IEA CLEAN COAL CENTRE

ANNUAL REVIEW

2020

THE **GLOBAL RESOURCE** ON THE
CLEAN USE OF **COAL**

IEA
CLEAN COAL CENTRE

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MESSAGE FROM THE GENERAL MANAGER

Welcome to the 2020 Annual Review of the IEA Clean Coal Centre.

This has been a challenging year with the COVID-19 pandemic having a major adverse global impact on much of our work programme. We closed our office in London during March last year and have no plans to reopen it given the ongoing health concerns. All staff now work from home and virtual contact rather than actual face to face contact is now the norm, both for internal discussions and for our international activities.

Consequently our 2020 programme evolved and included:

Assessment studies for the sustainable use of coal in a carbon constrained world, which represent the core activity. Output of each study includes a comprehensive but succinct report and a separate policy relevant executive summary. We now provide a Mandarin version of the summary, which is distributed by the Beijing Research Institute of Coal Chemistry. The output of these studies has increased during 2020, reflecting the refocus of our overall work programme. We have focused a significant level of effort on India, recognising its position as the second largest coal user after China, including work that has been supported by the IEA Coal Industry Advisory Board. This comprises an in depth study to establish a pathway for reducing CO_2 and other emissions such as SOx, NOx and particulates from coal power in India out to 2040, including accelerating the uptake of high efficiency, low-emissions (HELE) power plant and CCS over the next 20 years.

We have broadened the scope of the studies programme to include assessments such as the future global role of coal

We have broadened the scope of the studies programme to include assessments such as the future global role of coal, reflecting on the heterogeneous nature of energy availability and the contrast between its use in OECD countries compared to developing nations. This includes the use of coal to supply non-energy products, including rare earth elements that are essential for the operation of many modern energy systems, and the recognition that energy transformation is not limited to power plants but rather can encompass other aspects such as system flexibility, smart grids and virtual power plants, digitisation of electricity grids, distributed generation, as well as the need to economically integrate carbon capture, utilisation and storage under these conditions. We are also working with external contractors to better understand the financial and operational impact of trying to operate power grids with very high capacities of variable renewable energy sources, looking how dispatchable power with CCS/CCUS can provide the necessary stability in a cost-effective manner.

Outreach activities include our various workshops and conferences that typically have taken place in member countries, together with focused training and capacity building initiatives for implementation in developing countries. Prior to the UK starting its government imposed national lockdown in March 2020, we held a coal related workshop in Brussels as part of an EC sponsored initiative and then our cofiring of coal and biomass workshop in Japan with strong support from our member there.

Since March we have held some virtual meetings to complete the EC work but have ceased implementation of other specialist workshops and our international CCT conference until safe international travel can be re-established.

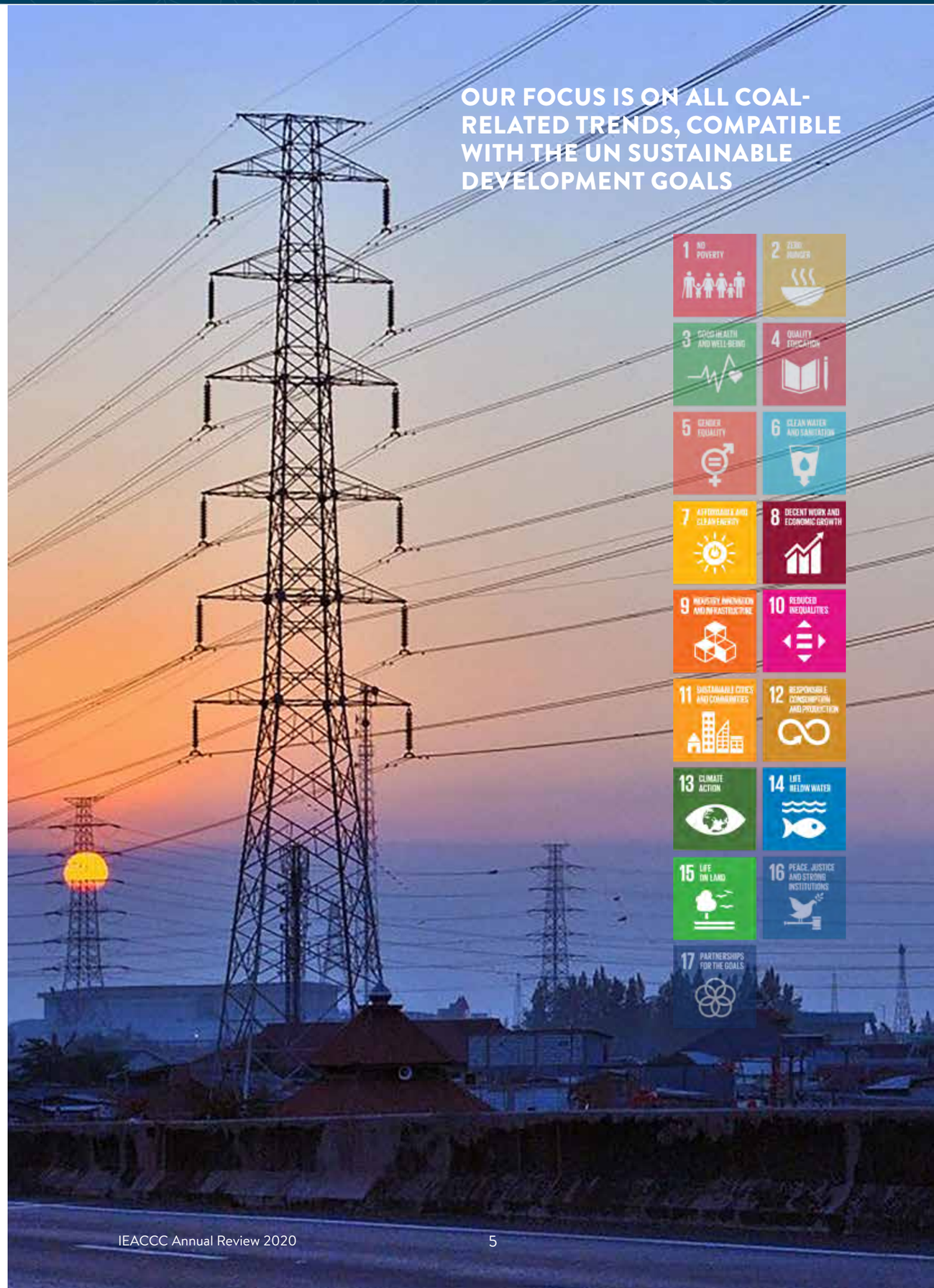
Nevertheless, we have moved forward with a major capacity building and training programme, with US Department of State support. This initiative is focused on Indonesia and India. It comprises capacity building with the Indonesian coal power sector to identify sustainable strategies for mercury monitoring, evaluation and reduction. Alongside this is a complementary capacity building programme with the Indian coal power sector, focusing on emissions monitoring and emissions reduction, and flexibility of plant operation, recognising that such reduction strategies can provide the associated means to limit mercury emissions. The project is proceeding with the intention to establish training packages that can be delivered on a face-to-face basis if possible. However, if necessary, virtual training will be the fallback option. This pragmatic approach will provide long term and sustainable benefits for the coal power sector in both Indonesia and India, with scope to be used by other emerging economies in due course. We are also working closely with the UN Economic Commission from Europe via the Expert Groups on Cleaner Electricity Systems and Sustainable Energy to address sustainable coal related issues and link that to providing a framework for achieving carbon neutrality in the region by 2050. This has included the preparation of specialist policy-driven briefing notes on power-based interplay of coal with renewables, better flexibility and high environmental performance, as well as identifying strong policy options for ensuring CCS/CCUS deployment.

During the course of 2020 we have seen communication become paramount to doing business. Staying connected to our members, audiences, as well as to our colleagues has become even more important as many people around the world have now embraced the virtual way of working. The focus has been on sharing knowledge and relevant content with our digital community. We have stepped up our social media activity with the aim of making the IEACCC content even more readily available to our users.

Our website (www.iea-coal.org) has seen a steady increase in visitors from the USA, India, UK, Australia, Japan, Pakistan, South Korea, Philippines, South Africa and Germany. During March – September 2020 there has been a staggering 45% increase in the number of people who navigate to our website! On our social media platforms, Twitter, LinkedIn and YouTube, we also see enhanced engagement with our audience, and people seem excited by the content we provide.

We are pleased to acknowledge the valuable input of our Executive Committee in overseeing our work, which is guided by our Chairman, Mr Scott Smouse of US DOE and our Vice Chairman, Dr Noel Simento of the Australian National Low Emissions Coal R&D Initiative.

Dr Andrew Minchener OBE
General Manager IEA Clean Coal Centre



THE IEA CLEAN COAL CENTRE

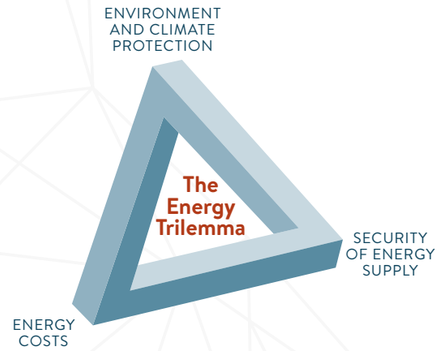
We are a technology collaboration programme that is mandated by the International Energy Agency, but which is functionally and legally autonomous.

Our organisation is non-profit making and we are supported financially by national governments primarily and corporate industrial organisations.

We provide independent information and analysis on how coal can become a much cleaner source of energy. Our focus is on all coal-related trends, compatible with the UN Sustainable Development Goals. We promote best practice in all aspects of coal production, transport, processing and utilisation. We address the role of coal in the energy trilemma and the need to balance security of supply, affordability and environmental issues. Much of our focus is on reducing emissions of CO_2 and other pollutants from coal use through high efficiency, low emissions (HELE) technologies. Increasingly, we are examining the positive impact that CCS/CCUS can have on ensuring a positive interplay with variable renewable energy sources to ensure a cost effective and reliable power grid.

AT THE IEACCC WE:

- publish **reports** and reviews and run **webinars** on technological developments for the sustainable use of coal together with complementary **studies** covering market issues and policies;
- provide a wide range of **blogs** covering both technological and policy related coal issues;
- support industry professionals through provision of **workshops and conferences**;
- undertake extensive **outreach activities**, particularly in developing and industrialising countries;
- facilitate **research and development**;
- provide **expert advice** to our members;
- encourage the use of our **online resources**;
- are establishing a **Knowledge Partners Network** to bring together like-minded companies and organisations that share our beliefs.



We are based in London and comprise a team of policy specialists, technologists, engineers, scientists and other experts. All information and advice are independent and free from political or commercial influence. Please visit our website **www.iea-coal.org** both to view our information, most of which is available at no charge, and to contact us to determine how we might cooperate further.

Technology Collaboration Programme
by iea

MEMBERS OF THE IEA CLEAN COAL CENTRE

Our membership has a depth and breadth of character which offers great networking potential and helps us maintain a truly global outlook. The members are representatives of national governments while our sponsors include utilities, coal companies, equipment and service suppliers and research organisations.

THE MEMBER COUNTRIES ARE:

- AUSTRALIA
- EUROPEAN COMMISSION
- ITALY
- JAPAN
- POLAND
- SOUTH AFRICA
- USA

THE SPONSORS ARE:

- Anglo American (South Africa)
- Beijing Research Institute of Coal Chemistry (BRICC)
- Electric Power Planning and Engineering Institute (EPPEI) of China
- SUEK (Russia)

Representatives of the members convene twice a year for the Executive Committee meetings of the IEACCC, which in 2020 have been on a virtual basis. At the meetings, they suggest topics for research, agree the work programme and budget, comment on our studies and outreach activities. Increasingly, there are detailed strategic discussions, reflecting that the IEACCC is broadening the scope of its work programme.

BENEFITS OF MEMBERSHIP

Membership of the IEA Clean Coal Centre gives members the assurance of being part of a comprehensive international programme of energy cooperation. They have immediate access to:

- World class analysis, research and assessment, and a network of experts dedicated to improving the efficiency of coal use and reducing its environmental impact. This includes independent and global perspectives on clean coal from mining, processing, transport, combustion, emissions control, carbon capture, increasing efficiency, and management of residues, through to economics and policy analysis
- All our study reports (approximately 10 are published each year)
- Draft copies of reports and the opportunity to contribute to and comment on them prior to publication
- Monthly webinars, based on reports, which can be viewed live or at any time after the event.
- Most importantly, the members can nominate topics for the studies programme, which are reviewed for selection at the Executive Committee meetings twice a year.

SUPPORT

- A superb network of contacts via other members and the permanent staff
- An online library including reports, emission standards and clean coal technology documentation
- Access to expert staff, both for adhoc support and more extensive consultancy
- Expert staff available for presentations, including keynotes, at events in member countries.

EVENTS

We run various workshops and conferences, which we hold in member countries where possible.

Our technical workshops (typically 80 delegates) include series on: Advanced USC power plant; Cofiring biomass with coal; Mercury and multi-pollutant emissions from coal. We will be introducing further events including a workshop on non-energy use of coal once the pandemic has been addressed.

We also hold our popular Conference on Clean Coal Technologies (CCT) every 2 years, with the next one provisionally scheduled for late 2021/early 2022 in the USA.

BLOGS

These are proving increasingly popular, with our IEACCC team providing less formal but still comprehensive commentary on various coal-based issues and related topics for easy reference. The blog contains some of the most well-liked content on social media, and we gain many new visits to our website when they are shared on twitter.

The blog is an important voice in the energy debate, one with which we can reach a new audience and get engagement from the media.

PUBLICITY

Members' events are publicised on our events page and are listed in our Weekly news email.

Press releases by members are included in our Weekly news.

Our staff contribute features to publications in member countries, as requested.

WEBINARS

A webinar is presented by an IEACCC analyst on their current research every month on a Wednesday at midday (UK time). It can be viewed either live via GoToWebinars or at any time on demand from our YouTube channel. We had a 54% increase in viewers to our live webinars and a 58% growth in subscribers to our YouTube channel during 6 months of 2020.

SOCIAL MEDIA

On twitter we have had 36.9% increase in clicks on links and our following on Linkedin has Increased by 28.5%. Content such as our blogs and reports is popular with our followers on social media and often generate much engagement.

You can follow the IEACCC on LinkedIn, Twitter and YouTube.

IEACCC KNOWLEDGE|PARTNERS NETWORK

The IEACCC has established a Knowledge Partners Network with organisations that have a positive interest in sustainable coal production and utilisation. The aim is to:

- Show global solidarity between organisations that have a positive interest in sustainable coal utilisation.
- Showcase the breadth of our global knowledge partners to ensure better exchange of information and encourage future collaboration.

We invite likely organisations to become knowledge partners and exchange logos, theirs for inclusion on our new web page and ours on their websites, with links. We started sending out email invitations to our contacts in early February.

To date, we have gained close to 110 partners from companies, universities and other organisations within 27 countries, with further invitations and requests being processed. *(See pages 10 & 11)*

IEACCC
KNOWLEDGE|PARTNERS
NETWORK

Please get in contact if you would like to join our partnership!

THE IEA CLEAN COAL CENTRE SUPPORTS THE SUSTAINABLE DEVELOPMENT GOALS

WHAT ARE THE SDGS?

In 2019 the IEACCC started to highlight the relevance of our work to the Sustainable Development Goals (SDG). The SDG were adopted by all United Nations Member States in 2015 as a universal call to action to meet the urgent environmental, political and economic challenges facing the world. The 17 SDGs interconnect – they recognise that action in one area will affect outcomes in others, and that development must balance social economic and environmental sustainability.

HOW DOES THE WORK OF THE IEACCC SUPPORT THE GOALS?

The IEACCC mission statement is to continue to provide independent information and analysis on all coal-related trends compatible with the Sustainable Development Goals.

WHY DOES THIS MATTER?

Coal remains the second largest source of primary energy and the dominant fuel for generating electricity, and this will be the case for many years, particularly in developing countries.

The IEACCC identifies, analyses and publicises policy and technology developments that improve the uptake and use of all clean coal technologies. This work is especially focused on initiatives that lead to higher operating efficiencies while ensuring that emissions are minimised for coal-based power plants and industrial applications. The approach supports the SDGs of providing clean energy, promoting economic growth and improving infrastructure while minimising the physical and health impacts on the environment and communities.

These innovation- and policy-guided assessment activities are integral to the IEACCC operating framework as a unique provider of independent information and analysis on all matters related to clean coal development and deployment. In particular the IEACCC recognises the geographical shift in the deployment of coal technologies to the industrialising nations of Asia, Africa and Eastern Europe where a social licence to operate is important in the adoption of clean coal technologies to help alleviate energy poverty in the most sustainable ways possible.

The IEACCC integrates the messages of the SDGs in our published reports, webinars and blogs and in our outreach activities, including events organised both by ourselves and by other like-minded organisations.

OUTREACH

Our outreach programme continues to expand, despite the pandemic. The IEACCC continues to run its own conferences and workshops, which help to establish the key messages from the reports, with a focus on recipients in developing countries.

During 2020, this has included running one IEACCC workshop (*see page 16*), participating in other organisations' conferences and associated events, both physically and virtually, as well as taking part in a wide range of topical meetings.

The pandemic has brought new challenges for the IEACCC and we have had to refocus our activities since live international events and related activities have had to be postponed. Nevertheless, we have maintained strong virtual contact with our members/sponsors, have continued to promote our work and have participated in numerous virtual meetings, workshops and conferences to maintain our international presence. We have also started looking at how best to establish a webcast series on key international energy issues for 2021 rollout.

WORK WITH THE UNITED NATIONS

The IEA Clean Coal Centre has a long-standing cooperation arrangement with the United Nations Economic Commission for Europe (UNECE), on activities that significantly reduce greenhouse gas emissions from fossil fuel-fired electricity generation, recognising that this objective has positive impacts on several of the United Nations SDGs. The IEACCC representative is Dr Andrew Minchener OBE, who is a member and Vice-Chair of the Bureau of the UN Group of Experts on Cleaner Energy Systems, which is a subsidiary body of the Committee on Sustainable Energy (CSE). He is also a member of their Task Force, which aims to establish a framework for achieving carbon neutrality by 2050, recognising the importance of a technology agnostic approach. In addition, Dr Lesley Sloss is a member of the UNECE Group of Experts on Coal Mine Methane (CMM), which undertakes and promotes activities aiming at reduction of greenhouse gas emissions from coal mines.

UNECE

The IEACCC via Dr Lesley Sloss co-leads the UN Environment Coal Partnership under the Minamata Convention on Mercury together with Macquarie University in Australia. The remit of the Coal Partnership is to act, on behalf of UN Environment and ratified parties, to ensure that the coal sector is dealt with appropriately within the Convention and that compliance strategies are carried out in an effective manner. To this end, the Coal Partnership has worked since the beginning of the negotiations to help produce supporting documents for the Convention, including sitting on the expert group which produced the BAT/BEP (best available technology/ best environmental practice) guidance for reducing emissions from the coal sector. The Coal Partnership continues to attend all negotiations and related Minamata meetings to provide continued expert guidance for the parties to the Convention.

UNEP MINAMATA CONVENTION ON MERCURY

MACQUARIE University

US DEPARTMENT OF STATE PROJECT

The IEACCC is proud to have won a substantial grant from the US Department of State to run a project entitled: 'Capacity building in Southeast Asia to reduce mercury and other pollutant emissions from the coal combustion sector'. The project, being managed by Dr Lesley Sloss, began at the end of 2019, and will run until the end of 2023.

The grant is divided into two sub-awards, one focusing on Indonesia and one on India. Each is discussed below.

INDONESIA

Indonesia has a population of around 280 million people across more than 17,500 islands. Coal currently provides 50–55% of the electricity in the country. There are still regions of Indonesia with little or no access to power. Indonesia is one of the most coal-rich regions of the world and coal mining and export are the backbone of the economy. Indonesia plans to double the capacity of coal-fired plants within the next ten years and, as coal use increases, so will emissions of pollutants such as mercury, unless action is taken.

Indonesia ratified the Minamata Convention on Mercury in September 2017 and must now take action to comply with the aims of the Convention. For the coal sector, this means producing an inventory of mercury emissions which must be maintained in order to evaluate the progress of the sector towards achieving emission reduction goals. In addition, stakeholders must evaluate mercury emissions from the coal combustion sector to determine the most cost-effective and appropriate means to reduce mercury.

The work on the Indonesia project is split over 3 Phases:

- **Phase 1:** Quantify mercury emissions from the entire Indonesian coal fleet, on a unit-by-unit basis and rank plants to identify those with the greatest potential for cost-effective mercury reduction;
- **Phase 2:** provide training and capacity building in Indonesia on mercury monitoring and control; and
- **Phase 3:** Create a catalogue of potential policies and projects which will inform the Indonesian Government's National Action Plan for coal under the Minamata Convention on Mercury.

Phase 1 of the project was completed on time and on budget in December 2020, with the assistance of BCRC-Asia (the Basel and Rotterdam Convention Regional Centre in Asia) and MEMR (the Indonesian Ministry of Energy and Mineral Resources). The IEACCC also contracted expert help from Uniper, UK, and AEA (Atlantic Energy Associates), USA.

The IEACCC has published a technical report covering Phase 1 of the project which is now available from the website (www.iea-coal.org). This portion of the work assisted the Indonesian government in the development of a national inventory of emissions from the coal utility sector. A dataset of all coal-fired units in Indonesia was created and plant specific data were used to estimate mercury releases from each coal fired utility unit on a g/GWh basis. Estimates for total mercury emissions for each unit both annually and over the remaining operational lifetime of the plant were calculated. Plants were then ranked according to their mercury emissions and the potential for significant mercury reduction. Three top-ranking plants were selected for further investigation, to take place in Phase 2 of the project.

Dr Lesley Sloss presented a summary of the Phase 1 work in an IEACCC webinar in January 2021. Phase 2 of the work will be launched at an on-line event on the IEACCC platform on the 22-24th March 2021.

The Indonesian Government – the Ministry of the Environment and Forestry (MOEF) and the Ministry for Energy and Mineral Resources (MEMR) – has been supportive of this project and have indicated that they wish to work closely with the IEACCC to inform future policy, including the compliance strategy for the Indonesian coal sector under the Minamata Convention.

INDIA

For India, the project objective is to provide training and capacity building to empower Indian stakeholders with strategies to reduce emissions from coal plants, focussing on approaches which reduce several pollutants at once in a cost-effective manner.

To achieve this, the work plan focuses on three areas where training will be most beneficial:

- **Pillar 1:** measuring and monitoring emissions from coal plants accurately and reliably for compliance and control purposes;
- **Pillar 2:** identification of multipollutant techniques and technologies most suited to Indian plants and coals, as well as identifying routes for ash management;
- **Pillar 3:** maximising plant flexibility, to allow plants to ramp their output up and down to meet demand whilst ensuring that efficiency is maintained, and emissions are not elevated.

The funds for the Indian portion of the project were only released in February 2021 and so this portion of the project is still in the initial stages. However, the IEACCC is already working with CenPEEP (the Centre for Power Efficiency and Environmental Protection, India), NTPC, NPL (National Physical Laboratory, UK and India), CSE (Centre for Science and the Environment), AEA, and EPRI (Electric Power Research Institute, USA) to determine the specific needs of Indian stakeholders for each of the Pillars of work and to develop appropriate training materials.

DIARY OF CONTRIBUTIONS AT VARIOUS INTERNATIONAL STAKEHOLDERS' CONFERENCES AND WORKSHOPS

28-30 January 2020: Launch of US State Department Capacity Building Project on **Reducing Mercury Emissions from the Coal Sector in Indonesia**. Organisation, participation, and presentation by **Dr Lesley Sloss** in cooperation with the US Embassy in Jakarta, Indonesia.

5 February 2020: **Toby Lockwood** attended the IEA high-level workshop event: **'ETP 2020: The role of CCUS for a cleaner and more resilient energy sector'** in Paris.

14-16 February 2020: Participation and presentation by **Dr Andrew Minchener** at the **10th World PetroCoal Congress and Expo.** in New Delhi, India.

25-26 February 2020: Organisation, participation and presentations by **Dr Andrew Minchener, Debo Adams, Xing Zhang and Benedicte Brocks** at the **9th Cofiring Biomass with Coal Workshop**, which was organised by the IEACCC in conjunction with our ExCo partner NEDO and held in Kokura Japan.

25-27 February 2020: **Dr Qian Zhu** attended the **4th Connected Plant Conference** in Atlanta, Georgia, USA.

28 February 2020: Participation and presentations by **Dr Andrew Minchener** and **Debo Adams** in the final workshop of the EC funded **CoalTech2051** project, which attracted a wide-ranging mix of attendees including Lou Hrkmann of USDOE and various EU MEPS. This took place in Brussels, Belgium, and was the first of only three major face to face events at which the IEACCC participated in early 2020 prior to the global pandemic.

5 March 2020: **Dr Lesley Sloss** attended **Advisory Group Meeting of the Centre for Energy Policy**, Glasgow, UK. The CEP produces reports and white papers relating to the status of the energy sector in Europe, most recently focusing on the new UK funding potential for CCS and the progression of the Just Transition in Europe.

VIRTUAL

1 April 2020: **Debo Adams** delivered monthly virtual presentations to update the **IEA Coal Industry Advisory Board** on progress on the study 'A pathway to reducing emissions from coal power in India'. Presentations were also given by **Paul Baruya, Toby Lockwood, Dr Qian Zhu** and **Dr Malgorzata Wiatros-Motyka**. There has also been valuable virtual collaboration with Indian stakeholders, including four meetings to present and discuss the work. The meetings were held on 28 September with the **Ministry of Power, Ministry of Coal**, **CEA** and **Central power generating companies**, on 14 October with **State generating companies**, on 29 October with **NITI Aayog** and on 18 November with **independent power producers**. The meetings were attended by **Debo Adams, Toby Lockwood, Paul, Baruya, Dr Malgorzata Wiatros-Motyka** and **Dr Qian Zhu**.

27 April 2020: Video conference between **Dr Andrew Minchener** and **Debo Adams** with the **CoalTech2051 partners** to conclude the technical aspects of the EC CoalTech2051 project.

19-20 May 2020: **Greg Kelsall** (on behalf of Dr Andrew Minchener) participated in a 2-day virtual meeting at the UNECE Carbon Neutrality Framework meeting contributing to the workshop '**Role of greenhouse gas removal technologies and CCUS**'.

May-September 2020: **Dr Andrew Minchener** participated in various meetings with other experts to define contributions to the **UNECE project for establishing a technology agnostic policy framework for carbon neutrality by 2050 within the region**.

These activities comprised:

- 9 May 2020: **Dr Andrew Minchener** participated in virtual meeting of the **IEA Working Party on Fossil Energy**. Gave presentation on the strategic approach of IEACCC to adapting our work programme due to certain aspects being postponed because of the curtailing of international travel.
- 20 July 2020: Participated in a **UNECE virtual meeting** on an initiative to introduce CCUS within the regional energy mix and to establish arrangements for the November virtual meeting of the group of experts on cleaner electricity systems.
- 3 September 2020: Submitted drafts of the IEACCC contribution to various briefing documents. Participated in **UNECE** meeting to plan technical summit on CCS/CCUS scheduled for later in September.
- 14 September: Participated in a follow-up meeting to review presentation options for forthcoming **Energy Week**.
- 24 and 25 September 2020: Participated in a virtual workshop addressing work undertaken to establish a regional framework for carbon neutrality, with emphasis on deployment of CCS/CCUS.
- 2 November 2020: Participated in preparatory meeting for the **UNECE Week** scheduled for late November.
- 5 November 2020: Participated in a further preparatory meeting with emphasis for making the case for CCUS deployment.
- 23-25 November 2020: Participated in sessions at the **UNECE Energy Week**, including presenting on the Interplay of power generation technologies within the grid system to lower carbon emissions intensity and ensure operational stability.
- 27 May 2020: Virtual discussions between **Dr Andrew Minchener** and Scott Smouse relating to the ongoing members programme plus related external contracts.

8 June 2020: **Dr Lesley Sloss** attended the '**UN Global Mercury Partnership – Partnership area leads**' meeting. IEACCC has led the Coal Partnership Area since its inception and the Partnership now acts as the spokesperson for the coal sector at all COPs of the UN Minamata Convention. The Coal Partnership runs annual meetings for those involved in controlling mercury emissions from the coal combustion sector - these are run in conjunction with the IEACCC's annual MEC (Multi-pollutant emissions from coal) workshop.

17 June 2020: **Dr Lesley Sloss** ran a teleconference with **EPRI, USA**, to refine the details of project work in India, to form part of the US State Department Project on Capacity Building in Asia.

19 June 2020: **Dr Malgorzata Wiatros-Motyka** presented in a teleconference comprising representatives of **Poland's Ministry of Climate, Ministry of State Assets**, a representative of the **Government Plenipotentiary for Strategic Energy Infrastructure**, and several energy company managers and directors.

22 June 2020: Video conference between **Dr Andrew Minchener, Debo Adams** and **Toby Lockwood** with **Imperial College** contractors re '**Total system costs assessment and modelling study**' to ensure a clear way forward to identify the true costs of deploying variable renewable energy (VRE) sources on the power grid, which are much higher than those reported by governments and various international organisations. Subsequent review meetings were held on 13 August, 28 September and 27 November 2020

30 June 2020: **Dr Lesley Sloss** took part in a conference call between **IEACCC, EPRI** and **CSE India** to address potential issues with emissions monitoring, to help in evaluation of the Indian Government's approach to monitoring emissions from the coal sector to comply with India's new emission limits.

30 June 2020: **Debo Adams** took part in the Launch of the **Just Transition Platform** – Coal regions in transition virtual week and carbon intensive regions seminar, which gave an important insight into European policies on coal.

8 July 2020: **Dr Andrew Minchener** participated at an **ASEAN virtual workshop** by giving a presentation setting out the regional benefits of clean coal utilisation plus CCUS. This provided a useful introduction to key government officials/stakeholders from the member countries, namely Indonesia, Thailand, Singapore, Malaysia, Philippines, Vietnam, Brunei, Myanmar, Cambodia and Laos.

9 July 2020: **Dr Andrew Minchener** participated at an **ASEAN virtual Business Meeting** by giving a presentation setting out our activities as part of a membership initiative. Again, this provided a useful introduction to the representatives from the ASEAN member countries. Contact has been followed up by email, due to the lack of face-to-face opportunities.

22 July 2020: **Dr Lesley Sloss** took part in the virtual **UNEP Global Mercury Partnership** – experts meeting on '**Oil, gas and non-ferrous metal**'. IEACCC leads the Coal Partnership and sits on the Partnership Advisory Group (PAG). The Minamata Convention on mercury currently excludes oil, gas and non-ferrous metals from its source inventories. To address this omission, a new study is being commissioned to provide information on emissions from this sector to the next COP.

22 July 2020: **Dr Lesley Sloss** and **Debo Adams** took part in the **UNECE Group of Experts** coal mine methane meeting to which we provide relevant information from our studies.

23 July 2020: **Paul Baruya** delivered a virtual keynote address at the **10th Global Webinar Series on 'Recovery of coal market in post-COVID times.'** This was organised by the Energy and Environment Foundation of the World PetroCoal Congress.

23 July 2020: **Dr Lesley Sloss** attended the **UN Global Methane Initiative (GMI) Coal Mines** subcommittee meeting.

30 July 2020: **Stephanie Metzger** took part in a video call with Michelle Manook, the CEO of the **World Coal Association** and Matt Lee, their Policy Advisor to discuss her work on carbon pricing, which will feature in forthcoming WCA events.

20-21 August 2020: **Dr Malgorzata Wiatros-Motyka** participated in the CII power summit, an online conference on emissions, efficiency increases and other technologies applicable to the Indian energy sector.

2-3 September 2020: **Paul Baruya** presented the **IEACCC India Study update to the IEACIAB experts meeting**. Over 40 people attended virtually, including CEOs and senior staff from coal mining, coal trading and power companies.

7 September 2020: **Dr Malgorzata Wiatros-Motyka** participated in the **VGB's Future Energy System** virtual technical committee meeting as the IEACCC representative.

7 September 2020: **Dr Malgorzata Wiatros-Motyka** attended '**Energetyka w czasie zmian**' (Energy sector in transition), a Polish webinar, which included discussions about the future of the coal sector in Poland.

8-10 September 2020: **Xing Zhang** participated in the **29th Clean Coal Day** in Japan 2020 International Symposium.

17 September 2020: **Dr Andrew Minchener** participated in a virtual conference held by the **Asociación Nacional de Empresas Generadoras** (ANDEG), a national association of energy producers in Colombia by giving a presentation addressing options for clean coal utilisation within South America, while also setting out the benefits of international cooperation, including joining the IEACCC Knowledge Partners Network. **Stephanie Metzger** discussed carbon pricing with Catalina Rubio from ANDEG, after Ms Rubio viewed her webinar on the topic.

27 October 2020: **Dr Lesley Sloss** presented a paper on Sustainable coal development on behalf of Dr Andrew Minchener at the online **World Coal Association's Coal Markets Forum**.

27 October 2020: **Toby Lockwood** and **Dr Malgorzata Wiatros-Motkya** gave presentations at the **European Technology Development Consulting** (ETD) online event: Materials, inspection, monitoring and assessment (MIMA) for high temperature plant.

2 November 2020: **Paul Baruya** and **Toby Lockwood** took part in a recorded discussion to exchange ideas on the current and future situation for coal markets and technologies. Facilitated by Christopher Hansen, **Global Energy Management Program**, University of Denver, Colorado.

3 November 2020: **Dr Lesley Sloss** attended the online **UNEP Briefing on the 4th Meeting of the COP** for parties to the Minamata Convention. Lesley will be active at the COP (scheduled for November 2021) in her capacity as Lead of the Coal Partnership and will be leading a side event on the US State Department Project on Capacity Building in Asia.

4 November 2020: **Debo Adams** presented '**A pathway to reducing emissions from coal power in India**' to the IEA Coal Industry Advisory Board plenary meeting. It was also attended by the authors of the study **Toby Lockwood, Paul, Baruya, Dr Malgorzata Wiatros-Motyka** and **Dr Qian Zhu**.

13 November 2020: **Dr Andrew Minchener** participated in a virtual meeting with **USDOE, UNECE** and **Euracoal** regarding possible CoalFirst initiatives.

23-25 November 2020: **Dr Andrew Minchener** participated in the **UN ECE Energy Week** virtual conference, presenting on 'Technology interplay for cost effective reliable power generation' and participating in the technology agnostic carbon neutrality framework initiative discussions.

4 December 2020: **Dr Andrew Minchener** gave a virtual presentation on Global coal gasification RTD at the **Coal Preparation Society of India Autumn Meeting**.

8 December 2020: **Dr Andrew Minchener** participated in the IEA Working Party on Fossil Energy workshop on the **Energy-Water-Nexus**, presenting on the wealth of information reviewed and published by IEACCC.

9 December 2020: **Dr Lesley Sloss** presented on the status of the US State Department project on capacity building in Asia at the **Annual US EPA/AWMA Information Exchange Conference**, USA.

10-11 December 2020: **Dr Andrew Minchener** participated in the IEA Working Party on **Fossil Energy Biannual Review Meeting** and provided an overview of the work of IEACCC during 2020.

14 December 2020: **Toby Lockwood** was a panellist at the webinar launch of '**Reducing CO_2 footprint of India's Coal Based power**', a report produced by knowledge partners CSE India.

15 December 2020: **Dr Andrew Minchener** participated in the **Mission Energy India Gasification** virtual meeting and presented on Global IGCC development and deployment.

15-16 December 2020: **Dr Lesley Sloss** attended the **11th meeting of the UNEP Global Mercury Partnership Advisory Group** in her capacity as Lead on the Coal Partnership. She presented information on the status of partnership membership and gave an update on the US State Department project.

COFIRING 9 KOKURA, JAPAN
WORKSHOP 25-27 FEB 2020

The ninth IEACCC workshop on cofiring was both stimulating and thought provoking. Concern about the Coronavirus meant that several presentations were pre-recorded and then slotted into the programme. Although we missed the chance to question the speakers, the presentations were of a very high standard and ran smoothly.

The workshop began with two site visits. The first was to Nippon Steel Engineering which has a bench scale plant developing a new fuel from woody biomass and brown coal. The process improves the quality of both fuels and produces a standardised product. NSE have a patent on a lignite-biomass mix torrefied briquette and the project is supported by NEDO. Then we were back on the coach for a quick tour of the Shin Onoda power station, run by Chugoku Electric Power Company. This 1000 MW power plant was commissioned in 1986 and runs pretty much constantly. At Shin Onoda they currently burn 2.6 Mt/y of imported coal and cofire about 20,000 t/y of wood chips. They aim to increase the rate of cofiring to up to 300,000 t/y using wood pellets from North America and Australia. A feed-in tariff (FIT) will help them cofire at a ratio up to 10.4%. The two main modifications are to adapt one mill exclusively for pellets and to alter the boiler burner. Shin Onoda is on a compact site of only 290,000 msup2 and uses well-maintained state-of-the-art technology. Emissions are kept to 60 ppm NOx and 68 ppm SOx. There is also an ESP to capture fly ash.

The workshop proper opened the following day with welcome addresses from Dr Andrew Minchener (IEACCC), Makoto Nunokawa (NEDO) and Nobuhiro Abe (Kitakyushu Convention and Visitors Association). By 2030 Japan aims to have 26% of its power sourced from coal plant and renewables will be supported. The electricity companies in Japan currently cofire around 3% biomass. Already 13 coal-fired power plants in Japan have tried cofiring biomass. The use of imported wood is increasing rapidly and is expected to reach 5 Mt/y by 2025. However, there are growing concerns about the sustainability of the biomass for cofiring. In April 2019 biomass for cofiring lost its eligibility for the FIT so the low carbon price means that it cannot compete with coal.

Wenping Hu's (EPPEI) recorded presentation was particularly interesting. China has huge potential for cofiring, but only a few projects are in operation – most are in the planning stage. In June 2018 the NEA of China announced 89 cofiring projects at a previous IEACCC Cofiring workshop. However, very few are active; of 56 projects announced that would cofire agricultural and forestry wastes, only 2 are in operation; the other 56 have been suspended, largely due to a lack of supportive polices such as a fixed price. On the other hand, much research continues in China on the effective co-gasification of biomass and coal. China produces more than one billion tonnes of biomass a year and less than half of it is used as fertiliser, fuel, feed or bedding. CFB gasification is being researched in China, although the large scale projects previously announced are currently stalled. There is massive potential in China to cofire agricultural residues, but the policies need to be in place.

The advantages of torrefaction were outlined by Michael Wild (International Biomass Torrefaction Council). Torrefied biomass is a more homogeneous material than wood chips and is more similar to coal – it ships, stores, mills and combusts in a similar way. Gordon Murray (Wood Pellet Association of Canada) discussed the sustainability of biomass and described the various schemes in operation. There are national standards in the UK, Netherlands, Belgium and Denmark and the EU Renewable Energy Directive (RED II) recently introduced sustainability criteria. There are various third party certifiers including the Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC) and the Sustainable Biomass Programme (SBP). The SBP is designed for the utility industry. Canada has 9% of the global forest and all Canadian pellet exporters are SBP certified.

CFD modelling is a popular tool for examining and fine-tuning various aspects of cofiring. For example, it has been used to balance fuel and air to improve combustion and to optimise boiler efficiency.

Presentations from Ramboll and Loesche examined the transport and milling of wood pellets in more detail. Presenters from Firefly AB and the University of Greenwich described the attendant risks of handling biomass – mainly fires, explosions and the health hazards of inhaling biomass dust.

Oxyfuel combustion of biomass with coal and carbon capture and storage (CCS) was explored as a way to reduce emissions to a minimal level. This topic is gathering support as it has potential as a method to help countries achieve their Paris Agreement goals.

Although SCR for NOx control is not a major part of cofiring biomass, it is important for coal-fired power plants. The catalysts in SCR can be poisoned by Na, P and K which are present in higher concentrations in biomass than coal, so a high biomass content tends to deactivate the catalysts. But this impact is usually minor if biomass is cofired at a rate of 10-20%.

The Cofiring 9 workshop had an applied and industrial focus which reflects the status of the technologies. There was much discussion about the conversion of biomass and its combustion. The use of agricultural residues clearly has potential, but there are challenges in turning it into reality, partly due to the issues with slagging, fouling and corrosion. Wood pellets are well established and work continues on torrefaction. The sustainability debate rumbles on, but seems to be more of a media concern than a scientific one.

The safety issues when handling biomass are critical – plenty of pictures of unwanted fires and explosions were shown. But cofiring biomass clearly has a role in reducing emissions of CO_2 from coal-fired power plant and, when combined with CCS has the potential to result in negative emissions, so it is definitely a topic that merits further research, discussion and collaboration.

REPORTS PUBLISHED IN 2020

In the calendar year 2020 the IEACCC have published more reports than in 2019. Nine in-house reports have been published as well as a study for the USA State Department 'Reducing mercury emissions from the coal combustion sector in Indonesia'. In addition, a study for the CIAB was undertaken 'A pathway to reducing emissions from coal-fired power in India', published in January 2021.

All of our reports are available from our website and the majority have been presented as webinars which can be found on the IEACCC YouTube channel.

REDUCING MERCURY EMISSIONS FROM THE COAL COMBUSTION SECTOR IN INDONESIA

Dr Lesley Sloss, Paul Baruya, Dr Malgorzata Waitros-Motyka, Toby Lockwood of the IEA Clean Coal Centre and Dr Wojciech Jozewicz, Roger Brandwood, Ilham Riyadi Muhammad, Anton Purnomo, Erlangga Hassan | 76 pp, December

Indonesia ratified the Minamata Convention on Mercury in September 2017 and must now take action to comply with the aims of the Convention. For the coal sector, this means producing an inventory of mercury emissions which must be maintained in order to evaluate the progress of the sector towards achieving emission reduction goals. In addition, stakeholders must evaluate mercury emissions from the coal combustion sector to determine the most cost-effective and appropriate means to reduce mercury.

This report covers Phase 1 of the project which assists the Indonesian government in the development of a national inventory of emissions from the coal utility sector. A dataset of all coal-fired units in Indonesia has been created and plant specific data used to estimate mercury releases from each coal-fired utility unit on a g/GWh basis. Estimates for total mercury emissions for each unit both annually and over the remaining operational lifetime of the plant were calculated. Plants were then ranked according to their mercury emissions and the potential for significant mercury reduction. Three top-ranking plants were selected for further investigation, to take place in Phase 2 of the project.

CARBON PRICES AND THEIR IMPACT ON COAL POWER, CCC/308

Stephanie Metzger | 90 pp, September

Carbon pricing is viewed by many economists as the most cost-efficient method of reducing greenhouse gas emissions, such as CO_2. Several countries and sub-national jurisdictions have implemented carbon pricing policies since the 1990s, to mixed results. This report examines the EU Emissions Trading System (ETS), the US Regional Greenhouse Gas Initiative, the Chinese ETS, and a number of smaller systems to illustrate the variety of carbon price designs that have been used. So far, market stability has been a major challenge for existing systems. Supply adjustment mechanisms, price floors and ceilings, and auction reserve prices have all helped to rebalance ETS markets. Electricity carbon leakage has also affected the abatement potential in the power sector.

Generally, it is agreed that emissions reductions do occur under a carbon price; however, questions remain about the strength of the causal link to this outcome and whether the results are enough to meet climate goals. Furthermore, the impact on coal power has been varied and often unpredictable. The economics of carbon pricing suggest that power producers may move away from coal as it is penalised for higher levels of emissions. However, this switch has not happened uniformly. Some countries have seen an increase in the use of natural gas over coal, while others have maintained coal power as a primary energy source. Other government policies can also interact with carbon prices, changing the fuel mix in different ways. Finally, carbon pricing is supposed to spur investment in low-carbon technology, such as carbon capture and storage (CCS), but there may be less of an effect than originally predicted. Revenue from carbon prices could be used to support such technology initiatives, as well as programmes to help ease the transition for fossil fuel-dependent communities. Carbon pricing is not a one size fits all solution, so there needs to be careful consideration of the broader social, economic, and political context of each jurisdiction when implementing carbon taxes or ETSs. Ultimately, carbon prices may serve as a political signal of a country's commitment to combatting climate change as much as an economic tool for doing so.

DIGITAL TRANSFORMATION OF THE COAL SECTOR, CCC/307

Dr Qian Zhu | 80 pp, September

The global power industry is undergoing fundamental changes of decarbonisation, decentralisation and digitalisation, which pose significant challenges to energy systems and the coal sector, especially coal fired power generation. The power sector has begun a digitalisation process that is transforming the way electricity is generated, transmitted and distributed, and will help it meet the challenges.

A suite of digital technologies such as the Industrial Internet of Things (IIoT), Big data, Analytics and Artificial Intelligence (AI), Digital Twins, the Cloud, and Mobility have been developed and are finding applications in power generation processes. Digitalising coal power plants with these innovative technologies will increase their efficiency, affordability, reliability, and sustainability. Digitalisation of power plants will be based on five key functions: connection, monitoring, analysis, prediction and optimisation. Today, the ever faster and ubiquitous connectivity provides the foundation to a digital plant by enabling the connection of sensors, devices, assets and people. The IIoT provides the building blocks of a digital plant, allowing for collection, transmission, analysis and management of operations, processes and assets data. AI-enabled analytics is the core technology for the next generation of coal power production. Advanced analytics, in conjunction with Big data, provides tools to identify or predict any issues and determines the appropriate actions with real-time responses to resolve or prevent the problems, and help power producers make informed decisions to maximise the performance and profitability potential of assets, plants and fleets to achieve the best possible outcomes.

Digital technologies can also be applied to coal mining, helping to automate and optimise coal production, improve operational efficiency, environmental performance, workers' safety and production workflow at reduced costs.

This report studies the digital transformation of the coal sector with a focus on coal-based power generation. The latest developments in digital technologies that can be applied in coal power plants are reviewed, and how they affect power systems and coal power generation, their potential benefits and risks are discussed.

COKING COAL – THE STRATEGIC RAW MATERIAL, CCC/306

Paul Baruya | 106 pp, August

Steel is an essential raw material with a wide array of applications throughout society. Globally, iron and steel industries use methods that require metallurgical coking coal, chiefly the integrated blast furnace and basic oxygen furnace method (BF-BOF). This form of steel manufacture has changed little over the years, but the industry has become more competitive and efficient in its use of raw materials such as coal. Electric arc furnace (EAF) steel production is well established, but massive supplies of reliable and affordable electricity are limited in growing regions such as Asia. The BF-BOF method thus remains the main form of steel production and will sustain a market for coking coal for many years. The iron and steel sector is the principal market for coking coal; thus trends in the former drives demand and prices. Other factors that affect the coal market include the challenges faced by mining companies and dry bulk infrastructure. For large steel-producing countries such as China, India, Russia, and the USA, coking coal supplies are obtained from domestic resources. Other major steel producers such as those in OECD Asia rely on the international seaborne market to provide coking coal of sufficient quality. While coking coal reserves are abundant worldwide, the supply chain can face occasional challenges, such as weather-related impacts and industrial action. If supply shortages lead to high prices, the effect is felt by steel producers, whose operating costs are affected by raw materials. In carbon-constrained economies, the outlook for coking coal is more subdued. Yet, economies undergoing a more rapid energy transition increasingly rely on solutions such as wind power that are dependent on steel. The role of the BF-BOF plants will remain significant; thus, the role of coking coal could be substantial. Numerous possibilities have been considered to lower CO_2 emissions from the steel industry by reducing or eliminating the need for metallurgical coke. These include the use of more scrap or shifting production to EAF processes. Other innovative developments such as hydrogen-based ironmaking or using carbon capture have also been explored.

TECHNOLOGY DEVELOPMENTS IN THE COFIRING OF BIOMASS, CCC/305

Xing Zhang and Simone Meloni | 80 pp, August

Although declining in Europe and Canada, cofiring biomass with coal is a subject of growing interest in Asia so work continues on developing the technology. This review facilitates the technology transfer 'from West to East'. Biomass characteristics and the options for cofiring are described, of which direct cofiring is the most widely used method. Biomass pretreatment methods include washing and leaching, torrefaction, steam explosion, densification and pelletisation. Generally, pretreatment methods are combined such as the pelletisation of torrefied material. Agricultural residues are of interest for cofiring in Asia, partly to improve local air quality. However, compared to woody biomass, they have a higher concentration of chlorine, phosphorus, and alkali and alkaline earth elements, which result in slagging and fouling. The report discusses the latest developments in combustion related issues such as cofiring in CFB boilers, cogasification cofiring, oxyfuel cofiring and cofiring ratios. Oxyfuel cofiring of biomass, if combined with carbon capture and storage has the potential to result in negative emissions of CO_2. Attention should be paid to biomass handling, storage and fire protection as it has a lower ignition temperature and is more explosive than coal. Computational fluid dynamics (CFD) is a powerful tool in the development of coal and biomass cofiring technologies for increased understanding, exploration of unfamiliar conditions, design, troubleshooting, and optimisation of combustion processes.

The impacts on emission controls and ash utilisation from cofiring are analysed. Cofiring biomass can help meet various Sustainable Development Goals including Goal 7 affordable and clean energy, Goal 9 industry innovation and infrastructure, Goal 12 ensure sustainable consumption and production, and Goal 13 climate action. However, government support, and favourable regulatory and environmental policies are still required for the widespread deployment of cofiring.

CARBON CAPTURE, UTILISATION AND STORAGE – STATUS, BARRIERS AND POTENTIAL, CCC/304

Greg Kelsall | 93 pp, July

Around 170 GWe of coal-fired power generation with CCUS will be needed by 2050 as part of the transition to a net zero CO_2 emission future. The Asia Pacific, including China, is a key region where this will need to be implemented. This must be achieved as part of a combined approach of limiting global temperature rise, whilst providing access to reliable and affordable energy to support economic development and improved living standards. It forms part of an 'inclusive transition' where OECD countries work with developing nations to move towards a lower emissions future that does not disadvantage an important section of the global population. Good progress has been made in reducing the cost of CCUS through the early commercial-scale demonstration projects and the latest front end engineering design (FEED) studies, with CO_2 capture costs now projected to be in the range of 43 45 US$/t CO_2. Further cost reduction can be expected through 'learning by doing' where perhaps 50 70% cut could be achieved from the current cost of around 65 US$/t CO_2, as the technology is rolled out commercially. However, to kickstart this roll-out, a strong financial and regulatory regime will need to be put in place which delivers more positive carbon pricing signals, provides investment for carbon transport and storage infrastructure and provides more accessible debt and equity financing on the back of lowering CCUS specific project risk.

BENEFICIAL USES OF COAL FLY ASH, CCC/303

Dr Ian Reid, Anne M Carpenter, Dr Alice Masili | 93 pp, March

Fly ash, formerly regarded as a coal power waste material was collected and stockpiled. Now, it is considered environmentally and economically advantageous to maximise commercial use of this by product. Worldwide the total consumption of fly ash exceeds 60%, although this figure can approach 100% in specific regions. For example, cement products containing up to 50% fly ash provide an enhanced construction material. Inclusion of ash in cement is one of the most significant industrial means to reduce carbon intensity in the construction industry due to the high energy demand of cement manufacture.

Global changes to the coal power industry are reflected in fly ash production, which is dominated by Asia, while there are shortages in the USA and Western Europe. International fly ash exports from Asia and Eastern Europe are currently estimated at US$100 million per year. Amid rising demand, the market price of fly ash has risen and is currently one third that of cement.

The varied industrial applications of fly ash include:

- Construction and engineering materials: concrete, bricks, blocks and geopolymers. Incorporation of ash into construction materials leads to a product possessing enhanced strength that is especially important in complex engineering projects such as bridge, tunnel and dam structures, and as a structural road-fill material.
- Agriculture: ash possessing low levels of contaminants is suitable for agricultural use, to improve key soil indicators such as carbon content, water retention and fertility.

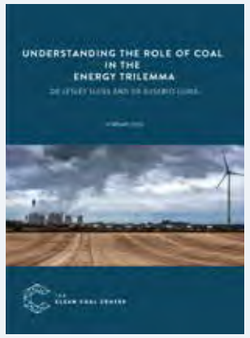
- Mineral extraction: The extraction of valuable elements (such as rare earths and germanium) from fly ash is significant to the renewable energy and aerospace industries, while fly ash can also be a source of aluminium.
- Advanced materials: composites, ceramics, fillers, zeolites and proppants. Fly ash is increasingly applied in the manufacture of advanced composite materials to extend the material properties and replace valuable metals.

MARKET DESIGNS FOR A RELIABLE ELECTRICITY GRID, CCC/302

Toby Lockwood | 132 pp, March

The growing deployment of variable renewable energy presents a challenge for electricity market design for grids with liberalised markets. Lower operating hours and other pressures have led to rapid retirement of thermal plant in many regions, raising concerns over how to drive investment in a future grid which provides sufficient firm capacity to meet demand, as well as the essential attributes of a reliable grid. To ensure resource adequacy, many markets have employed a form of capacity mechanism, while others have opted for an 'energy-only' approach in which investment is driven by wholesale price signals alone. Meanwhile, compensation mechanisms for grid services such as inertia, frequency control, voltage control, and constraint management have also come under increased scrutiny, as the proportion of thermal plant which has conventionally provided these services has declined. This report reviews how various liberalised markets have addressed these issues, with a focus on how different approaches are affecting the viability of coal plant. Finally, it considers some key markets in Asia which are beginning to tackle the same challenges as they move towards less regulated models.

UNDERSTANDING THE ROLE OF COAL IN THE ENERGY TRILEMMA, CCC/301



Dr Lesley Sloss and Dr Eusebio Loria | 95 pp, February

The energy trilemma is how to balance three aspects of energy production: security of energy supply; the environmental sustainability of energy chains; and energy affordability. Balancing this trilemma is a challenge, as countries prioritise according to their own regional issues. Many governments of developed nations, where electricity is available and affordable, have opted to increase their investment in environmental sustainability. However, low to middle-income countries, with both low per capita GDP and CO_2 emissions, tend to prioritise economic growth and improved access to affordable electricity.

The aim of the Paris Agreement is to limit the global temperature increase to 2°C and to achieve this through the decarbonisation of the global economy. Many governments have therefore set challenging targets for renewable energy uptake within the next few decades. However, a carbon-free electricity generation system based on renewable energy for baseload is not currently achievable. Further, uptake of renewable energy over the next decades will be insufficient to cover increased electricity demand from electrification of transport and industry as countries also move away from oil and petroleum. Until carbon-free baseload power is achievable at scale, the push towards the environment corner of the trilemma will be challenging and expensive and will raise issues of energy security in some regions. Energy security and the delivery of consistent and reliable power is vital for stable and growing economies. The security corner of the triangle will always take priority and so strategies to reduce emissions must ensure that the security of energy supply is maintained.

This report discusses how the desired rapid decarbonisation of the energy sector in an economic and timely fashion will be a significant challenge without coal in at least a bridging capacity, particularly in low-middle income countries. The pathways for phasing out traditional coal use in terms of cost, technical feasibility, and the effect on economies and society are reviewed. Clean coal technologies could act as a bridge to cleaner power and should be considered as future zero emission options.

HISTORIC EFFICIENCY IMPROVEMENT OF THE COAL POWER SECTOR, CCC/300

Dr Qian Zhu | 85 pp, February

Improving coal power fleet efficiency is one of the most cost-effective ways to reduce emissions of CO_2 and other air pollutants from the power sector. The average efficiency of the global coal power fleet has increased steadily over the years and is currently around 37.5%. However, this is still way below the >47.5% efficiency that today's state-of-the-art power plants can achieve, leaving huge room for improvement. This study looks at the trend of efficiency improvement of the coal power fleet at global and national levels over the past two decades. Case studies for China, India, Japan and the USA identify the key drivers and barriers to coal fleet efficiency improvement in the past, and how they were addressed. The historical coal power fleet efficiency data are analysed in relation to various nations' policies and regulations to see which were effective and which were less so. With this information and insights, decision-makers can gauge effective approaches to minimise the environmental impacts of coal power generation through fleet efficiency improvements.

Improving efficiency of existing coal power plants incurs capital costs. Plant owners need to be motivated to invest in power plant efficiency upgrades, usually by mandates or incentives. This study has found that compliance with government policies and regulations has been the main driver in most cases. While top down approaches appear to be most effective if the policies are well formulated and are fully implemented, a competitive market provides opportunities and economic incentives to power plant owners to improve power generation efficiency and therefore, acts as another main driver. Policies, if poorly designed and not carefully considered, could create uncertainties and burdens on power plant owners discouraging them from investing in efficiency upgrading projects.

2021 PROGRAMME

FORTHCOMING EVENTS

Currently, we cannot take forward any of our well-regarded workshops or our Clean Coal Technologies Conference, due to the risks still arising from the global pandemic. The expected UK vaccination programme in the first half of 2021 offers hope that we can restart our events schedule. However, we will all face uncertainties throughout 2021. Consequently, it is a more realistic option to plan for a 2022 schedule.

REPORTS IN 2021

- A PATHWAY TO REDUCING EMISSIONS FROM COAL POWER INDIA
- A TECHNOLOGY ROADMAP FOR HIGH EFFICIENCY, LOW EMISSIONS (HELE) COAL POWER PLANT
- INCREASING THE EFFICIENCY OF PULVERISED COAL FIRED POWER PLANT
- POTENTIAL MARKETS FOR HELE COAL-FIRED TECHNOLOGIES
- ADVANCES IN CARBON PRODUCTS FROM COAL
- BELT AND ROAD INITIATIVE – OUTLOOK FOR COAL
- HYDROGEN PRODUCTION FROM COAL
- ANALYSIS OF REGIONAL FOSSIL FUEL-BASED ENERGY STORAGE NEEDS, OPPORTUNITIES, AND TARGETS
- LONG-TERM COAL SUPPLY AVAILABILITY
- COAL AND ITS POTENTIAL IN DEVELOPING AFRICA
- BLENDED FIRING OF COAL AND LIGNITE IN BOILERS
- PROSPECTS FOR COAL IN EASTERN EUROPE
- ECONOMIC AND CARBON EMISSIONS ASSESSMENT OF COAL CCS POWER GENERATION AGAINST OTHER LOW CARBON TECHNOLOGIES
- METHANOL PRODUCTION AND MARKETS

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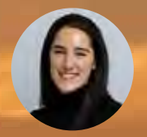
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The IEA Clean Coal Centre provides independent information and analysis on how coal can become a cleaner source of energy, compatible with the UN Sustainable Development Goals.

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