ASSOCIATES:

Mr.	Gatut S.	Adisoma	Deputy Chairman for International Affairs, Indonesian Coal Mining Association (APBI-ICMA)	IDN
Mr.	Julian	Beere	Head of Business Development and Strategy, Thermal Coal, Anglo American Operations Ltd.	ZAF
Mr.	Karl	Bindemann	Business Manager, Northern Europe and Africa, EPRI International Inc.	USA
Mr.	Mick	Buffier	Group Executive – Corporate Affairs, Government and Industry Relations and Sustainable Development, Xstrata Coal Pty Ltd.	AUS
Ms.	Gina	Downes	Corporate Consultant: Environmental Economics, Climate Change and Sustainable Development Department, Group Sustainability, Eskom	ZAF
Mr.	Mücella	Ersoy	Chief Engineer, Project Planning Dept., Turkish Coal Enterprises	TUR
Mr.	Michael	Flannigan	Executive Associate, Peabody Energy Company Inc.	USA
Dr.	François	Giger	Strategy Manager, Thermal Generation and Engineering Division, Electricité de France	FRA
Mr.	Jan-Kees	Hordijk	Manager, Concepts & Economics, Essent Business Development	NLD
Ms.	Veronika	Kohler	Director, International Policy, National Mining Association	USA
Mr.	Roland	Lübke	Economic Affairs, German Coal Association (GVSt)	DEU
Mr.	Tim	Marples	UK Coal Mining Ltd.	GBR
Dr.	Ireneusz	Pyka	Team for European Funds, Central Mining Institute (GIG)	POL
Ms.	Maggi	Rademacher	Performance Improvement and Operational Excellence, Steam Global, E.ON Kraftwerke GmbH	DEU
Dr.	Hans-Wilhelm	Schiffer	Head, General Economic Policy/Science, RWE AG	DEU
Mr.	Donald W.	Seale	Executive Vice President and Chief Marketing Officer,	USA

			Norfolk Southern Corporation	
Mr.	Deck	Slone	Vice President, Investor and Public Relations, Arch Coal Inc.	USA
Mr.	Benjamin	Sporton	Deputy Chief Executive, World Coal Association	GBR
Mr.	J. Gordon	Stephens	Washington Representative for Joy Global Inc.	USA
Mr.	L. Cartan	Sumner Jr.	Vice President, Office of the CEO, Peabody Energy Co. Inc.	USA
Mr.	Sergey	Tverdokhleb	Adviser to CEO and Head of Corporate Policy and Special Projects Department, SUEK (Siberian Coal Energy Company)	RUS
Mr.	Masato	Uchiyama	Executive Managing Officer, J-Power	JPN
Mr.	Naoki	Ueda	J-Power	JPN
Mr.	Steven	Winberg	Vice President, Research & Development, CONSOL Energy Inc.	USA
Mr.	Yoshihiro	Yamamoto	Manager, Coal & Uranium, Energy & Mineral Resources Department, Idemitsu Kosan Co. Ltd.	JPN
Mr.	Alex	Zapantis	Principal Adviser, Product Stewardship, Rio Tinto Energy	AUS

GUESTS & SPEAKERS:

Dr.	Chris	Greig	Professor of Energy Strategy & Director of the University of Queensland Energy Initiative	AUS
Prof.	Georgy	Krasnyanskiy	Belovkaya Coal Mine	RUS
Dr.	Andrew	Maxson	Senior Project Manager, Industry Technology Demonstration, Generation, Electric Power Research Institute	USA
Mr.	Craig	McPherson	Senior Vice President, Chief Operating Officer, Denbury Resources Inc.	USA
Mr.	Brian	Ricketts	Secretary General, EURACOAL	BEL
Mr.	Ernie	Thrasher	Chief Executive Officer, Xcoal	USA
Mr.	Jeff	Watkins	Chairman of Coal, Wood Mackenzie	USA

IEA & STAFF:

Mr.	Marco	Baroni	Energy Modelling Unit, IEA	INT
Dr.	Keith	Burnard	Energy Technology Policy Division, IEA	INT
Mr.	Carlos	Fernández	Senior Energy Analyst (Coal), Gas, Coal and Power Markets, IEA	INT
Mr	Brian	Heath	Executive Co-ordinator, CIAB	GBR
Dr.	Wolf	Heidug	Carbon Capture and Storage Technology Unit, IEA	INT
Mr.	Timo	Panke	Gas, Coal and Power Markets Division, IEA	INT
Mr.	Keisuke	Sadamori	Director, Energy Markets and Security, IEA	INT
Mr.	Johannes	Trüby	Gas, Coal and Power Markets Division, IEA	INT
Ms.	Maria	van der Hoeven	Executive Director, IEA	INT
Mr.	Laszlo	Varro	Head, Gas, Coal and Power Markets, IEA	INT
Dr.	Markus	Wråke	Head, Energy Supply Technology Unit, IEA	

CIAB

Coal Industry Advisory Board

For more information about the IEA Coal Industry Advisory Board, please refer to www.iea.org/ciab, or contact Carlos Fernández at the IEA (carlos.fernandez@iea.org) or Brian Heath, CIAB Executive Co-ordinator (mail@ciab.org.uk).

IEA – International Energy Agency

9, rue de la Fédération
75739 Paris Cedex 15
FRANCE
tel: +33 (0)1 40 57 65 00/01 info@iea.org www.iea.org