INTERNATIONAL ENERGY AGENCY
COAL INDUSTRY ADVISORY BOARD

CIAB

39th PLENARY MEETING

DISCUSSION REPORT

IEA Coal Industry Advisory Board Plenary Meeting
Ministère des Affaires Étrangères Centre de Conférences
27 rue de la Convention, Paris
2/3 November 2017

CIAB PLENARY DISCUSSION SESSIONS

Held on Thursday, November 2nd, and Friday, November 3rd, 2017

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 assembly includes a series of discussion sessions with presentations from external and member speakers on issues of relevance to a broader audience. This report covers the three discussion sessions discussed at the CIAB's 39th Plenary meeting.

"Discussion Session 1: The State of Play"
Chaired by Colin Marshall, President and Chief Executive Officer, Cloud Peak Energy Resources LLC

- **World Energy Investment 2017**
  Mr. Laszlo Varro, Chief Economist at the IEA
- **Case Study: Progress on the Osaki CoolGen project**
  Mr. Akira Yabumoto, Director, Energy Resources Strategy, J-POWER
- **ASEAN's Energy Equation: The role of low emission coal in driving a sustainable energy future**
  Mr. Benjamin Sporton, Chief Executive Officer, World Coal Association

Discussion

"Discussion session 2: Financing Coal – The impact of Multilateral Development Banks."
Chaired by Peter Freyberg, Head of Coal Assets, Glencore Coal

- **Multilateral development bank Finance and coal power plants**
  Mr. Paul Baruya, Coal Market Analyst, IEA Clean Coal Centre
- **Japanese Bank for International Cooperation (JBIC) experience in ASEAN countries**
  Mr. Yoshimasa Ohashi, Regional Head for Europe, the Middle East, and Africa, Japanese Bank for International Cooperation
- **Roles of Export Credit Agencies, MDBs and Government Partnerships for Enhanced Clean Coal/HELE Deployment in ASEAN**
  Dr. Han Phoumin, Energy Economist, Economic Research Institute for ASEAN and East Asia, - presented on his behalf by Benjamin Sporton
- **Work Program of the Experts on Cleaner Electricity Production from Fossil Fuels (CEP) of the United Nations Economic Commission for Europe (UNECE)**
  Ms. Mucella Ersoy, Turkish Coal Enterprises (TKI) is also the Vice Chair of the CEP

Discussion

"Discussion Session 3: CCS - Global Progress"
Chaired by Mr. Glenn Kellow, President and Chief Executive Officer, Peabody Energy

- **Development Status and Learnings of the Allam Cycle**
  Rodney Allam, Partner, 8 Rivers Capital
- **CCU: Learning by Doing**
  Mr. Aniruddha Sharma, Chief Executive Officer, Carbon Clean Solutions
- **CIAB CCS paper: Recommendations to Expedite CCS Deployment and Development**
  Mr. Ken Humphreys, CCS Working Group Member

Discussion

Introduction

The discussion sessions aim to engage the IEA Secretariat, CIAB Members including consumers (particularly the electricity industry), producers and infrastructure/transportation providers, and guests, in a debate on significant issues affecting the coal industry and its role in effectively mitigating greenhouse gas emissions today and in the future. The three sessions started by defining the current position of clean coal in a post-Paris Agreement world. The second session took a look at how clean coal projects are financed across the globe and the role of international banks. The final session looks at the progress achieved CCS as a proven technology before providing clear policy recommendations from the industry as needed to deploy CCS across the world to reach the carbon abatement targets by 2040. These recommendations for global leaders in government and are based on best practices at the country level and provide policies and incentives to foster and create a pathway for large-scale capture projects and storage to be implemented within nations dependant on coal.

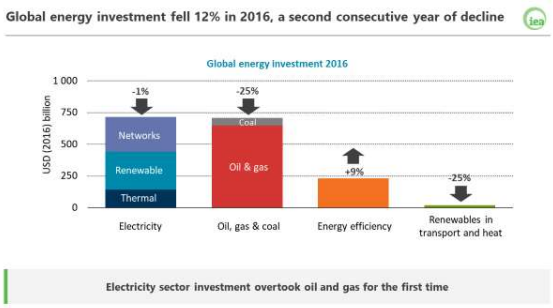
DISCUSSION SESSION 1:
The Current State of Play
Chaired by Colin Marshall, President and Chief Executive Officer, Cloud Peak Energy Resources LLC

Mr. Marshall opened the first session which looks at the changing face of coal. Market fundamentals dispel the belief that coal will vanish from the energy world in this generation, the trajectory is flat, but the fuel remains a critical source of power and energy security for many countries. The first presentation will look at the changing face of investment in the energy industry today and in the future as reported in the IEA World Energy Investment. Investment has fallen in the past two years, while it has risen for energy efficiency measures, it is down 25% for traditional fossil fuels like gas, oil, and coal. The Asian region still relies heavily on coal in many countries, CIAB Member J-Power will provide a progress report on their Osaki CoolGen project a cutting-edge clean coal plant relying on Integrated Coal Gasification Combined Cycle (IGCC) technology. The most robust growth for coal is expected in Southeast Asia, the third presentation analyses the role of low emission coal to power the energy markets and support sustainable growth in the region. The session will highlight the significant progress of clean coal technologies with the deployment of high-efficiency low emission (HELE) technologies and the rollout of carbon capture storage and utilization projects across the globe which will be crucial to meet future carbon abatement targets.

World Energy Investment 2017
Laszlo Varro, Chief Economist at the IEA

Mr Varro introduced the work being undertaken at the IEA analyzing energy investment by sector and regions across the globe, drawing on the World Energy Investment 2017 report published by the IEA in summer. While it reports on the state of play, but it does not provide an outlook on how future investment would need to be made to meet climate targets at the lowest cost.

Global energy investment has declined sharply in the past two years including --12% in 2016. The sharpest decrease was seen in the gas and oil industries where weak market conditions diminished shale fracking. This was the first time in a century, where investment in the electricity sector (networks, renewables, thermal) was higher in nominal terms than in the oil and gas sector. The costs of many technologies like LEDs and renewables declined contributing to the sharp drop in overall investment.



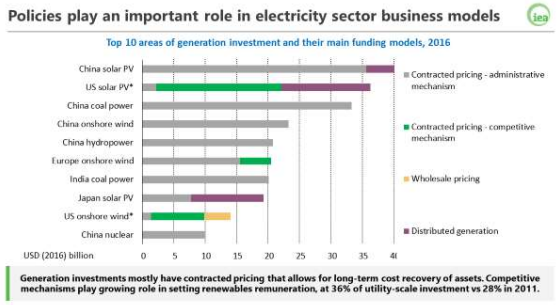
He explained that the cornerstone of investment is allowing companies to invest capital from their own balance sheets for most energy investment. Project finance makes up only 7% on project financing compared to 93% from company's individual balance sheets.

Global clean energy R&D funding will need a boost to achieve targets. Global spending topped out at $26 bn or less than the R&D budgets of the top three IT companies. He believes the most important overlooked investment segment is from private households when purchasing energy efficient appliances.

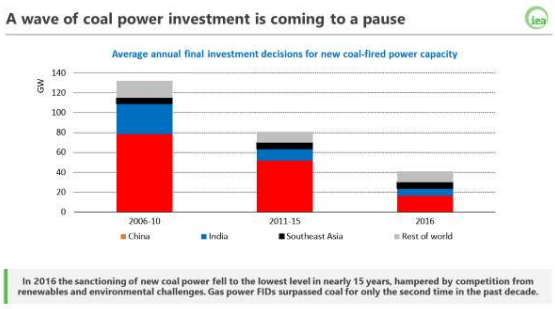
Electricity demand has stagnated in the US and Europe despite different end user prices. It appears there has been a decoupling between economic growth and power consumption since the last recession in OECD countries. For example, US GDP is +10% higher than before the financial crisis but electricity consumption remains stable. There are also energy efficiency examples in countries like India, where the country rolled out a LED light program and the purchasing of far more efficient household appliances. generators.

The cost declines are revolutionary for wind and solar and approaching the marginal cost of traditional fuel sources. The remarkable decline in prices is not just technological, but half of the decline is due to the reduced cost of capital. In many countries, renewable sources benefit from auction prices that combine technology incentives with ultra-low cost of capital. As investor confidence improves, the projects can use leverage for project financing and low interest rates is a major advantage for renewables compared to coal, gas but also emission free hydro and nuclear projects. Investors are willing to take a lower level of return to get a share of the pie. But as new low carbon investment covers only around half of the global electricity demand increase, there is a gap to be filled by fossil fuels (mainly gas and coal)

He explained that electricity storage investment will also need a boost but it depends on regulation and market design. Current mechanisms usually focus on short-term frequency regulation and demand shifting with policies hinged to reward services such as capacity, flexibility and avoided grid costs. At this point in time, batteries are not able to compensate for electricity generation due to demand peaks or volatile renewable sources leading to a bottleneck.



While coal power generation capacity is still coming online through 2017, he said since 2016 there is a collapse in coal-fired generation with few new units in the pipeline where investment decisions take 5-10 years. The slowdown is mainly occurring in China and India. Investment is at the lowest level in 15 years partly due to the increased competition from renewables.



On the flip side, investment in gas fired units remain robust with high growth in the U.S. and North Africa. Both areas have access to abundant cheap gas sources.

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The World Energy Investment report finds that policies play the most important role driving electricity sector business models. Investments with contracted pricing allow investors to capture the long-term costs of that asset.

He reviewed the investment drivers on how gas competes with coal in both China and the U.S. China faces the difficulty of securing adequate sources to low-cost import gas. In the country, around one quarter of coal is used by industry outside of steel and power generation. If China moves to LNG, this could have a significant impact on the global gas market.

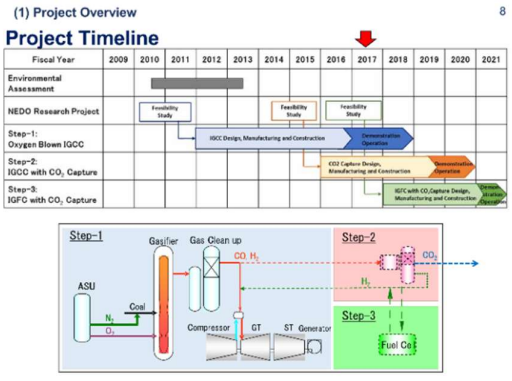
In contrast, over 2/3 of new gas production in the U.S. is sourced from cheap domestic shale gas. Market prices for gas are volatile, but the fracking can adjust short-term quickly to price signals. In the U.S. when oil prices go up, shale gas prices go down. Even in a down cycle, investments in shale positions remains fashionable and the industry thrives even during the downturn. Still, U.S. LNG faces the challenge of transport options which are expensive than either coal or pipeline gas. This is creating a lag or bottleneck of in investment for liquification capacity.

Despite the downturn in investment, he believes that gas projects like the following will succeed with policy support.

Case Study: Progress on the Osaki CoolGen project

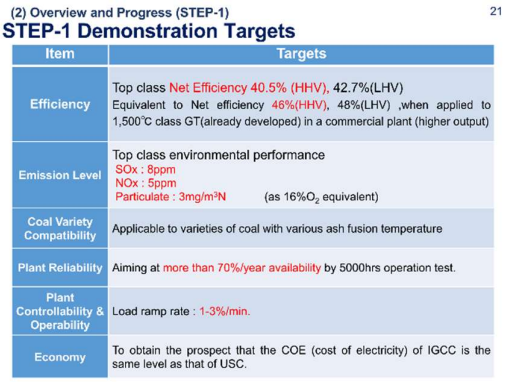
Mr. Akira Yabumoto, Director, Energy Resources Strategy, J-POWER

Mr. Yabumoto explained the background of the Osaki plant, the cornerstone of innovation in the J-POWER portfolio that will combine both cutting edges oxygen-blown integrated coal gasification combined cycle (IGCC) technology and demonstrate carbon capture in three steps. This plant is a state-of-the-art low emissions technology and a part of the company's global sustainable development program which embraces the development of high-efficiency clean coal technology. The first step was the development of the oxygen-blown IGCC plant which will be demonstrated through 2018; the second phase will add CO_2 capture to be demonstrated in 2019/2020, followed by the third step of adding fuel cells for IGFC demonstration in 2021.

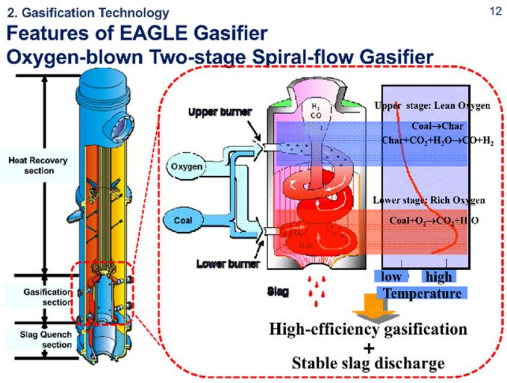


The project is being built by the OSAKI CoolGen Corporation which is jointly owned by two private sector companies: Chugoku-Electric and J-POWER, receiving significant financial support from the public sector: the Ministry of Economy, Trade and Industry (METI) and New Energy and Industrial Technology Development Organization (NEDO). He provided an overview of the Japanese energy mix which is highly dependent on imported resources for power generation. Only 6% of energy is self-sufficient within the country, so to achieve energy security, the government has chosen a strategy to embrace a “best mix” energy policy that includes coal, together with other resources.

The project’s success is dependent on achieving low emission levels, high efficiency and reliability and to deal with a wide range of coal qualities.



The Osaki plant relies on the development of the "EAGLE" gasifier which stands for energy application for gas, liquid, and electricity and can be used for both low- and high-grade coals for gasification.

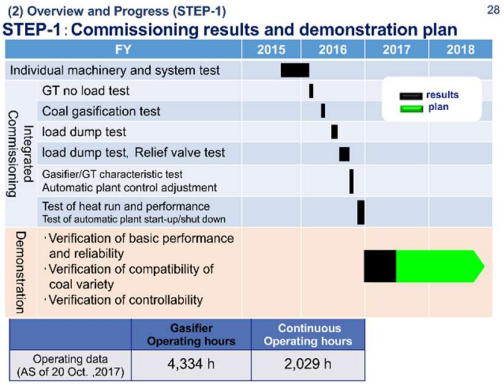


Osaki project combines the carbon capture unit with the implementation of IGCC technology to reduce emissions, but also to achieve a higher efficiency rate. This is critical to ensure that the capture process is efficient and is compatible with IGCC operation. IGCC is expected to reach an efficiency rate of 46-48% with 1500 degree C class gas turbine resulting in the reduction of CO_2 emissions by about 15% compared to existing USC plants. There are further possibilities to increase gas turbine temperature up to 1700 degrees C in the future as technology evolves.

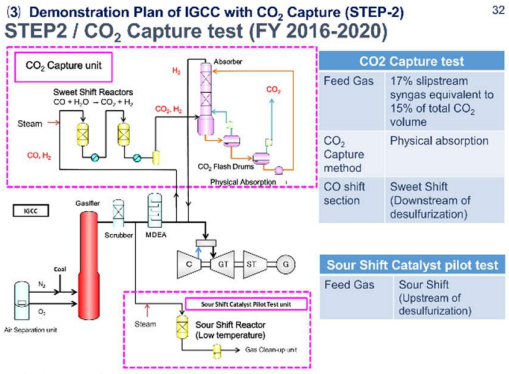
The project timeline is expected to take more than 11 years between the start of the environmental assessment from 2010-2013 and the completion

of the IGFC plant with time for demonstration and operations in 2021.

The plant began demonstration operations in March 2017, and the gasifier had operated over 4,300 hours in total and over 2,000 hours continually by October 2017.



In the next phase, the plant will be implementing carbon capture technology with a capture rate targeted at over 90% with more than 99% purity. The plant efficiency is aimed at 40% while capturing CO_2 with IGCC technology. This phase will also be conducted by Osaki Coolgen Corporation, receiving support from the government.

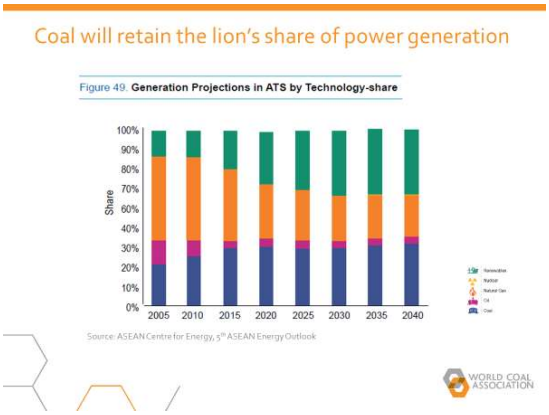


ASEAN's Energy Equation: The role of low emission coal in driving a sustainable energy future

Benjamin Sporton, Chief Executive Officer, World Coal Association (WCA)

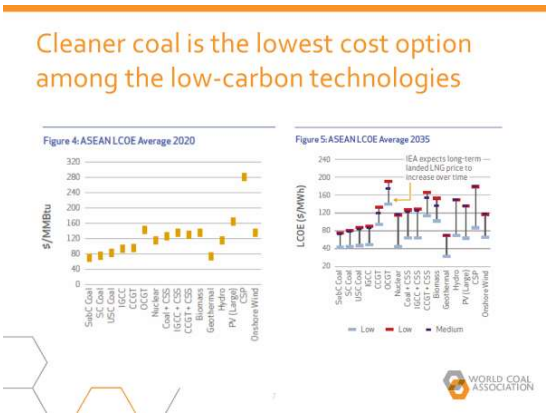
Mr. Sporton summarized the findings from the WCA report, 'ASEAN Energy Equation', a comprehensive analysis of the energy security and sustainable development opportunities that cleaner coal technologies (CCT) provide in the region. The report was done in cooperation with Charles Ripper & Associates. The report also includes energy forecasts for the Southeast Asian region from the ASEAN Centre for Energy report, "5th ASEAN Energy Outlook".

Both reports forecast that Southeast Asia will continue to grow into a global energy demand center for all fuels including coal. The future energy mix will need to rely on all fuels to solve the social, economic and environmental energy trilemma. Coal is expected to remain the primary fuel source for power generation through 2040. The ASEAN Centre for Energy expects power demand to expand by +4.6% annually. This results in the tripling of coal-fuelled power capacity in the region growing with 60 GW towards 95 GW in 2025 and 196 GW in 2040. This strong growth will dethrone gas as in the capacity mix in the region through 2040 and will be supplemented by renewable technology.

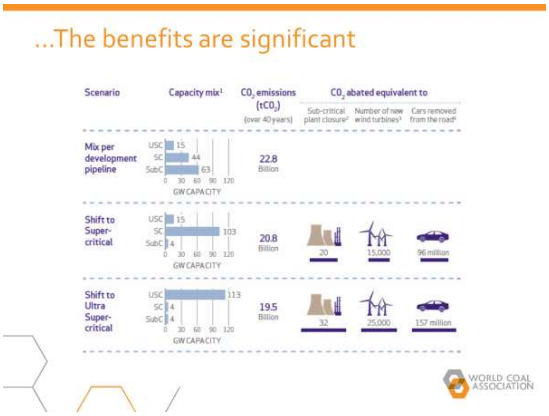


The resulting coal-fired generation is forecast to rise by 230% with an additional 472 TW of electricity generation.

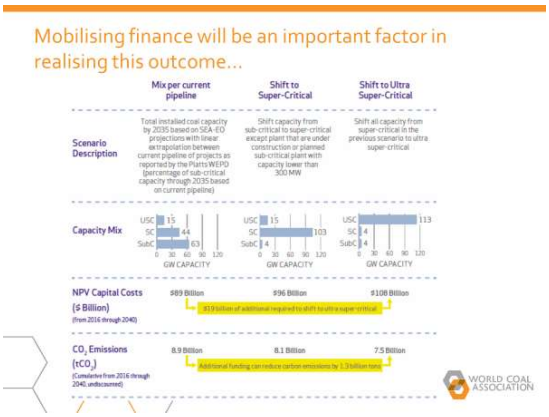
To balance coal in their energy mix, ASEAN countries have created an action plan where coal, CCT, energy efficiency and renewables energy sources are all critical pillars in the equation through 2025. Significant improvements in energy efficiency will slow demand growth in the region in a projection similar to the IEA.
As demonstrated in the graphs on this slide, the various coal-fueled power generation technologies are the lowest cost option available for mass deployment. More advanced coal technologies have a slightly higher LCOE compared to subcritical coal. However, this is due to the initial higher capital costs. After removing this initial construction component, the operating costs are primarily determined by fuel costs. Operators building more efficient cleaner plants burn less coal will have lower operating costs. Moreover, cleaner coal plants tend to have a lower fixed cost, due to higher levels of automation and less maintenance.



The implementation of more efficient coal-fired units would deliver not only cost benefits and reduce emissions at the local and global levels. For example, Shifting the region's forecast coal capacity in 2035 from the current mix to ultra-supercritical would mitigate cumulative emissions by 1.3 bn tonnes.



Despite the benefits, the challenge to deploy CCT will be mobilizing adequate financing sources. Players in the region would benefit if financing from multinational development banks. For example, Philippines is looking to work with the World Bank for project financing, and poorer countries like Myanmar are looking for concessional financing. The key priority is not just securing access to energy, but at a low cost and offering solutions with fewer emissions.



Discussion

Mr. Hans-Wilhelm Schiffer asked if the Osaki Cool Gen project was financially supported by the government or if there plans to promote further projects? ***Mr. Yabumoto*** answered that in step one, 1/3 of financing was provided by the government, but for the more challenging phase two, the government would finance 2/3 of the project. The roadmap in the report outlined is consistent with the government energy roadmap from 2016.

Mr. Julian Beere asked the emission levels of air pollutants besides GHGs for the Osaki plant compared to gas-fired units. ***Mr. Yabumoto*** said the current emission levels are on par with those of existing ultra-supercritical (USC) units. The absolute emissions are dependent on plant design. Currently, with the appropriate scrubber equipment, it is possible to achieve almost the same SO_x and NO_x levels for modern gas plants.

Mr. Mick Buffier asked if the project will also address carbon storage and how high the additional cost to the unit would be. ***Mr. Yabumoto*** answered that the project only concentrates on capture, but that J-POWER would be interested in a future storage project. The project is aiming to keep operating cost levels inclusive of capture, equivalent to USC unit achieving the same level of efficiency. He believes the most substantial challenge for future HELE and USC projects will be the availability of financing mechanisms in the private and public sector particularly for project in developing nations.

Mr. Paul Baruya noted that units with a size of 200 to 300 MW are usually a non-standard technology. In the Philippines, the country needs to construct these smaller units on the islands to improve the security of supply. He said that after his last visit, he believes that local banks have

adequate funding sources to build these smaller units without MDB funding. ***Mr. Sporton*** added that some ASEAN countries are discussing the need for an organized grid especially if they are going to be increasing the penetration level of renewables in the generation mix.

Mr. Yoshimasa Ohashi clarified that the Japanese Bank for International Cooperation (JBIC) is open to supporting the financing of coal-related projects for overseas project done in cooperation with Japanese industry.

Mr. Marshall thanked all of the Speakers for their informative presentations and for showing the positive applications for coal around the globe.

DISCUSSION SESSION 2

Financing Coal – The impact of Multilateral Development Banks
Chaired by Peter Freyberg, Head of Coal Assets, Glencore Coal

Mr. Freyberg opened the second session which takes a deeper dive into the role of financial institutions, particularly, multilateral development banks (MDB) in the financing of coal projects both on the consumer and producer side, across the globe. He said the Asian Development Bank (ADB) is financing HELE technology projects, but the number of projects on their books is limited. In July the U.S. Department of Energy (DoE) changed its policy and will now finance projects abroad that assist countries to use these fuels more efficiently. While less than 1% of total investment comes from these sources, it is significant since MDB's are symbolic for other private banks and provide seed money. He said today's sessions include three presentations all looking at the developments and financing of coal-fired projects in Asia and across the world and the ongoing work by some members of the financial sector to ensure future work with MDBs, government, and other financial partners.

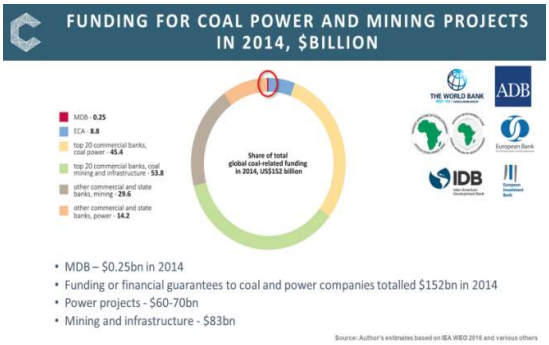
Multilateral development bank (MDB) Finance and coal power plants
Paul Baruya, Coal Market Analyst, IEA Clean Coal Centre

Mr. Baruya's presentation provided a storyboard of the work the largest MDBs undertake across the energy sector across the globe. This is based on research conducted by the IEA Clean Coal Centre (CCC) on global finance for coal power plants; this presentation focused on the policies and investments of the thirteen global and regional MDBs. The only global banks are the World Bank and the New Development Bank (earlier BRICS). The role of MDBs is similar to traditional banks by providing financial support and financial advice to customers, but the motives are different, with these investments made to support economic and social development activities in developing countries to promote sustainable development.

In addition to direct financing, MDBs provide a security blanket for risky projects and participation can ensure a multiplier effect to secure other leading finance partners to create a project finance syndicate. The MDBs are led by their Member countries, with the World Bank (WB) strongly influenced by the United States and backing the new policy in 2013 to restrict funding for coal-fired power stations.

He said recent investments by MDBs in coal-fired projects has been trending down in the past decade, but individual MDBs can provide a minimum or a significant amount of funding for the project. In 2009, the last substantial investment by the WB was made providing $3.8 of $10.8 bn to Eskom for the large Medupi project in South Africa. Recently the WB-financed $40 m out of $2 bn for the Kosovo power plant. The Asian Development Bank (ADB) has approved $0.9 and Islamic Development Bank (IDB) $0.2 of $1.8 bn in Jamshoro, Pakistan.

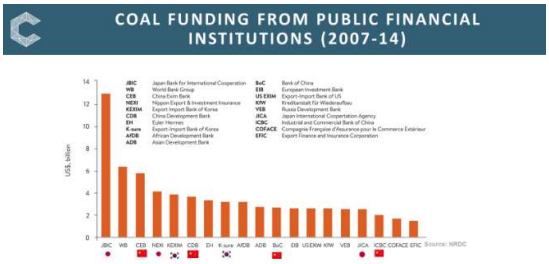
He said that the report finds that the level of MDB financing is insignificant compared to total investments of $152 bn for coal power and mining in 2014.



Instead, the gap in financing is being provided by other players like: is being done by sources: Asian credit agencies, development banks, sovereign bonds and underwriting agencies. Many countries are favoring debt with less conditional borrowing from bilateral export credit agencies or with fewer strings attached. His research shows that the banks with the most substantial total assets include: the Chinese Development Bank (CDB) and Export-Import

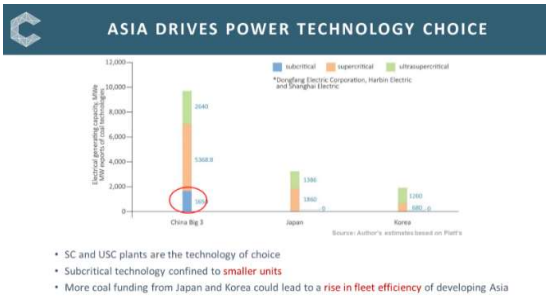
Bank of China (C-EXIM), and they have also been highly active in financing coal power projects worldwide.

Looking specifically at funding for coal projects between 2007-2014, the data shows that Asian export credit agencies and development banks account for 2/3 of the financing and underwriting of publicly financed investments. The leading source is from the Japanese Bank for International Cooperation (JBIC) the most significant source of funding.



Asian export credit agencies and development banks accounted for two thirds of the funding and underwriting from publicly financed institutions

He said that upcoming new coal-fired plants are mainly planned in Asia. Currently, there are 280 GWe under construction in 37 countries all of these plants are already committed and funded through to 2022. The majority of new coal-fired capacity is supercritical or ultra-supercritical by choice, and there is a drive towards HELE technologies in Asia. Subcritical units are the minority and confined to smaller units.



He said that MDBs typically provide financing to lower income countries such as those with an average income below $12,500. Many of these countries are in need of stable electricity support economic development like in Africa. The African Development Bank (AfDB) estimates that lack of access to reliable electricity costs the economy 1-4% of GDP per year, where a great deal of Africa is already dependent on renewable energy today.

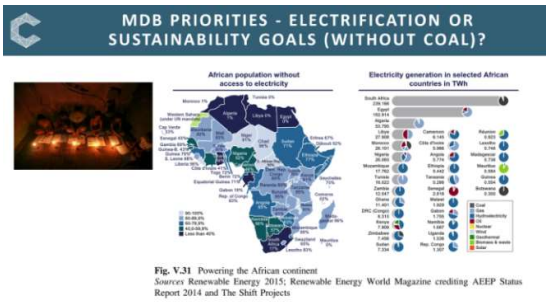


Fig. V.31 Powering the African continent
Sources Renewable Energy 2015; Renewable Energy World Magazine crediting AEEP Status Report 2014 and The Shift Projects

He reiterated that while MDB makes a small financial contribution to overall investment, their influence is by establishing lending policies for other public and commercial banks. They face a conflict in investment strategy between development goals and sustainability goals. China and Japan banks have led the stream of overseas investments in coal projects but chiefly in supporting HELE plants in the region.

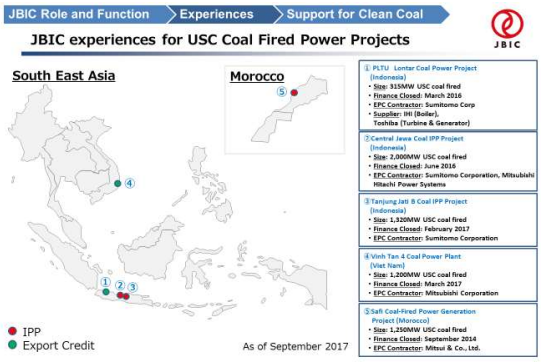
Mr. Freyberg thanked Mr. Baruya for the informative presentation on investment trends. He agrees with the findings the MDBs have stepped away but still there doesn't seem to be a lack of investment in Asian countries with Asian banks stepping up to finance these projects. He saw a graver problem for African nations and wondered if any institutions were stepping up to fill this financing gap.

JBIC experience in ASEAN countries
Yoshimasa Ohashi, Regional Head for Europe, the Middle East, and Africa, Japanese Bank for International Cooperation

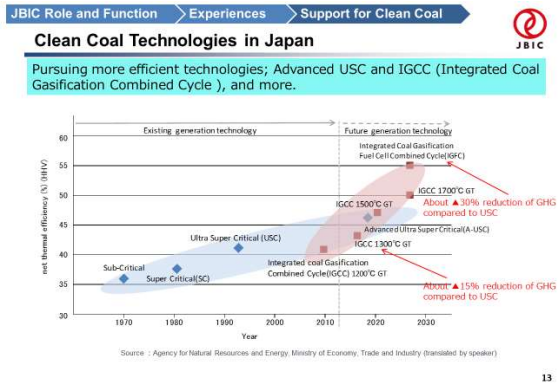
Mr. Ohashi explained that JBIC is an export credit agency which provides policy-based finance with a mission of contributing to the sound development of Japan, the international economy and society as a whole. JBIC is 100% owned by the Japanese Ministry of Finance, and the bank has sixteen global offices including three in Europe.

He said that JBIC supports commercially viable projects primarily by providing loans to overseas importers and financial institutions to finance exports of Japanese products or overseas investment loans to support Japanese foreign direct investment. Also, JBIC supports GREEN (Global action for Reconciling Economic growth and Environmental preservation) projects with a focus on environmental conservation.

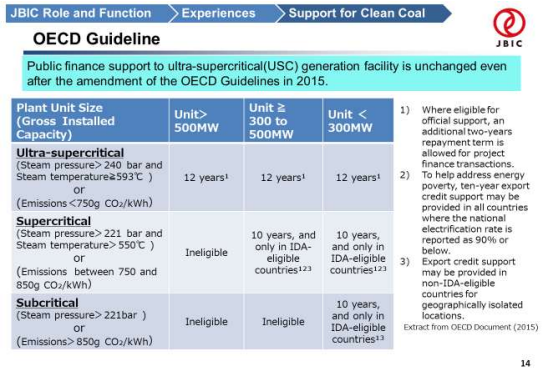
JBIC actively support clean coal projects and initiatives. A recent project was for a 2x 1,000MW ultra-supercritical (USC) coal-fired IPP project in Central Java in Indonesia, a first of a kind in the country. The bank is also providing Vietnam Electricity (EVN) with funding for the 600 MW Vinh Tan 4 unit, the first coal-fired USC plant in Vietnam. The facility is being constructed by Mitsubishi Corporation as the EPC contactor. In addition to financing HELE technologies, JBIC has provided funding to the NGR Energy/JX CCS project with EOR since July 2014.



Mr. Ohashi said that many European banks had taken the stance to withhold finance from coal projects rejecting the role of coal as a primary source for stable power generation with transparent availability at a stable cost. The JBIC strategy on clean coal technology focuses on supporting economic growth via electricity and to continuously support USC and EOR projects and to prepare for the next generation technologies like IGCC and IGFC. The bank is needed to support further innovation and R&D of Japanese industry. This strategy aligns with the policy of the Japanese government to support 3E+S (Economy, Energy Security, Environment and Safety). Examples of support are as a "partner for quality infrastructure" since 2015 and co-funding the "Cool Gen" program to achieve further efficiencies with IGCC and CCS. The country is a global leader in the development of IGCC technology with two pilots underway (Osaki CoolGen plant and the NAKOSO plant**)** and plans to push for future commercialization in Japan.



He gave an overview of OECD guidelines for public financial support of USC generation facilities which were amended in 2015. The criteria are a function of the installed capacity of the unit and the technology which are based on the size of unit and the chosen technology (USC or Supercritical or Subcritical).



He concluded by reiterating JBIC's plans to continue to support clean coal technology in the future as well as renewable and energy efficiency projects. It is in the interest to consider the best mix of technologies for an individual country and the interests of Japanese suppliers.

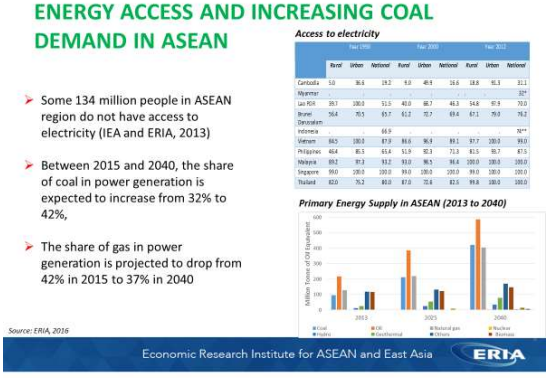
Mr. Freyberg thanked Mr. Ohashi and the JBIC team for joining the Plenary meeting and for being a pragmatic partner by creating financial opportunities for industry and opening the pathway for clean coal in other countries.

Roles of Export Credit Agencies, MDBs and Government Partnerships for Enhanced Clean Coal/HELE Deployment in ASEAN
Dr. Han Phoumin, Energy Economist, Economic Research Institute for ASEAN and East Asia (ERIA)

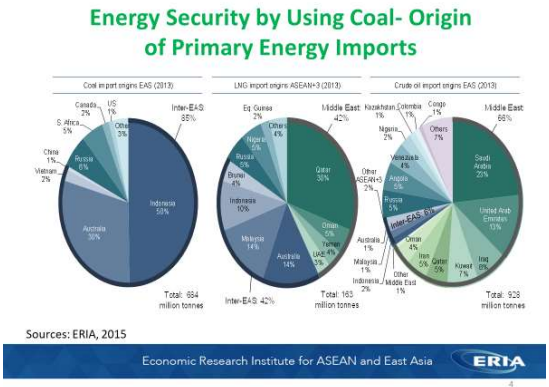
Mr. Sporton gave the presentation on behalf of Dr. Han Phoumin of the Economic Research Institute for ASEAN and East Asia (ERIA), whom due to a travel conflict is unable to attend the Plenary meeting. ERIA is an international organization which was established in 2007 by an agreement between sixteen heads of government in the region. It collaborates "closely with the ASEAN Secretariat, researchers and research institutes from East Asia to provide intellectual and analytical research and policy recommendations" and to build capacities to strengthen policy research.

Mr. Sporton said that the WCA works with the ERIA and the ASEAN Centre for Energy (ACE) to understand coal industry regional trends and to build a long-term partnership to promote clean coal technology in the region.

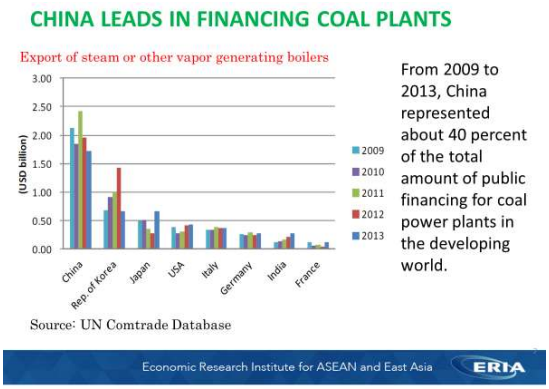
A key finding in ERIA's research is that the ASEAN region will remain heavily dependent on coal to meet robust demand growth for the next several decades. Coal is an abundant and economically viable fuel source compared to gas that offers energy security for many nations. Ideally, MDBs, policymakers, government and industry would work together to form partnerships to use coal more cleanly in these emerging Asia.



The need for power is immense with approx. 134 mn people in the region without access to electricity. Coal dominance in developing countries is often attributed to the fact that it is reliable, abundant, and affordable. The analysis forecasts that the share of gas in power generation will fall from 42% to 37% in favor of coal by 2040. When viewing fuel imports, coal is often seen as the more secure source usually stemming from Indonesia and Australia compared to LNG sources on riskier transport routes.



In the past, coal-fired power plants OECD countries were financed through official export credit agencies and MDBs. During President Obama's administration, there was a call in the Climate Action Plan to restrict financing for new coal-fired capacity at by MDBs led by OECD countries like the WB. This has implications for other regional banks like the ADB and local banks which uses the WB credit policies as guidance. The work of ERIA shows that China is bridging this gap and providing the bulk of financing for coal plants and providing a market for Chinese boiler and turbine manufacturers. Japan also has a keen interest in clean coal technologies and supports the deployment of high technological standards across the globe.



The deployment of HELE technologies face challenges in some countries plans for new coal-fired units. The lack of financing options could encourage countries to choose the cheaper less efficient technological option. The higher upfront costs could be a significant obstacle for developers and suppliers for HELE and ultra-supercritical technology for CPPs.

In his presentation, ***Dr. Phomin*** provided a policy framework which could be deployed to support cleaner more efficient coal plants across the region. The equation is multivariate and includes innovative financing with flexible standards, clear

environmental regulations, and methods to mitigate risk and encourage investment in a Clean Environment Fund.

Work Program of the Experts on Cleaner Electricity Production from Fossil Fuels (CEP) of the United Nations Economic Commission for Europe (UNECE)
Ms. Mucella Ersoy, Turkish Coal Enterprises (TKI) is also the Vice Chair of the CEP

Ms. Ersoy reported on the 2018/19 work program of the Group of Experts on Cleaner Electricity Production from Fossil Fuels (CEP) which falls under the United Nations Economic Commission for Europe presented at the meeting the previous week. She would like to explore the option of potential cooperation and synergies between this group and the CIAB for overarching work. The mission of this expert group is to share best practices in cleaner electricity production from fossil fuels, CCS as well as CCUS, EOR with CO_2.

She said that the Expert Group was considering eight topics for their 2018-2019 work plan. The issues under consideration include four extensions of current work as well as four new areas for new analysis.

She explained that the principles for financing clean fossil fuel projects and deployment of cleaner coal technologies pose some challenges for policymakers. Investment criteria must focus on emissions and efficiency performance for all technologies which do not pose a burden to a particular industry or a country.

The UNECE engages with the coal industry to facilitate dialogue between industry, government, and financial institutions. This work encourages the deployment of HELE technologies in developing countries but also seeks more detailed solutions by providing recommendations directed at financial institutions. The UNECE recommendations for the plant operators in the coal industry recognize the need for net reduction of carbon emissions and net social benefit of replacing inefficient operations including biomass.

Ms. Ersoy asked if there were volunteers from the CIAB industrial experts who would like to peer review future research. ***Mr. Freyberg*** encouraged volunteers and said that this could provide an option to consider for the upcoming work programme.

Ms. Ersoy said that UNECE represents member States, the coal and financial industries, operational experts as well as academia, whom all work together to formulate recommendations and develop best practices. The Expert Group engages with the WCA. The recommendations were distributed at the COP-23 meeting in Bonn. ***Mr. Freyberg*** thanked Ms. Ersoy for her work and said that he hopes that governments are listening to the recommendations of this Group. ***Mr. Fernando Zancan*** added that this is a UN approach and that in the previous year the Group had presented a paper on CCS. There is a voice and next Monday, they will present to COP23 attendees.

Mr. Freyberg thanked all four speakers for the informative presentations and examples of engagement in support of clean coal across regions. The industry has seen the decline in the consumption of coal in some developed countries in Europe and the United States as well as investment levels for new projects in developing nations. The presentations today show how the gap has been filled by development banks and credit agencies in Asia as well as other channels. He emphasized the point that there are still a billion people who are energy poor lacking access to power and clean cooking facilities, who still await the opportunity to benefit from the availability of reliable a reliable energy source.

Discussion:

Mr. Beere asked what the impact could potentially be if Western banks would if they changed their investment guidelines. ***Mr. Sporton*** said that in an event in May, General Electric reported a return of the global MDBs would have a substantial impact. He asked whether regional banks also provide the other benefits of expertise of commercial banking since commercial Western banks are trimming their knowledge and refocusing on renewables. ***Mr. Baruya*** cannot comment on MDB policy and strategy, but he feels the direct import/export have even more competence dealing directly with their equipment manufacturers streamlining the process and lowering overall costs.

Mr. Fernández noted that it was challenging to quantify total investments since many Chinese banks lack transparent reporting on investments like JBIC. He warned that due to this lack of transparency some conclusions might be misleading. ***Mr. Baruya*** answered that all data analyzed is sourced from public information sources like Platts or banking reports so there could be some discrepancies.

Mr. Greg Evans asked for detail on the position of state development banks ***Mr. Baruya*** answered that the Chinese state banks are solid and are currently underwriting projects in Eastern Europe and Greece. There is often the misconception that they undercut offering cheap financing, but from his experience, Chinese commercial banks are providing market interest rates banks with good performance and projects currently funded making a profit. He said there are plans to create an updated investment report on China which will take a closer look at what would happen if there is a debt crisis

Mr. Thava Govender said that in South Africa they have to close five coal-fired plants due to overcapacity. In response, they have asked the African Development Bank to invest in the infrastructure, so South Africa can provide 8,000 to 10,000 MW of generation capacity to neighboring countries since it is inefficient to construct additional new plants.

Mr. Buffier asked what criteria JBIC uses to evaluate projects like the Osaki CoolGen which are not yet commercially feasible. He inquired whether these projects are funded on behalf of the Japanese government since they would not be likely to receive wholesale funding from traditional sources. ***Mr. Ohashi*** said JBIC usually only support commercially viable projects, but for this example, the bank could ask the partner or government for a guarantee. The path is dependent on the project, and a solution is found on a case-by-case basis using mediation.

Mr. Beere also thanked JBIC for the bank's pragmatism and for also establishing new standards for these projects. He asked if he saw an impact if other MDBs would start financing these projects. ***Mr. Ohashi*** answered that distant past JBIC had worked in tandem with the Asian Development Bank (ADB) and World Bank (WB), there if the project does not have a Japanese recipient or beneficiary, JBIC has no justification to be involved.

Mr. Ohashi said that JBIC was not approached by Pakistan for financing, but the bank has funded hydropower plants in the country in the past.

Mr. Carlos Fernández commented on the financing of the project in Pakistan. The nation has faced a severe financial crisis, and the Asian Development Bank decided to finance a very controversial 1.2 GW coal power plant (Jamshoro). But this plant is struggling to go ahead, and in the meantime, financed and built by Chinese organisations, around 8 GW are under development. ***Mr. Bob Gentiles*** said this shows the pragmatism of Chinese institutions.

DISCUSSION SESSION 3
CCS - Global Progress

Chaired by Glenn Kellow, President and Chief Executive Officer, Peabody Energy

Opening the last discussion session, ***Mr. Kellow*** turned the focus of the meeting in the previous discussion session to promote success stories and applications of CCS. He reported that clean coal technologies and advances made in CCS are not widely reported in the market and media. In this session, he said we would hear directly from Mr. Allam, an inventor of a critical technology component for CCS to expand in the utility sector, from Mr. Sharma, who will give an overview of steps forward being taken to ensure carbon solutions for smaller scale projects. The conclusion will be presented by Mr. Ken Humphreys, a senior expert in CCS and the former CEO of the FutureGen project. Mr. Humphreys spearheaded the CIAB working group which drafted a series of recommendations at the country level that should be undertaken to provide support CCS deployment in regions and across the globe. This was done in conjunction with a large group made up of CIAB Associates and experts across the world.

Development Status and Learnings of the Allam Cycle

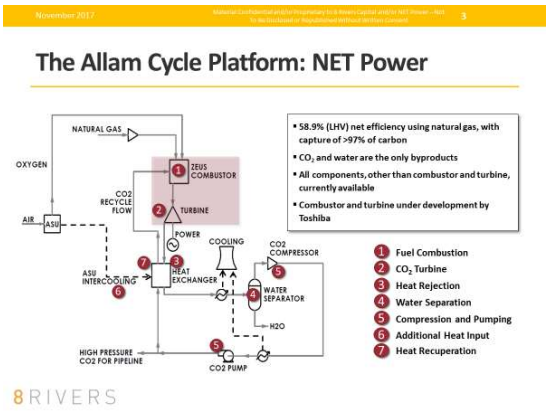
Rodney Allam, Partner, 8 Rivers Capital

Mr. Allam said his drive to invent a new technology was driven by the realization that CCS costs for gas and coal plants would need to fall significantly to be on par with other forms of generation capacity and for large-scale deployment. He reached this conclusion while working on an oxy-fuel plant engineering study with carbon capture in the 1970's and 1980's. This was confirmed by the first Intergovernmental Panel on Climate Change (IPCC) report published in 2003 that found that this technology was estimated at between 50 and 80% higher than traditional electricity generation costs.

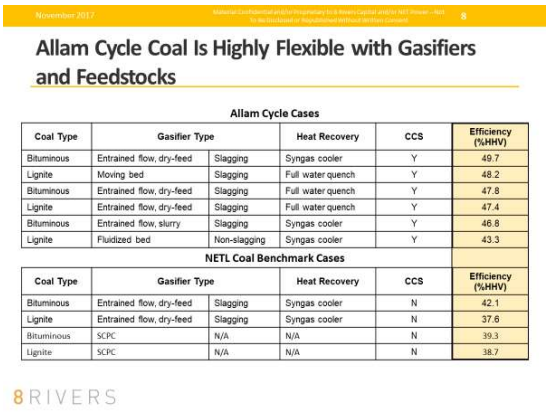
As a result, he invented the Allam Cycle, a semi-closed supercritical CO_2 Brayton cycle which utilizes CO_2 as the working fluid with natural gas,

gasified coal and other carbonaceous fuels. This oxy-combustion technology improves operational costs by creating a more efficient core power system and reducing heat from the system to reduce O_2 and fuel requirements.

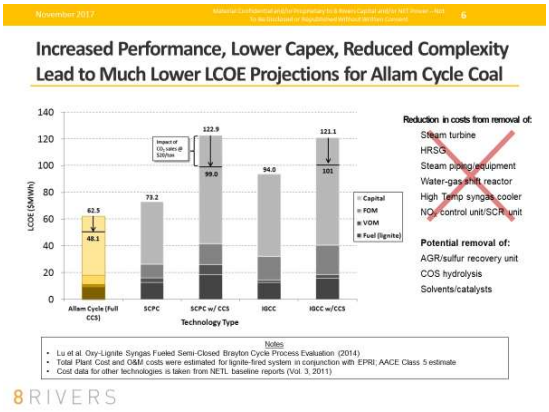
He presented on the progress of NET Power, a company that is commercial the use of the Allam Cycle with natural gas, on a 50MWth demonstration plant being built in Texas. The plant design was scaled down from a 300MWe commercial design. When fuelled by natural gas, the Allam Cycle is capable of achieving an efficiency of 58.9% (LHV) while capturing greater than 97% of the carbon dioxide produced. NET Power's demonstration plant was undergoing commissioning as of late 2017.



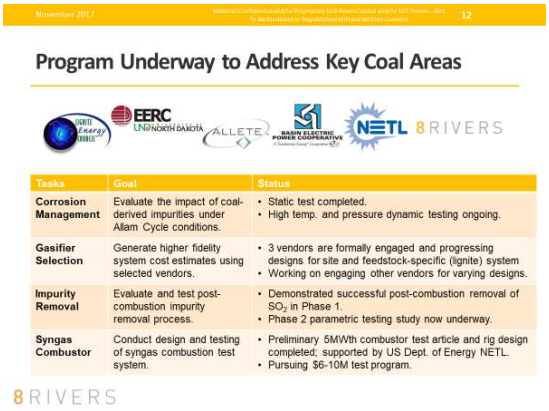
The NET Power project runs with gas, but ***Mr. Allam*** explained that the Allam Cycle could utilize syngas from any quality of coal. He reminded the round that low emissions are not limited to just CO_2, SOX, NOX, H_g, and particulates are also significant pollutants that the Allam Cycle does not emit. The Allam cycle is far simpler than IGCC technology utilizing less space for the site, less water during operations and does not require syngas coolers or additional SCR.



Mr. Allam explained the technological reasons for the lower cost projections using Allam Cycle technology which can also in principle function with coal. He said this technology would increase performance and availability at a lower cost of capital. He estimated that the Allam Cycle has a levelized cost of energy (LCOE) between $48-$63/MWh or similar to levels for an ultra-supercritical unit. He said these costs levels could be improved having a paying recipient for the CO_2 emissions. A further advantage is the elimination of the acid gas removal systems which would lead to additional significant cost savings.



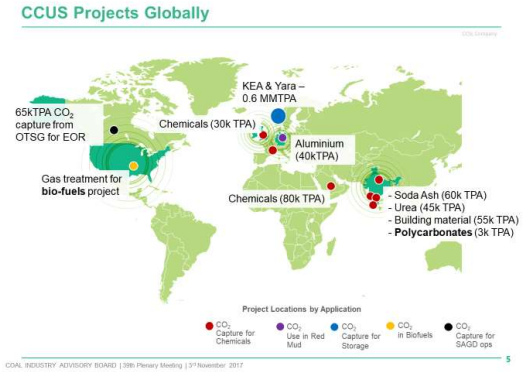
8 Rivers's invention in cooperation with other national and global partners is also being used to address key problems in the coal industry across the world.



Mr. Allam closed the session by noting that the core system would be validated by NET Power's demonstration project and there is currently a program underway to address the key coal aspects. The goal is to complete additional pilot- and commercial-scale demonstrations in the near future.

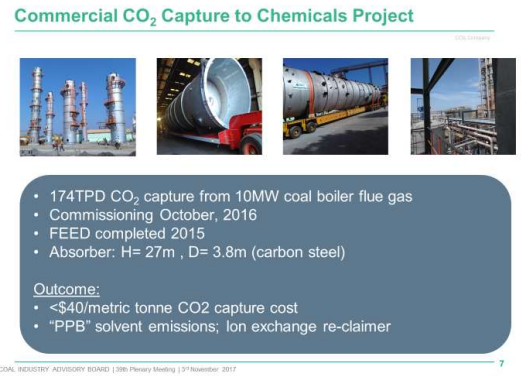
CCU: Learning by Doing
Aniruddha Sharma, Chief Executive Officer, Carbon Clean Solutions

Mr. Sharma started by explaining the work, project list and product palette of Carbon Clean Solutions (CCSL). The company was launched in 2009 and initially funded by the British Government and U.S. Department of Energy. The company offers design license and patented solvent and services. Their business model is to decarbonize coal in a manner that is both sustainable and affordable and matches industrial CO_2 emitters with consumers from industries like chemical and oil/gas.

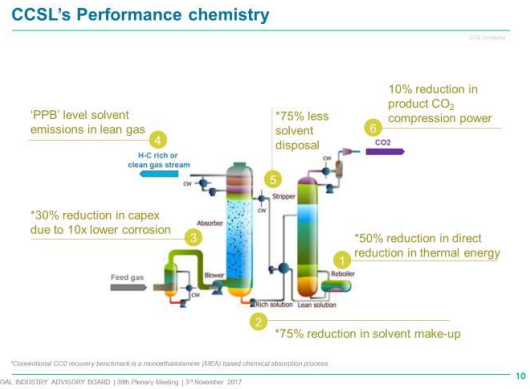


In 2017, CCS is currently working on a number of industrial CO_2 projects across the globe. Ongoing projects can be found in Canada, India, Saudi Arabia, four projects in Europe and a biofuels project in North America.

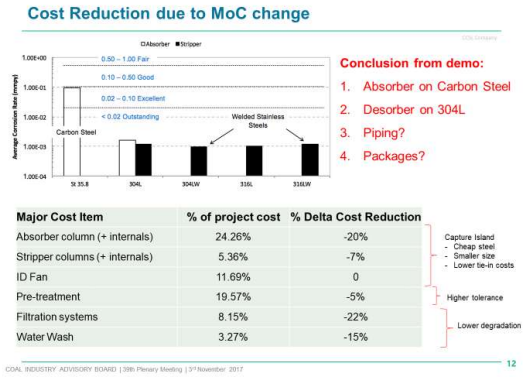
Mr. Sharma believes that coal will stay in the energy market and will be led by growth in India where they have an office and four projects underway to capture CO_2 in chemical processes. At the end of October, an MOU was signed for 2,000 MW of new coal-fired capacity in the country. CCSL launched a demonstration plant in India that was completed in nine months and launched in October 2016. The commercial capture sits atop of a 10 MW boiler and is an industrial application. The project utilized carbon steel and new chemical solvents to avoid corrosion of the equipment. He said the costs of operating the project is near $32/tonne.



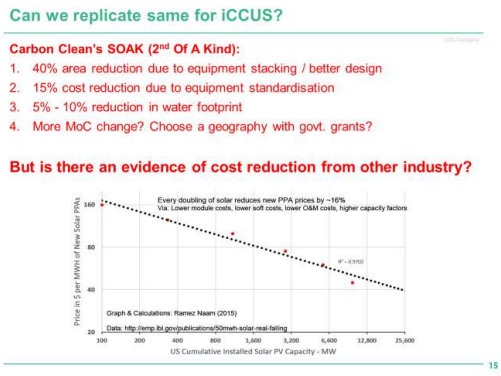
For customers to pursue carbon capture, there is the necessity to bring down costs to a level where there is an incentive to switch or below the customer's alternative commodity. CCSL utilizes two-step CCS process which firsts cleans up the soot, and then SO_x removal since flue gas desulphurization (FGD) isn't always a standard in all countries. He said that adding this to a project would increase CAPEX projects by approximately 20%.



To encourage carbon capture, it is critical to lowering both capital expenditures and operating expenses for the site. He gave an analysis of factors driving capital and operating expenses in a recent demonstration. By adjusting materials to carbon steel savings of up to 30% in capital expenses and combined with an improved chemical process up to 50% in operating expenses could be reached. Their approach includes changing the feedstock to impact emissions, not including in acid or multiple stage wash processes, and reducing water consumption.



He said that CCSL had very positive results from their demonstration plants. The firm is now concentrating on how to move from the high-cost first-of-a-kind (FOAK) to successfully deploy many more units by standardizing and replicating technology and plant design reducing costs. Third/fourth demonstration projects are currently being negotiated.



Mr. Sharma turned the focus back to India where he sees significant market potential in existing and new plants for carbon capture, and there is momentum, but that CO_2 capture costs are grossly misunderstood. He said that clean energy incentives are not currently aligned in support of CCU/CCS and education of policymakers and the public on costs and decarbonization options will be needed to achieve the same standards as renewables.

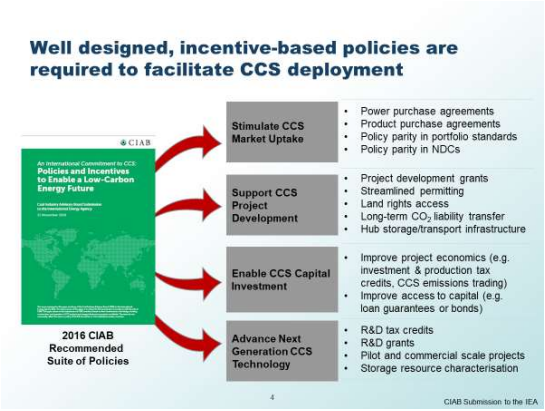
CIAB CCS paper: Recommendations to Expedite CCS Deployment and Development
Ken Humphreys, CCS Working Group Member

Mr. Humphreys first thanked all of those who contributed to the CIAB paper including Associates, Members and experts from across the globe. He invited Plenary participants to be active and repeat these messages and recommendations engaging industry partners and policymakers.

He said the underlying assumptions in this paper remain true to the 2016 CIAB work. We firmly believe that the goals of the 2 Degree Scenario (2DS) can't be met without the deployment of CCS on a large scale globally and the technology is a key to achieve these objectives at the lowest cost. To be successful, this needs to be based on a model of international cooperation that provides incentives but not punitive mandates and in a partnership with government and industry.

Government needs to put policies in place that create an environment conducive for the public and private sectors to finance and provide investment. This environment supports innovation, and to learn by doing, which reduces costs and commercial risks. He warned policymakers that the right investing environment offering clear financial returns to bring industry to the table to unlock the billions needed in investment capital.

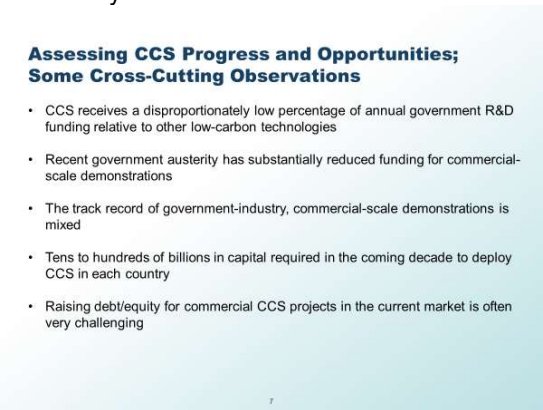
Building upon results from the IPCC report, it is estimated that the cost of reaching 2DS goals without the use of CCS would increase by 3% of total GDP through the end of the century adding tens of trillions of unnecessary costs. He said an approach without CCS is not affordable does not provide a pragmatic path for governments. He gave a summary of the catalogue of policies and incentives that all governments need to consider as published by the CIAB in 2016.



Mr. Humphreys reported the new publication builds off these messages but drills down into an action item list for four countries, where some apply across all regions and others are country specific. The world faces a conundrum with a stalled project pipeline but where there is a reasonable consensus that the world must move to a low-carbon energy future and governments have committed to ambitious emission reduction goals. There is a disjoint in the current policies and the level of financial support from

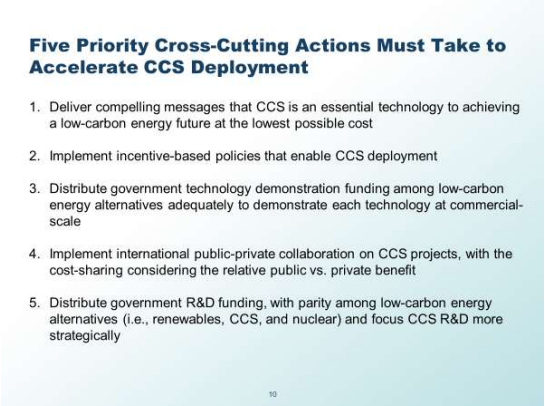
government and industry and commitment to expedite CCS deployment. He reminded the forum that all actions need to be enacted aggressively to jumpstart CCS deployment, but he warned that even this doesn't provide a complete solution but a starting point.

He reported on the challenging status of CCS technology in many countries across the globe with mixed results in large-scale pilot projects reduced funding and support from the investment community.



Still, there is positive work underway across the globe.

He proposed five central actions that must be taken to enable a path forward for widespread CCS deployment across the globe and within the timelines of the Paris Agreement. The overarching requirement is to create a government/industry partnership that ensures an international commitment to CCS. Actions that support this commitment need to deliver clear messages about CCS technology, provide funding on par with other low-carbon alternatives and build public-private collaboration across sectors and borders.



Mr. Humphrey then turned to the country-specific policy actions recommendations.

<u>1. Australia</u>

The country was an early leader in CCS with a number of successful projects online and the world's largest coal exporter.

<u>2. China</u>

As the country with an expanding energy market and a high level of CO_2 emissions, China is seen as a leader in carbon mitigation globally and has a strong governmental commitment.

3. The United Kingdom

The UK has cut back its financial support for CCS, but still provides a benchmark CCS strategy that encapsulates legislation for transport and storage infrastructure.

4. The United States

The U.S. has left the Paris Agreement, but there is still a high level of support for CCs project development and several large-scale CCS pilot plants underway that can serve as a basis for next-generation plants.

Mr. Humphreys reminded attendees that for CCS deployment to become a reality, there will need to be an international commitment and support from public and private partnerships. CCS technology is proven, and as demonstrated by the presentations given by Mr. Sharma and Mr. Allam, these costs are expected to fall as it provides an alternative to other industries beyond generation as a means to reduce carbon emissions.

Mr. Kellow thanked all speakers for their excellent presentations. He enjoyed this final session with the opportunity to see new technologies and potential game changers. ***Mr. Kellow*** said that FOAK projects provide an invaluable information base for CCS and to demonstrate the advantages and to lower costs. He has visited the Petro Nova CCS project which has saved 1 mn tpa. He asked what actions governments were taken to jump start CCS projects, but the recommendations only provide a starting point for the four countries that can only later be broadened globally.

DISCUSSION

Mr. Gentile asked whether the Net Power project has government support or funding (like from the Department of Energy). ***Mr. Allam*** answered that there was no government funding for construction and this was limited to a very limited amount sourced from the British government to optimize the selection of materials at the start of the project. The private partners of the Net Power project like Exelon and 8 Rivers are funding sources.

Mr. Juho Lipponen thanked the CIAB for the new report and recommendations and said he concurs with the findings. He said that the primary concern is the slow growth in the project pipeline which are drying up. He sees that this is a policy issue that needs to be solved. He found the two presentations today inspiring and presented game changing technologies available at reduced costs.

IEA research has identified bottlenecks in investment and coordination of infrastructure. He said that it may be more efficient for the government lead to plan and construct common transportation and infrastructure and leave private industry to develop individual projects. He said the IEA is working diligently to promote the message of the need and criticality of CCS.

Mr. French asked if Mr. Allam could provide further information on the timescales and costs for the NET Power project. ***Mr. Allam*** answered that the pilot is in a test run with about 7,000 hours planned to demonstrate to industry the full flexibility of the system. Once this is completed, 8 Rivers Capital plan to operate the 50 MW plant as

a natural gas plant for a limited time and the company plans to have a coal version by 2021.

Mr. Varro warned high capital costs are killing projects in the pipeline. Further cost reductions for construction and materials are needed to increase the number of new projects under development.

Annex – Plenary Meeting Participants

CIAB Members

Mr	Peter	Freyberg	Head of Global Coal Assets, Glencore	Australia
Mr	Jeyakumar	Janakaraj	Chief Executive Officer, Adani	Australia
Mr	James	Palmer	Asset President BMC & MAC, BHP Billiton	Australia
Mr	Fernando	Zancan	President, Brazil Coal Association	Brazil
Mr	Li	Dong	Vice President, Shenhua Group	China
Mr	Roberto	Junguito	President, Cerrejon	Colombia
Mr	Andrea	Clavarino	Chairman of the Board of Management, Coeclerici Logistics S.p.A	Italy
Mr	Eiji	Hagiwara	Executive Officer and General Manager, Coal Business Department, Idemitsu Kosan Co.,Ltd.	Japan
Mr	Sunao	Nakamura	Senior Executive Vice President, JERA Co., Inc.	Japan
Mr	Yoshihiko	Sakanashi	Senior Counselor, J-POWER	Japan
Mr	Thava	Govender	Group Executive: Transmission & Sustainability, Eskom Holdings SOC Ltd.	South Africa
Mr	Seamus	French	Chief Executive Officer, Bulk Commodities & Other Minerals, Anglo American	UK
Mr	Benjamin	Sporton	Chief Executive Officer, World Coal Association	UK
Mr	Bob	Gentile	President and CEO, Leonardo Technologies	USA
Mr	Glenn	Kellow	President and Chief Executive Officer, Peabody Energy	USA
Mr	Colin	Marshall	President and Chief Executive Officer, Cloud Peak Energy Resources LLC	USA
Mr	Peter	Salditt	Head of Underground Mining, Komatsu Mining Corporation	USA
Mr	Alan	Shaw	Executive Vice President and Chief Marketing Officer, Norfolk Southern Corporation	USA

CIAB Associates:

Mr	Mick	Buffier	Group Executive - Coal Assets, Glencore	Australia
Mr	Rajesh	Gupta	Head of Finance and Company Secretary, Adani	Australia
Dr	Graham	Winkelman	Senior Manager Environment, BHP Billiton	Australia
Mr	Zhang	Zifei	Vice President, China Shenhua Energy Company	China
Mr	Howard	Gatiss	Commercial Vice President, Cerrejon	Colombia
Dr	Richard	Busby	Head of HSE Solutions, Uniper	Germany
Mr	Roland	Luebke	Economic Affairs, Steag	Germany
Dr	Hans-Wilhelms	Schiffer	Advisor to the RWE Executive Board, RWE	Germany
Mr	Shintaro	Sawa	Senior Chief Associate, Coal Business Department, J-POWER	Japan
Mr	Toshiro	Shibihara	Senior Chief Associate, Coal Business Department, Idemitsu Kosan Co.,Ltd.	Japan
Mr	Akira	Yabumoto	Director, Energy Resources Strategy, J-POWER	Japan

Mr	Hideki	Yukimura	General Manager, Coal & Oil Unit, Fuel Transaction Group, JERA Co., Inc.	Japan
Mr	Marcin	Kapkowski	Vice President of the Management Board LW Bogdanka S.A., Lubelski Wegiel "Bogdanka" S.A, Poland	Poland
Mr	Gina	Downes	Corporate Consultant: Environmental Economics, Climate Change and Sustainable Development Department, Group Sustainability, Eskom	South Africa
Mr	Mucella	Ersoy	Chief Engineer, Project Planning Department, Turkish Coal Enterprises (TKI)	Turkey
Mr	Julian	Beere	Executive Head of Strategy, Business Development and Infrastructure, Coal, Anglo American	UK
Mr	Cristina	Bruce	International Relations Principal, Anglo American	UK
Mr	Liam	McHugh	Policy Advisory, World Coal Association	UK
Mr	Michael	Flannigan	SVP, Global Government Affairs, Peabody Energy	USA
Mr	David	Lawson	Vice President, Coal, Norfolk Southern Corporation	USA
Mr	Richard	Reavey	Vice President Public Affairs, Cloud Peak Energy Resources LLC	USA
Mr	Skip	Stephens	Washington Representative, Komatsu Mining Corporation	USA

CIAB Speakers & Guests:

Mr	Greg	Evans	Executive Director – Coal/ Chief Executive (COAL21), Minerals Council of Australia	Australia
Mr	Brian	Ricketts	Secretary-General, Euracoal	Belgium
Mr	Yang	Jiachun	Assistant to Vice President, Shenhua Group	China
Mr	Liam	Jingfeng	Manager, Science & Technology Dept., Shenhua Group	China
Mr	Li	Song	Deputy GM, International Dept., Shenhua Group	China
Mr	Serge	Perineau	Chairman, CTX	France
Ms	Maggi	Rademacher	Executive Coordinator, CIAB	Germany
Mr	Kazushige	Gobe	Chief Representative of Paris office, Japanese Bank for International Cooperation	Japan
Mr	Hiroki	Kaku	Deputy Director, New Energy and Power Finance Department II, Japanese Bank for International Cooperation	Japan
Mr	Yoshimsa	Ohashi	Regional Head for Europe, the Middle East and Africa, Japanese Bank for International Cooperation	Japan
Mr	Ryuta	Suzuki	Director, New Energy and Power Finance Department II, Infrastructure and Environment Finance Group, Japanese Bank for International Cooperation	Japan
Mr	Margarita	Agapidou	Regional Manager, Western Europe, CRU	UK
Mr	Paul	Baruya	Coal Market Analyst, IEA Clean Coal Centre	UK
Mr	Rebecca	Gordon	Head of Energy and Technology Metals, CRU Consulting	UK
Mr	Adam	Parums	Senior Coal Analyst, CRU	UK
Mr	Aniruddha	Sharma	Chief Executive Office, Carbon Clean Solutions	UK
Mr	Rodney	Allam	Partner, 8 Rivers	USA

Mr	Ken	Humphreys	CCS Expert, CIAB	USA

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Mr	Juho	Lipponen	Head of CCS Unit, IEA	France
Mr	Samantha	McCulloch	Energy Analyst - CCS Unit, IEA	France
Mr	Keisuke	Sadamori	Director, Energy Markets and Security, IEA	France
Mr	Paul	Simons	Deputy Executive Director, IEA	France
Dr	Johannes	Trueby	Energy Analyst - World Energy Outlook, IEA	France
Mr	László	Varró	Chief Economist, IEA	France

**participated by video*

Coal Industry Advisory Board
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