INTERNATIONAL ENERGY AGENCY
COAL INDUSTRY ADVISORY BOARD

CIAB

37th PLENARY MEETING

DISCUSSION REPORT

IEA Coal Industry Advisory Board Plenary Meeting
IEA Offices, Paris, 19/20 November 2015

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

CIAB PLENARY DISCUSSION SESSIONS

Held on Thursday, November 19th and Friday November 20th, 2015

The *Coal Industry Advisory Board* (CIAB) is a group of high level executives from coal-related enterprises, established by the International Energy Agency Governing Board in July 1979 to provide advice to the IEA from an industry perspective on matters relating to coal. The CIAB Plenary meeting is held annually and is one of the mechanisms in which CIAB Members provide information and advice to the IEA on relevant energy and coal-related topics. The meeting includes a series of discussion sessions with presentations from external and member speakers on topics of relevance to a wider audience. This report covers the three discussion sessions discussed at the CIAB's 37th Plenary meeting.

"High-Efficiency, Low-Emissions (HELE) Coal-Fueled Technology Update"
Chaired by Mr. Seamus French, Chief Executive Officer of Coal, Anglo American, UK

HELE Coal Fuel Technology Update
Mr. Philippe Paelinck, Vice President Portfolio and Strategic Positioning, General Electric Power

Video - The Application of Technology in the Use of the World's Coal Resources: Recommendations to Global Policy Makers

Staged Pressurized Oxy-Coal Combustion: A High Efficiency Low Emissions Technology
Dr. Pratim Biswas, Chair, Department of Energy, Environmental and Chemical Engineering, Director, MAGEEP, Washington University in St. Louis

Discussion

"Coal-Based Electricity in a Post COP21 World"
Chaired by Mr. Brendan Pearson, Chief Executive Officer, Mineral Councils of Australia, Australia

Coal-based Electricity in a post-COP21 World
Mr. Benjamin Sporton, Chief Executive, World Coal Association

Video – Kusile Power Station (South Africa)

CCS, the Paris COP and Beyond – Why CCS Needs to Ramp-Up
Mr. John Scowcroft, Executive Advisor for Europe, the Middle East and Africa, the Global CCS Institute

Discussion

"Coal in India and China: The Next 10 Years"
Chaired by Mr. Chris Salisbury, Chief Operating Officer, Coal, Rio Tinto

Analysis on India and China for 2015 World Energy Outlook Publications
Mr. Roger Emslie, Principal Metals & Mining Consultant, Wood Mackenzie

India Outlook
Dr. Johannes Trüby, Directorate of Global Energy Economics, IEA

China Outlook
Mr. Zhilong Zhang, Director of Portfolio Management, China Shenhua Overseas Development and Investment Company Ltd.

Chinese Clean Coal Initiatives
Dr. Holly Krutka, Shenhua Science and Technology Research Institute, Executive Editor, Cornerstone, The Official Journal of the World Coal Industry

Discussion

Introduction

The aim of the discussion sessions is 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: advancements and implementation of HELE technologies in the electricity markets; developments in advanced technologies for using coal efficiently in a post COP21 world while effectively mitigating greenhouse gas emissions; and the prospects for coal use and investment in the largest developing economies China and India.

High-Efficiency, Low-Emissions Coal-Fueled Technology Update

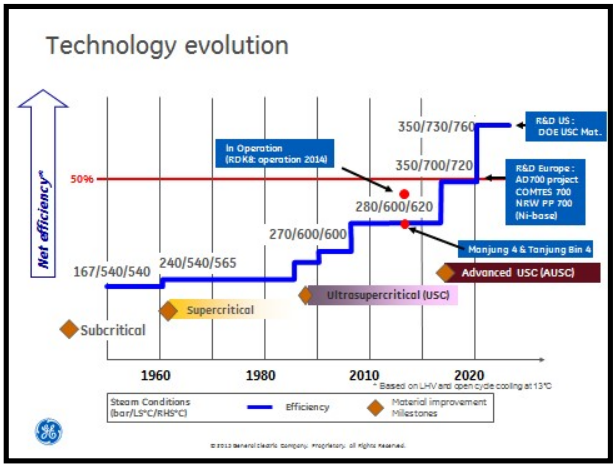
Chaired by Mr. Seamus French, Chief Executive Officer of Coal, Anglo American, UK

Mr. French emphasized the important role high-efficiency, low-emissions (HELE) coal-fired technologies play as a means to mitigate not only carbon, but all greenhouse gas (GHG) emissions, in power generation globally. As the presentations will demonstrate, significant advancements in coal technologies, not only HELE but also carbon capture storage (CCS) and carbon capture use and storage (CCUS), have been made both in the public and private sectors. He advised that the advancement and implementation of these coal-based technologies is not only needed to improve the environmental balance of fossil-fuel based generation, but to provide a secure energy supply base in partnership with renewables and to support the development of emerging economies particularly in Asia. He noted that to achieve these objectives, clarity on governmental policies and financial investment criteria is needed to build the next generation of more efficient power stations adopting HELE technology as an industry standard.

HELE Coal Fuel Technology Update

Mr. Philippe Paelinck, Vice President Portfolio and Strategic Positioning, General Electric Power

Mr. Paelinck provided an overview on the evolution of steam technologies over the past 50 years and explained the next steps needed to build the new generation of steam plants with boiler temperatures of 700-760°C and overall plant efficiency of 50% or more. He emphasized that plant operations are dependent on many factors including: steam cycle conditions and design, plant size, coal quality and cooling temperature conditions. Therefore, performance should not be defined just by set emission limits and plant efficiency ratings.



He provided a comparison of two recent ultra-super critical (USC) projects: the 912 MW RDK 8 in Germany, which is one of the highest efficiency steam plants in the world reaching over 46 %, (up to 58% of fuel utilisation with the additional combined district heat production), and the 1,080 MW Manjung 4 plant. The latter is the first USC plant in Malaysia with an efficiency +5% pts more than Units 1-3, but provides an example of where local operating conditions lead to a loss in overall plant efficiency.

The next step will be to design and build large advanced USC units (>1000 MW) built with double reheat steam turbines and boilers at a market competitive capital expenditure level. Currently the technology exists for the steam turbines but further work is needed on the materials for the boilers.

He underlined the technological advances made in new equipment to control and reduce other emissions (SO_X, NO_X, particulates and mercury) at a lower cost. He emphasized the need for the further roll-out of large scale carbon capture and storage (CCS) across the globe.

He gave an overview and outlook for global installed plant capacity from the GE Power Central Marketing & Strategy Team (GE/MACA). At the end of 2014, approx. 41% of all installed capacity globally (6,245 GW) was steam-fired with the majority of this using coal. The GE/MACA expects approximately 20% of their projected annual new plant capacity to be from coal over the next five years, with gas and renewable units comprising a growing share of the orders. It is possible that growth in China may slow, recover in India and

remain strong in ASEAN countries. Within new build projects, a shift to more frequent ultra super-critical technology (USC) for new plants is anticipated.

He pointed out one of the key challenges the industry faces, is the financing of commercial HELE and CCS technologies for large scale coal new build projects globally by large international financial institutions. For these standards to be adopted there needs to be clarity and support from the investment community to encourage long-term commitment and funding.

Video
The Application of Technology in the Use of the World's Coal Resources: Recommendations to Global Policy Makers
Mr. Gregory Boyce, *CIAB Chairman and Executive Chairman of Peabody Energy*

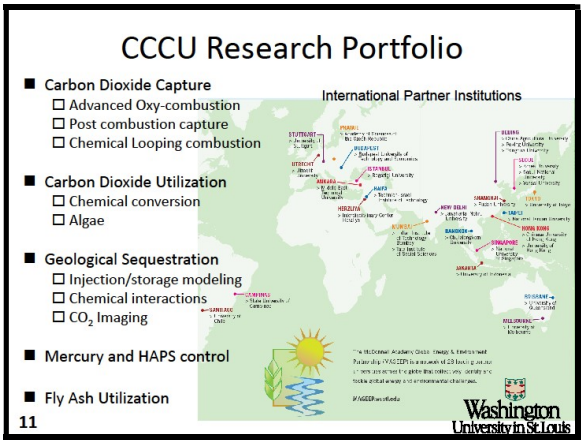
Mr. Boyce, provided global leaders and policy makers with a set of recommendations to consider regarding the role of coal in the energy path heading into the COP21 deliberations in Paris and considering energy poverty, where almost 3.5 bn people lack proper access to electricity for basic needs and the health issues for billions relying on biomass for basic cooking and heating.

He emphasized that advanced coal technology is a bridge to achieve electricity access, economic development and emissions reductions. He outlined five policy recommendations aimed to be constructive, designed to be pragmatic and anchored in technology:

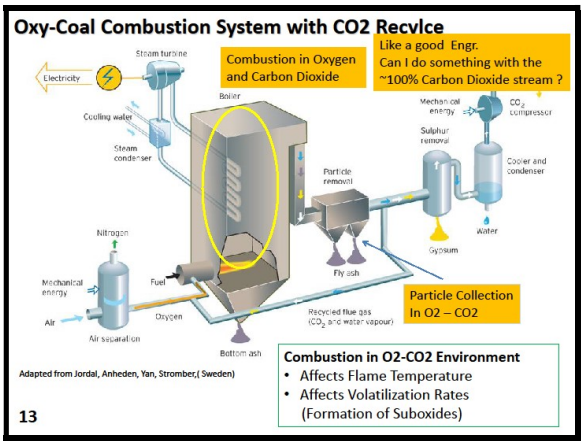
1) ensure that energy is available, reliable and affordable
2) recognize the immediate economic and environmental benefits of HELE technologies
3) provide policy support for the deployment of HELE technologies
4) encourage funding of HELE coal-funded projects to expand access to electricity
5) accelerate the commercialisation of next generation CCUS technologies

Staged Pressurized Oxy-Coal Combustion: A High Efficiency Low Emissions Technology
Dr. Pratim Biswas, Chair, Department of Energy, Environmental and Chemical Engineering, Director, MAGEEP, Washington University in St. Louis

Dr. Biswas, reported on the progress being made at the Consortium for Clean Coal Utilization established at Washington University in St. Louis in 2009. Part of the work is done in an international partnership mode through MAGEEP (McDonnell Academy Global Energy & Environmental Partnership; www.mageep.wustl.edu) a consortium of 30 universities and corporate partners in 15 countries "working together to collectively identify and collaboratively tackle important global energy and environmental challenges in an integrated and holistic manner." For clean coal technologies, research projects are underway across Australia, China, India and the USA and are related to advanced coal technologies, carbon dioxide capture, reuse and sequestration.



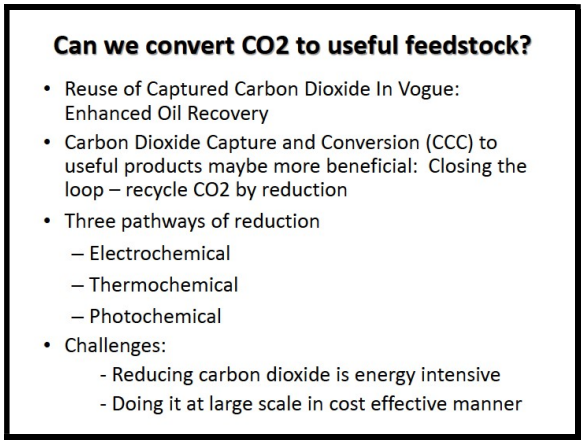
He illustrated how the availability of low cost, clean energy can help solve many of the global challenges, as outlined in the UN Millennium project. Going forward, the world will rely on a variety of primary energy sources. Since fossil fuels will (are being) still be utilized, it is imperative that advanced technology be used to circumvent environmental challenges from carbon and other emissions such as mercury and particulate matter.



He provided an overview of how stage pressurized oxy-combustion technology can be used to increase efficiency and to lower capital and operating costs. Design estimations with Powder

River Basin coal indicate a 5% improvement in efficiency over conventional oxy-combustion technology.

He made the point that CCS is a proven viable technology, but the utilization and conversion by recycling of the CO_2 for useful products would be beneficial, and help reduce and circumvent costs for the capture. Approaches such as reuse of the carbon dioxide for enhanced oil recovery (EOR) and chemical conversion to value added products should be explored. He explained the latest research methodologies to enhance efficiency of CO_2 reuse by catalytic conversion to value added products in his presentation.



He reiterated that cooperation is imperative for advanced clean coal technology research and development; education for the next generation and training programs are essential. To be efficient, multi-national groups like MAGEEP should be utilized and partnerships formed with universities and the corporate sector, and with groups like the CIAB, IEA and governments. Collective white papers should be developed to indicate the importance and viability of clean coal technologies in the overall energy mix.

Discussion:

Mr. Paelinck addressed the questions raised by ***Mr. Beere*** regarding the financing of USC projects outside of China, by remarking that securing financing remains a challenge with lobby efforts influencing some private investors and discouraging the funding of coal projects. He pointed out that many international financial institutions are rethinking their funding of HELE technologies as supported in the OECD accord. A second challenge for component manufacturers are the market structures, licensing and economic conditions at some regional and country levels which can discourage competition.

In response to a question on what the impact of increased renewables in the energy mix has had on CCS projects, ***Mr. Paelink*** commented that many utilities are currently less apt to make an investment decision in favour of large capital intensive projects like CCS due to the regulatory and commercial risks. As a result of increased renewable penetration, many utilities have seen lower wholesale prices and a loss of capitalization limiting new investment in large projects. ***Dr. Biswas*** pointed out that in his opinion, the most flexible available technology for CCS is oxy-fuel in terms of operation.

Mr. Ricketts remarked that guaranteed loans are often portrayed as a subsidy by the media. ***Mr. Fernández*** responded that the IEA position is to promote a better technology than the existing level and that there needs to be a distinction between the financing of projects in developing nations and other countries when making decisions on whether to support the building super critical (SC) or USC units. The OECD agreement is aligned to the IEA position.

Answering a question on whether coal-fired CCS operational costs align with other technologies, ***Mr. Paelinck***, noted that a direct comparison is difficult to make including mid- and long-term projections due to varied underlying assumptions, locations and site specific factors. He commented that some rough estimates for coal-fired CCS projects are near nuclear plant levels, but to compare generation costs commercial CCS and other technologies in the same region would be needed.

Mr. Buffier inquired on the underlying assumptions for the projected growth of installed capacity in China. ***Mr. Paelinck*** mentioned that load factors for the existing coal fleet were low which could impact the level of new orders. At the province level there is some flexibility when ordering plant technology.

Coal-Based Electricity in a Post COP21 World
Chief Executive Officer, Mineral Councils of Australia, Australia

Mr. Pearson spoke of the changing face of coal before and after the U.N. Framework Convention on Climate Change Conference (UNFCCC) of the Parties (COP21) in December. He is surprised by the public debate on climate change which paints coal as the largest source of carbon emissions. According to the IPCC, thermal coal is responsible for 18% of total GHG emissions. He stressed the point that if global policy makers want to solve climate change, one needs to focus not on a single source but on all sources of the problem.

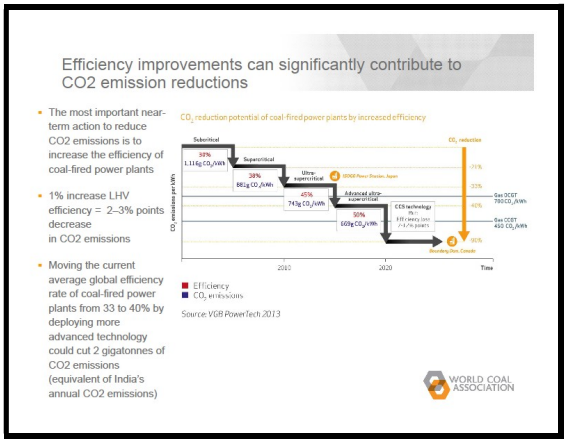
Secondly, he noted that country level proposals for emission reduction targets in the Intended Determined Contributions (INDC's) are published, yet it is important that each country's targets for coal initiatives be clear considering economic development and energy growth over time. As a third issue, he pointed out the need for clarity on climate financing. Of particular interest will be the UNFCCC rules to finance low carbon projects, particularly HELE initiatives.

Lastly, he encouraged transparency of carbon savings by initiative and country. To put it in perspective, HELE initiatives have led to emission reductions of 434 mn t CO_2e alone in China, which is estimated to be 5-10x higher than reductions achieved within the European Union trading scheme.

Coal-based Electricity in a post-COP21 World
Mr. Benjamin Sporton, Chief Executive, World Coal Association (WCA)

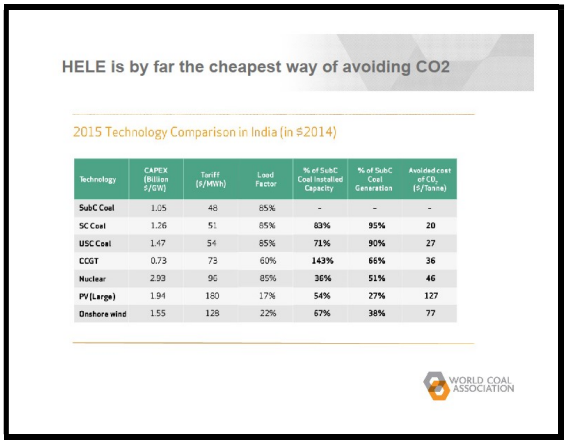
Mr. Sporton represented the WCA at the preparatory meetings leading up to and will participate in the COP21 conference. He noted that in general there is a public misconception in that coal-fired plants will disappear. This is driven by changes in electricity markets in Europe and U.S principally driven by heavy policy support for renewables. However, it ignores the growing role of coal in Asia. The fuel continues to play a significant role in developing and emerging economies in Asia particularly India.

With coal remaining in the energy mix for the foreseeable future, he emphasized that efficiency improvements for coal-fired plants and new build projects can significantly contribute to CO_2 emission reductions. These technologies represent one of the most important near-term actions that can be taken using proven technology. An added advantage of implementing super critical (SC) and USC technology with modern emission control systems are the large reductions in other pollutants beyond carbon including: sulphur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter (PM), mercury and sulphur trioxide (SO_3).



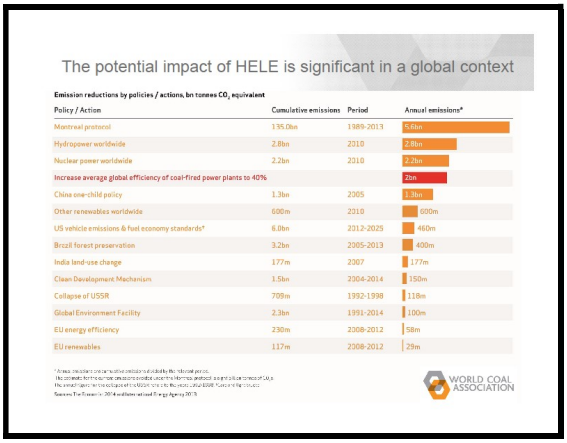
He noted that a shift to HELE technology would have significant environmental impacts. As an example, a move in the development pipeline to supercritical (SC) technology would save 80 Gt of CO_2e or the equivalent of 200 mn cars and a shift to USC technology would be the equivalent of abating emissions from 500 mn cars. He provided highlights from a report released by the WCA entitled, "The Case for Coal: India's Energy Trilemma" looking at the potential impact of HELE initiatives in India for global climate emissions with modern emission control technology.

He remarked that HELE technologies are also one of the most cost efficient ways of carbon emission avoidance as shown in a recently released study by the WCA.



Technology	CAPEX ($/kW)	Tariff ($/MWh)	Load Factor	% of SubC Coal Installed Capacity	% of SubC Coal Generation	Avoided cost of CO_2 ($/Tonne)
SubC Coal	1.05	48	85%	-	-	-
SC Coal	1.26	51	85%	83%	95%	20
USC Coal	1.47	54	85%	71%	90%	27
CCGT	0.73	73	60%	143%	66%	36
Nuclear	2.93	90	85%	36%	51%	46
PV (Large)	1.94	180	17%	54%	27%	127
Onshore wind	1.55	128	22%	67%	38%	77

He maintained that a balanced approach deploying HELE technology in coal-fired plants is a strategy that would allow for the management of carbon dioxide emissions while promoting energy access especially in developing nations. As an example, the rollout of HELE technologies globally could reduce total emissions by 2 bn t CO_2e.



He presented, the WCA proposal the PACE concept (Platform for Accelerating Coal Efficiency) to support the deployment of HELE technologies. PACE is an international platform to drive deployment of these technologies in developing and emerging economies using public private partnerships; the WCA looking for partners to help build up this initiative. He stated a critical issue in COP21 will be the willingness of countries to finance post-2020 climate actions at home and abroad. A few countries, like Japan, India, South Africa etc. have included provisions for HELE projects in their Intended Determined Contributions (INDC).

Video – Kusile Power Station (South Africa)

Prior to the discussion, a video from Eskom, showing the Kusile Power Station Project to remove sulphur dioxide, the largest construction site in the Southern hemisphere, was shown to demonstrate the importance of HELE technologies in South Africa to meet the energy needs of the nation. The strategic project totals 4,800 MW of installed coal-fired capacity (6 x 800 MW) contributing 11% of Eskom's production to the grid and the first project with FGD boiler technology that removes sulphur dioxide. It also has significant economic impact providing 600 long-term jobs but ensuring a secure supply of electricity for the nation.

CCS, the Paris COP and Beyond – Why CCS Needs to Ramp-Up

Mr. John Scowcroft, Executive Advisor for Europe, the Middle East and Africa, the Global CCS Institute

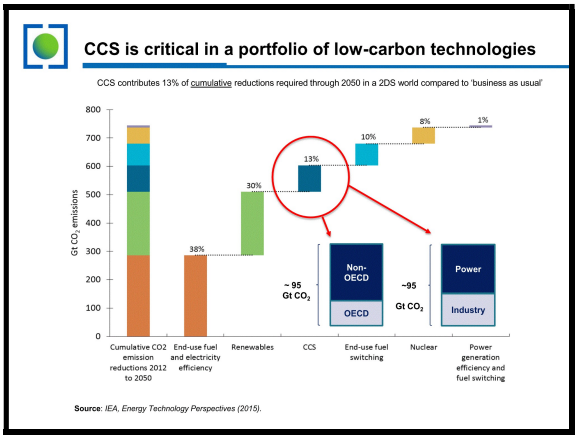
Mr. Scowcroft represents the Global CCS Institute, an international organization, with diverse members from government, small to large companies to research bodies, who are working to accelerate the development, demonstration and deployment of CCS globally.

He presented three key messages of the organization.

1) CCS is a vital component of a low-carbon future.

He noted that the global energy sector is at a crossroads where expectations are colliding between a "business as usual" scenario which is incompatible with climate change objectives. According to the IEA, global energy demand, also from fossil fuels, will continue to grow through 2040 and the proven reserves reported remain robust.

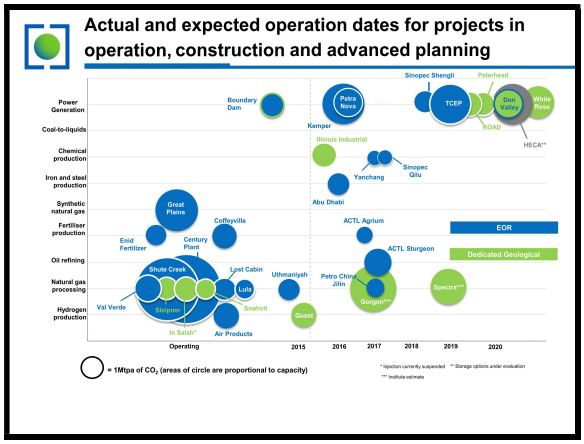
To solve this, he said a transformation is needed in how we generate and use energy. He pointed out that while renewable energy is one solution, other technological solutions, like CCS, will need to be implemented jointly in a low-carbon portfolio to reach the large scale reductions in emissions to restrict warming to 2°C. Citing the IEA Energy Technology Perspectives Report (2015), he expects that CCS must contribute 13% or 95 Gt CO_2 of the cumulative emission reductions through 2050 to meet the 2°C goal. To reach this target, these reductions will need to occur in OECD and non-OECD nations and in the power sector and across industry. In industrial processes like steel and cement there isn't another alternative to CCS to achieve the deep emission cuts necessary.



He pointed out that it also makes rational economic sense to lower carbon emissions in the power sector using CCS. Without CCS, it could cost up to $2 trillion more to decarbonize.

2) CCS is established and already reducing emissions

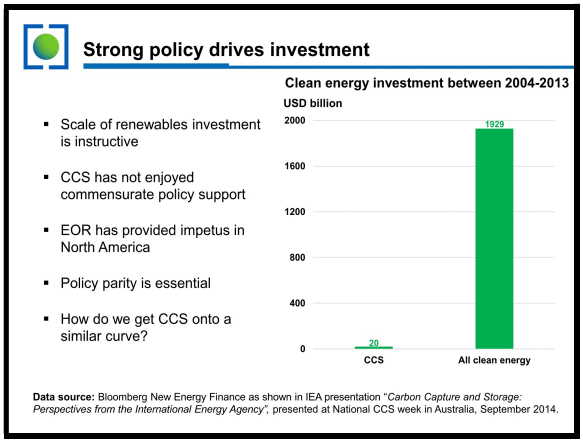
While cost is one factor, he emphasized the feasibility of CCS as a real technological solution; there are numerous CCS projects already operational with approx. 28 Mtpa of CO_2 capture capacity across the globe. Of the 45 large scale projects, there are 15 in operation and another 7 under construction. These projects are found across the globe, most projects are in the Americas and in Europe but include a steel plant (Gulf Co-ordinating Council). In Asia, China has made CCS a priority in the new five-year plan with 9 projects in various stages of planning and as a possible way to deal with air quality problems.



He reported on the positive mid-term outlook with up to 40 mt of CO2 capture capacity expected online in the next 18 months or the equivalent to emissions from 8 mn cars, but it is the few number of projects in the earliest planning stage of the project pipeline that is disconcerting.

3) Strong policy is required globally.

He warned though that strong policy support and regulatory clarity is needed globally to boost investment for the long-term commitment to CCS projects and mitigation. This includes answering regulatory uncertainties (i.e. trans-boundary movement, long-term liability), establishing policy parity with renewables, expanding R&D support and fostering knowledge sharing and exchange.



For those looking for more information, he reminded the audience that they can access the report "The Global Status of CCS: 2015" by visiting the website: www.global.ccsinstitute.com/status2015.

In the second part of his presentation, he provided an overview of the United Nations Framework Convention on Climate Change (UNFCCC) organization and architecture governing the Conference of the Parties (COP)/Conference of the Parties serving as the meeting of Parties to the Kyoto Protocol (CMP) and the bureau, permanent subsidiary bodies and convention bodies. He stated it is likely that that the Paris protocol will replace Kyoto in 2020, but the means to transfer the market mechanisms from Kyoto to a new Paris agreement must be defined. The United Nations Economic Commission for Europe (UN-ECE) has picked up the CCS champion role.

He explained that CCS technology will not likely be specifically cited in any agreement in Paris, but instead is likely to be a referenced as one of the "environmentally, socially and economically sound technologies". In a Paris agreement, it is expected that INDCs will likely be the building blocks of a new agreement. The INDCs of most countries fail to mention CCS specifically even those with projects in the pipeline. In addition to financing all green climate activities, a fundamental pillar will be setting up the body and means to measure, report, and verify countries' emissions, commitments and actions.

Discussion

Mr. Pearson opened the discussion with two questions to consider as the COP21 proceeds.

1) What are the direct implications that an accord could have on institutions?
2) What could be the implications of specific country initiatives?

Mr. Zapantis raised the issue of how the estimated $100 bn needed to for climate change could be financed between developed and developing nations. ***Mr. Scowcroft*** acknowledged financing is a critical issue that could be a deal breaker if not settled within an agreement.

Mr. Pearson mentioned that despite the pledges with a goal of $100 bn annually by 2020 only a fraction of the sum had been received for financing climate projects to date. ***Mr. Scowcroft*** informed the group that the Green Climate Fund provides regular updates on pledges received and projects funded. Still there is a lengthy process between funding and disbursement to projects so as of November only $1.2 bn had been distributed to climate projects of the $10 bn received to date.

Dr. Schiffer pointed out that in a recent interview the Chairman of the Intergovernmental Panel on Climate Change (IPCC) mentioned the importance of working with the energy industry for the large scale deployment of CCS for carbon mitigation. ***Mr. Fernández*** mentioned that the US has included CCS in the tax incentive scheme and wondered if this could change the landscape for CCS in the country? ***Mr. Marshall*** mentioned that the CCS tax credits were not sufficient in terms of size and money to encourage large scale CCS growth, but it is a building block to expand upon after the success of the Canadian Boundary Dam station. ***Mr. Sumner*** drew attention to the release of a white paper by the U.S. National Coal Council, done at the request of the Secretary of Energy, which recommends what policies and incentives are needed to bring CCS on par with renewable technologies for project developers. The paper can be found under:
http://www.nationalcoalcouncil.org/studies/2015/Leveling-the-Playing-Field-for-Low-Carbon-Coal-Fall-2015.pdf
The recommendations focused on: financial incentives, regulatory improvements and communication and collaboration.

Mr. Beere asked if policy makers understand the importance of CCS when only 4 countries have included the technology in the respective INDC. ***Mr. Scowcroft*** answered that it is important to remember 60-70% of the countries lack the electricity infrastructure to consider CCS an option for mitigation. Many developing nations instead have a primary focus of providing access to electricity for their citizens.

"Coal in India and China: The Next 10 Years"
Chaired by Mr. Chris Salisbury, Chief Operating Officer, Coal, Rio Tinto

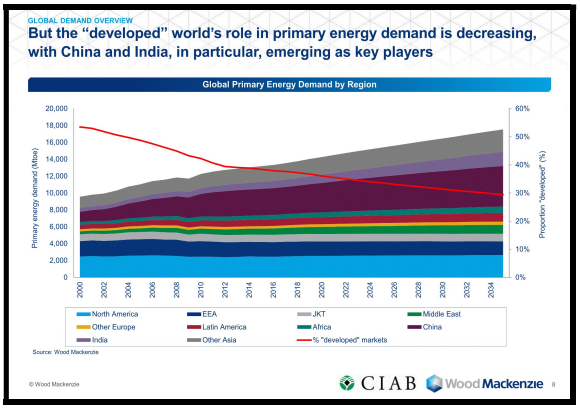
Mr. Salisbury advised that coal, as demonstrated in the earlier discussion sessions, will remain an instrumental part of the global energy mix now and into the foreseeable future. The question he put forth to our speakers, "What does coal potentially hold in the future for these countries?"

He set the context for the presentations noting the significant changes in the coal industry and energy sector which have occurred in just one decade. He reminded us of events like thermal coal prices of over $180/t (CIF ARA), volatility and the ever changing role of China in the global market since 2005. He acknowledged the difficulty of forecasting, but looked forward to the different perspectives of our four speakers on how the coal markets in these countries could develop over the next ten years.

Analysis on India and China for 2015 World Energy Outlook Publications
Mr. Roger Emslie, Director Metals & Mining Consulting, Wood Mackenzie

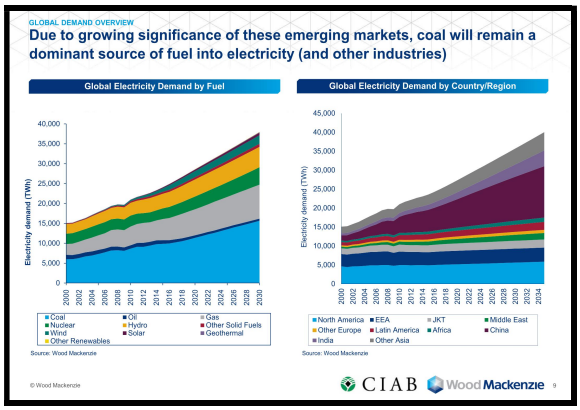
Mr. Emslie explained the support Wood Mackenzie provided to the IEA during 2015 for a special report on Energy and Climate Change as well as the World Energy Outlook, which included providing power stations and coal market information in India and China as well as updated mining production costs.

He continued by presenting the company's outlook for global demand where there is a divergent trend between the paths of the "developed" world and emerging nations. Energy demand will remain strong in developing countries, especially China and India, over the forecast period to spur economic growth.

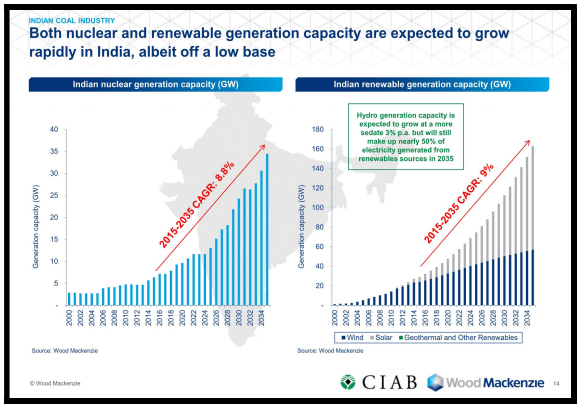


Energy demand in the emerging markets will be sourced from a diverse portfolio, but coal will remain a dominate fuel especially in power generation but also for other industrial processes. While the fuel mix in Europe and the U.S. continues to diversify and moves away from fossil fuels, he believes that this declining demand for

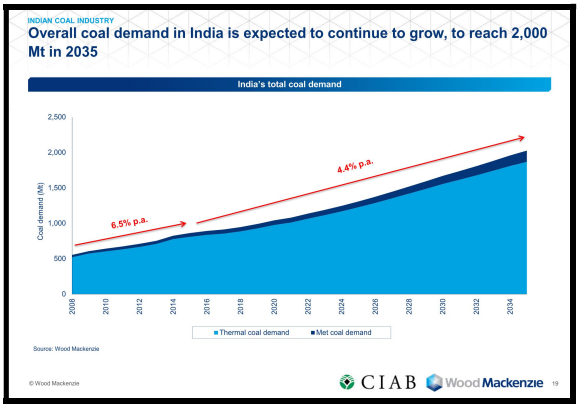
coal will be more than offset by demand in developing markets like India, ASEAN, Africa and the Middle East. So even though the share of coal in the global fuel mix will decline in the long-term, the expectation is that overall coal demand will rise through 2035.



Mr. Emslie then provided an overview of Wood Mackenzie's perspectives on the Indian coal industry where energy demand is expected to grow across all segments in a diversified portfolio to underpin strong economic growth. He pointed out that the underlying assumptions on capacity utilization and demand for these projections are different from the IEA.

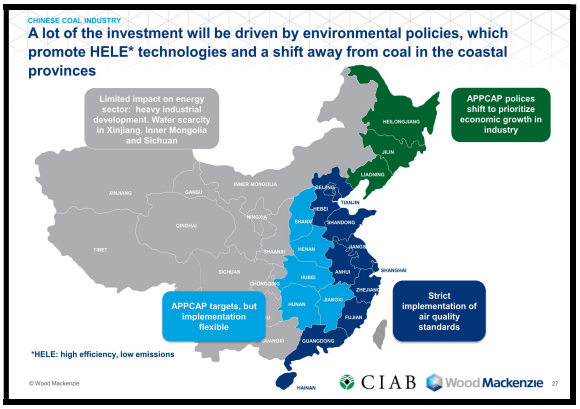


In the Indian power sector, strong growth in generation capacity is anticipated from nuclear and renewable sources, but the forecast is for coal to remain the dominate fuel (at over 70%) for electricity due to continued strong growth in coal-fired generation through 2035. It is also anticipated that steel production will keep demand high for metallurgical quality coals.

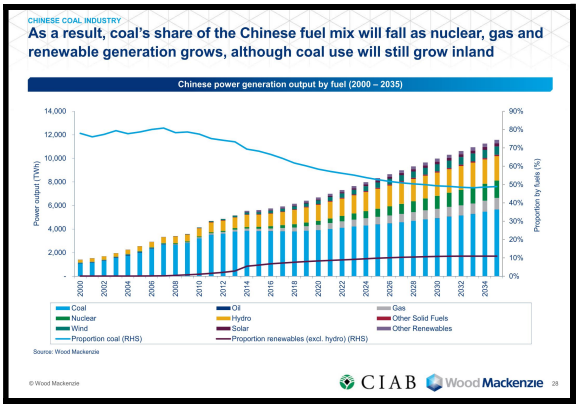


On the supply side, India is expected to expand domestic coal supply from 590 M t in 2015 to 1,270 M t by 2030, but reserves tend to be a lower quality (low heating values and high ash). To meet demand, the country is expected to continue to rely on imports from Indonesia and South Africa.

To conclude, he gave an update on the outlook for China where there is an aggressive push to improve air quality and emissions while maintaining economic development levels.



Here it is expected that nuclear and renewable generation capacity will grow strongly, but there will be a push for investment in HELE coal-fired technologies especially for new capacity built inland and in industrial hubs. As a result, the Chinese generation mix will continue to diversify, but coal use will remain strong out to 2035 especially in the inner Western provinces (even as coal's share in the Chinese fuel mix declines).



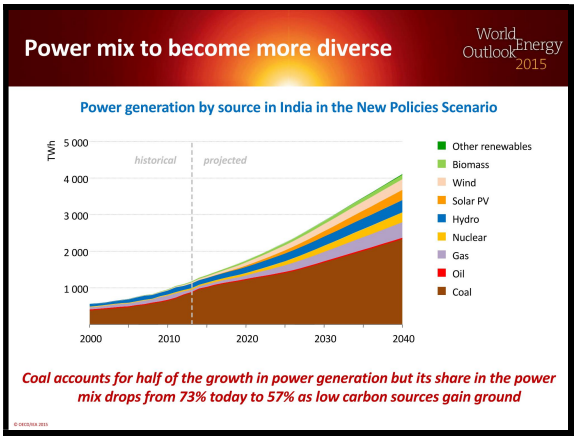
India Outlook

Dr. Johannes Trüby, Directorate of Global Energy Economics, IEA

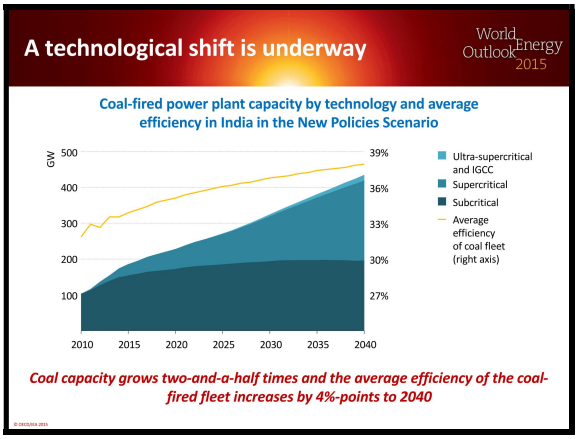
Dr. Trüby started by thanking CIAB for their support of Wood Mackenzie which provided a useful source of independent information for the World Energy Outlook. He provided a synopsis of the current transformation underway in India, the challenges for policy makers and an outlook for the emerging country's energy markets.

India is at the start of a major transformation with energy use doubling in the past 15 years and economic growth lifting millions from poverty; yet over 240 mn people lack access to electricity, power supplies remain unreliable and there is a heavy dependence on fossil fuels to meet energy needs. The IEA expects economic growth to expand rapidly (+6.5%) as India becomes the most populous nation over the next 25 years with the strongest growth in urban areas.

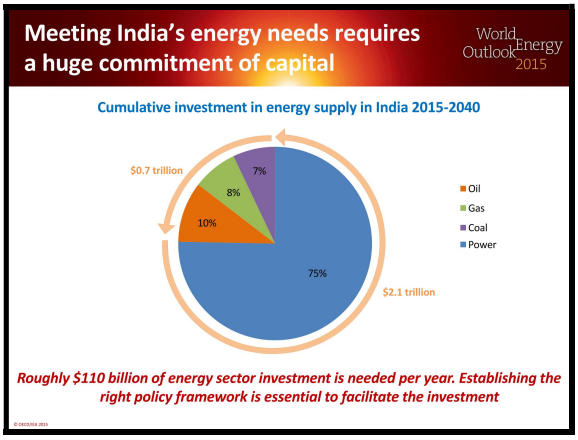
He illustrated the IEA projections that to meet this demand, the power generation mix will continue to diversify with growth in all segments particularly renewables. Still the IEA forecasts that over 50% of new generation will remain coal-fired, and gas will be critical to cover peak demand.



There is a critical need to promote HELE technologies for new build projects and to improve efficiencies in existing units. By 2040, it is expected, the average efficiency rate for coal-fired units will rise by +4% points, the cumulative savings from efficiency improvements (2015-2040) are equivalent of the annual CO_2 emissions from Spain.

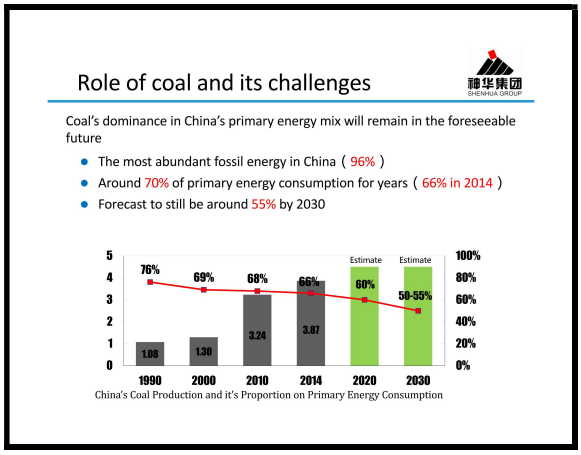


On the supply side, India remains a driving force in the global coal market reliant on imports to cover growing demand and to blend with lower grade domestic coal qualities. The IEA forecasts coal production to exceed to 925 mn tce before 2040. The Coal Mining Provisions Act could encourage a higher level of private participation and possibly open a door to foreign investment. He stresses that the potential of India's energy sector can only be reached with significant well managed investment from diversified sources to improve the quality of life for all citizens. India's energy needs require a huge commitment of capital in the energy sector of roughly $110 bn/yr for a total of $2.8 trillion between 2015 and 2040, with the vast majority in the power sector. To spur this investment, market reforms are needed to reduce the huge transmission and grid losses and to create a reliable government framework with fewer bureaucratic hurdles.



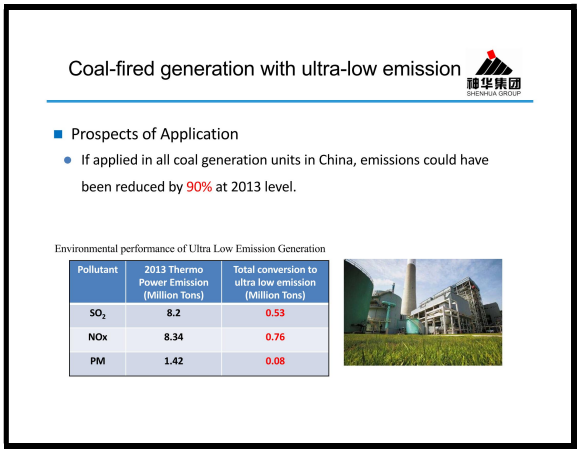
China Outlook
Mr. Zhilong Zhang, Director of Portfolio Management, China Shenhua Overseas Development and Investment Company Ltd.

Mr. Zhang, gave an insider's perspective on the role of coal in China, where he believes the fossil fuel will remain dominant for the foreseeable future due to its abundance and availability in China. Coal currently makes up 66% of primary energy consumption in 2014, a ratio that could fall, but only to about 55% by 2030.

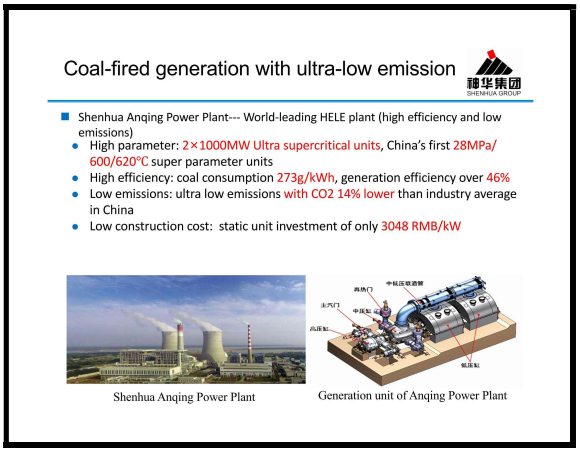


Therefore, the environmental footprint of demand must be considered and ultra-low emissions from plants and the integration of advanced pollutant scrubbing technology integrated in existing units to remove pollutants.
He reminded the audience of the current "long winter" for the coal industry underway after the "golden decade" with companies facing losses, lower demand and oversupply. The next phase will involve consolidation, diversification and transformation. The current market conditions pose a challenge for the domestic coal companies.

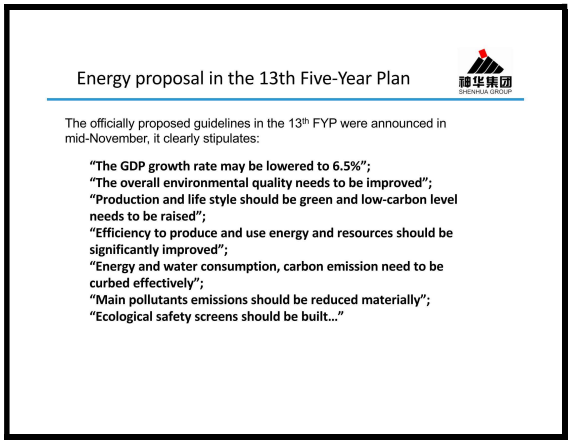
Despite the conditions, the path to HELE coal-fired units continues to emerge. If all existing generation capacity was upgraded, emissions could be reduced by 90%.



Within the Shenhua portfolio, the Anqing power plant is a benchmark and one of the world's leading HELE plant with an efficiency of over 46% and carbon emissions 14% lower than the industry average.

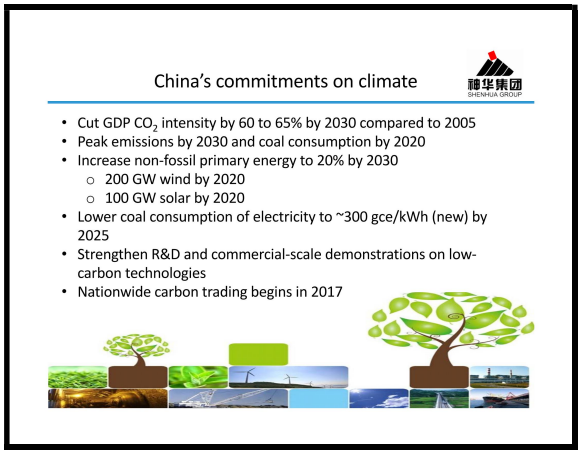


The mid-term guidance for China is outlined in the current Five-Year plan with clear economic, environmental and energy goals. There is also a strategy to seek a lower demand path by raising energy efficiency and awareness in the consumer region to transform attitudes of consumers towards energy consumption.



Chinese Clean Coal Initiatives
Dr. Holly Krutka, Shenhua Science and Technology Research Institute, Executive Director, Cornerstone

Dr. Krutka started by sharing the broad spectrum of activities that the term "clean coal" encompasses in China starting with strong climate commitments, efficiency and emission upgrades for existing plants, CCS/CCUS projects, water conservation measures and improving the efficiency of industrial and municipal boilers. Of particular focus was the country's strong commitment to addressing GHG emissions to 2030 through policy, research and development and knowledge sharing.



She estimated that coal-fired capacity will continue to grow from 780 GW in 2030 to 1100-1300 GW in 2030. In some cases, this growth will not increase coal consumption, but is instead replacing smaller, inefficient industrial and municipal uses of coal. To meet the defined 2025 target for coal intensity for power generation, 300 grams of coal equivalent (gce) per kWh, this would encompass adopting USC technology in new stations and HELE technology for all units larger than 600 MW. Other clean coal initiatives underway include reclaiming mined land, improving fly ash utilization and reducing waste products from the coal conversion process. Still there are numerous challenges due to the growing water conservation requirements, which mandate air cooling, and coal conversion water usage. The general theme of the presentation was focused around a strong ongoing push for research and to develop and deploy clean coal technologies. International collaboration and information exchange are vital to such efforts.

Dr. Krutka invited those interested to read Cornerstone (http://cornerstonemag.net/), an open-access quarterly publication sponsored by Shenhua Group and published on behalf of the WCA, committed to report on the role of coal in the global energy mix and explore technologies to minimize the environmental footprint.

Discussion

Mr. Salisbury inquired if there were additional risks in India and how this could potentially impact the coal market. ***Mr. Emslie*** responded the greatest risk is the lack of investment needed to meet electrification targets. Without investment there is an increased risk that the renewables target will not be fulfilled and reliance on coal will continue. In addition, there is a supply risk for import coal which is needed to match domestic coal output and qualities. ***Mr. Trüby***, explained that India has aggressive targets for domestic coal output and even if they only meet 2/3 of this level the country could become almost self sufficient, creating a risk for coal imports. ***Mr. Emslie*** mentioned the complications for imports and blending with the low calorific domestic coal sources.

Mr. Freyberg, asked if there were any policies that could prevent an increase in CO_2 emissions within the Indian status quo and existing technological projections? ***Mr. Trüby*** warned that due to the high temperatures in the country and low quality of coals, there are operational limits on the maximum plant efficiency levels achieved. There is room to improve the coal quality via blending with imports or washing processes. The Indian coal fleet is relatively young, so it is difficult to prematurely shut young inefficient plants without international investment and technological transfer to speed up this transition.

Mr. Beere questioned how can China build USC units at 1/10th the cost of the Kusile new build project and if this low cost technology could be transferred to India and other countries? ***Mr. Trüby*** advised that a closer evaluation of the specific plant and projects needs to be made when comparing investment costs. It would be helpful to

have more information on how a coal plant could be built at this cost level.

Mr. Sadamori asked for more details on the source of a gap between coal consumption and primary energy consumption? ***Mr. Zhang*** answered that the declining percentage of coal in the primary energy consumption is rooted in the fact that coal consumption will be falling/stable while the renewable base and output will likely increase. He anticipates that China producers will seek new coal customers abroad. ***Ms. Krutka*** added this is also due to gains in efficiency as they transition from municipal industry boilers and smaller units to high efficiency plants.

Mr. Olejarnik**,** thanked all presenters for there insights. If the "long winter continues after the golden age" in the Chinese energy sector, it will be interesting to see if China remain an importer or exporter of coal. ***Mr. Fernández*****,** warned about the risk in projections for China, where low utilization rates of existing coal plants, aggressive renewable targets and the economic situation can have an impact even in the short-term.

Mr. Ricketts, asked for more information on the assumptions leading to an increase in gas installed capacity in the for Europe despite the depressed price levels and low load factors? ***Mr. Fernández***, replied that in Europe the problem was created by a shift in the generation mix and there is currently no incentive to build a gas or any kind of conventional plants in the current economic environment.

Mr. French thanked all of the speakers for the insightful presentations. The quality of the presentations can be seen by the number of questions and discussions from delegates.

Annex – Plenary Meeting Participants (in person or via telconference)

CIAB Members

Mr. Gregory	Boyce	Executive Chairman, Peabody Energy	USA
Mr. Andrea	Clavarino	Chairman, Assocarboni and Chief Executive Officer, Coeclerici Logistics	ITA
Mr. Seamus	French	Executive Chairman, Anglo American Coal	GBR
Mr. Peter	Freyberg	Head of Coal Assets, Glencore	AUS
Dr. François	Giger	Strategy Manager, Thermal Generation and Engineering Division, EDF	FRA
Dr. Mathias	Hartung	Member of the Executive Board, RWE Power AG	DEU
Mr. Colin	Marshall	President and Chief Executive Officer, Cloud Peak Energy Resources LLC	USA
Mr. Petr	Paukner	Chairman of the Board, Coal Energy Ltd.	CZE
Mr. Brendan	Pearson	Chief Executive, Energy, Minerals Council of Australia	AUS
Mr. Joachim	Rumstadt	Chairman of the Board of Management, STEAG GmbH	DEU
Mr. Yoshihiko	Sakanashi	Senior Counselor, J-POWER	JPN
Mr. Chris	Salisbury	Managing Director, Rio Tinto Coal Australia Pty Ltd	AUS
Mr. Benjamin	Sporton	Chief Executive, World Coal Association	GBR
Mr. Fernando L	Zancan	President, Brazilian Coal Association	BRA

CIAB Associates

Mr. Julian	Beere	Head of Business Development and Strategy, Thermal Coal, Anglo American Operations Ltd.	ZAF
Mr. Karl	Bindemann	Technical Executive, Power Generation, EPRI International Inc.	USA
Mr. Mick	Buffier	Group Executive, Coal Assets, Glencore	AUS
Mr. Graham	Chapman	Advisor to the CEO - International Development, SUEK (Siberian Coal Energy Company)	RUS
Mr. Prach	Chongkittisakul	Vice President, New Energy Business, Banpu Public Co, Ltd.	THA
Mr. Mücella	Ersoy	Chief Engineer, Project Planning Dept., Turkish Coal Enterprises	TUR
Ms. Nikki	Fisher	Coal Stewardship and Carbon Footprint Manager, Anglo Operations Limited	ZAF
Mr. Frank	Huschka	Head, Fuel & By-Products, Operational Support, Global Unit Next Generation, E.ON	DEU
Mr. Takashi	Irie	Executive Senior Advisor, Planning Division, Energy Business Dept., J-POWER	JPN
Mr. Roland	Lübke	Economic Affairs, German Coal Association (GVSt)	DEU
Ms. Milagros	Miranda	Policy Director, World Coal Association	GBR
Mr. Richard	Reavey	Vice President Public Affairs, Cloud Peak Energy Resources LLC	USA
Mr. David	Ruddell	Vice President, Strategy and Development, Coal, BHP Billiton	AUS
Mr. Shintaro	Sawa	Director, Energy Business Dept., J-POWER	JPN
Dr. Hans-Wilhelm	Schiffer	Advisor to the RWE Executive Board	DEU

Mr. Toshiro	Shibahara	Senior Chief Associate, Coal Business Department, Idemitsu Kosan Co. Ltd,	JPN
Mr. Deck	Slone	Senior Vice President, Strategy and Public Policy, Arch Coal Inc.	USA
Mr. Cartan	Sumner.	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. Alex	Zapantis	Principal Adviser, Product Stewardship, Rio Tinto Energy	AUS
Mr. Zhilong	Zhang	Director of Portfolio Managment, Shenhua Group Corporation Ltd.	CHN

CIAB Speakers & Guests:

Dr. Pratim	Biswas	Chair, Department of Energy, Environmental and Chemical Engineering, Washington University in St. Louis	USA
Mr. Roger	Emslie	Managing Consultant, Wood Mackenzie	USA
Mr. Jianjun	Gao	China Coal	CHN
Dr. Holly	Krutka	Shenhua Science and Technology Research Institute, Executive Editor, Cornerstone, The Official Journal of the World Coal Industry	USA
Mr. Zenhya	LIU	China Coal	CHN
Mr. Philippe	Paelinck	Vice President Portfolio and Strategic Positioning, General Electric Power	FRA
Mr. Brian	Ricketts	Secretary General, EURACOAL	BEL
Mr. John	Scowcroft	Executive Adviser for Europe, the Middle East and Africa, Global CCS Institute	BEL

IEA & Staff:

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Ms. Samantha	McCulloch	Energy Analyst (CCS), IEA	INT
Ms. Maggi	Rademacher	Executive Co-ordinator, CIAB	INT
Mr. Keisuke	Sadamori	Director, Energy Markets and Security, IEA	INT
Mr. Paul	Simons	Deputy Executive Director, IEA	INT
Dr. Johannes	Trüby	Gas, Coal and Power Markets Division, IEA	INT
Mr. Johannes	Wagner	Gas, Coal and Power Markets Division, IEA	INT

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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 Alvarez at the IEA (carlos.Fernández@iea.org) or Maggi Rademacher, CIAB Executive Coordinator (coordinator@ciab.international).

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