

CCT 2019 HOUSTON TEXAS, USA 3-7 JUNE

PROGRAMME

HYATT REGENCY HOUSTON/GALLERIA

WELCOME RECEPTION, IN THE REGISTRATION AREA
MONDAY EVENING 18:00 - 20:00

REGISTRATION
TUESDAY MORNING 08:00 - 08:50

CO-HOSTED BY US DEPARTMENT OF ENERGY



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CCT 2019 HOUSTON TEXAS, USA 3-7 JUNE

Hyatt Regency Houston/Galleria

2626 Sage Road, Houston, Texas, United States, 77056

+1 832 803 1234

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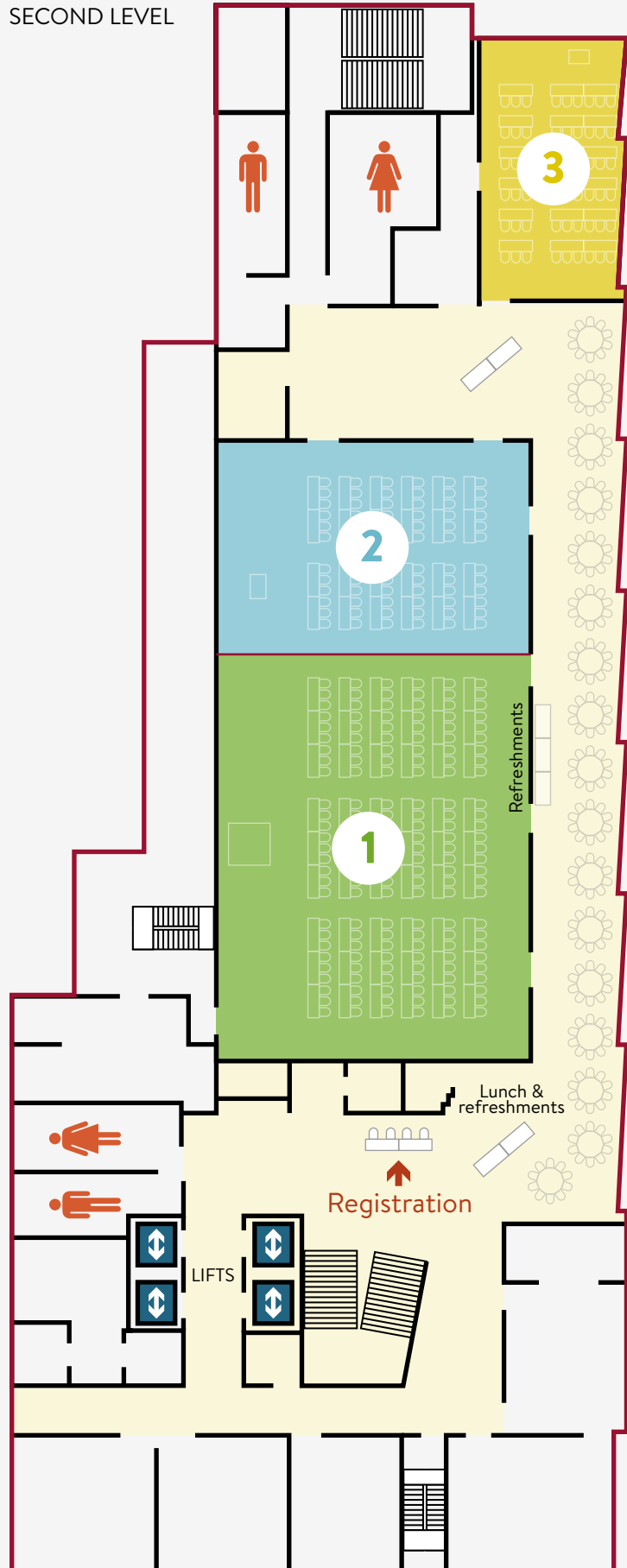


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SECOND LEVEL



Welcome to the 9th International Conference on Clean Coal Technologies

The 9th International Conference on Clean Coal Technologies (CCT 2019) is taking place in Houston, Texas, USA, with strong support from the United States Energy Association, and co-hosted by the US Department of Energy, which is a key member of the IEA Clean Coal Centre. For those of you who do not know us, the IEA Clean Coal Centre is part of a network of autonomous collaborative partnerships focused on a wide range of energy technologies known as Technology Collaboration Programmes (TCPs), organised under the auspices of the International Energy Agency (IEA).

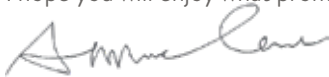
Our operating framework is designed to identify and publicise the best practice in every aspect of the coal production transport, processing and utilisation chain within the rationale for balancing security of supply, affordability and environmental issues. We are dedicated to providing independent information and analysis on how coal can become a cleaner source of energy, compatible with the UN Sustainable Development Goals. Through our conference and workshop series, we seek to take forward international knowledge transfer and capacity building, while providing a clear and impartial dialogue on the relative merits of coal technologies.

At previous CCT events, there has been considerable recognition of a need to ensure a careful balance between security of energy supply, cost, and environmental impact – ‘the energy trilemma’, which will vary from country to country. There is no ‘one-size-fits-all’ solution to climate change concerns since countries at different stages of the development cycle will pursue different approaches. In the USA, coal use is under pressure from very low-cost gas due to its successful fracking development programme. However, the US Government has increased coal exports for both thermal and coking markets, recognising the continued demand for this reliable low-cost energy source in many parts of the world. Japan and South Korea continue to prominently support clean coal utilisation via the high efficiency low emissions (HELE) approach, both for their internal markets and as technology export opportunities. For many developing nations, there is a strong focus on ensuring that their populations have access to electricity, which can be the most effective means to both improve education and their standard of living through industrialisation. In such cases, the fuel of choice is usually coal, being readily available, relatively low cost, and a proven choice for grid-based power generation.

However, it is essential to ensure that the environmental impact of pollutants such as particulates, SO_x, NO_x, and mercury are minimised and that carbon dioxide emissions can also be constrained as far as economically practicable. Developments in commercial flue gas cleaning and upstream techniques can now reduce emissions of conventional pollutants to levels close to that of gas turbines. Significant reductions in carbon dioxide emissions can be achieved through higher efficiency plant and more advanced steam conditions, with state-of-the-art plants now reaching efficiencies of up to 48% (net, lower heating value). Delegates at CCT will also hear about new concepts, many currently being tested at scale, which aim to achieve cycle efficiencies of some 50% to 53% within the next decade.

To achieve “near-zero” CO₂ emissions, there remains a need to introduce carbon capture, utilisation and storage (CCUS) technologies. It is noticeable that North America has been pushing forward with the demonstration of commercial prototype units and the introduction of more positive policies. Delegates will hear a series of presentations on how the ‘learning by doing’ approach of Canada’s Boundary Dam CCUS project can lead to significant reduction of capital and operating costs. Here in Texas, the success of the Petra Nova demonstration plant has been a landmark in the application of the technology to coal power at large-scale, while NET Power’s demonstration of the Allam Cycle – a pressurised oxy-fuel technology that uses supercritical carbon dioxide as a working fluid – is an excellent example of advancing CCUS innovation. From a policy perspective, the provision of the 45Q tax credit offers an attractive support for further large-scale operations in the US which will be discussed in detail in Wednesday’s panel session.

CCT 2019 features a comprehensive programme covering the key new technologies required for HELE plant, gasification options, and carbon dioxide capture from coal, together with expert insight on the changing policy and regulatory issues worldwide. Besides a wide range of technology-based presentations, there will be two policy-related panel discussion sessions featuring global energy experts. The international scope and variety of technologies on show are testament to the impressive response by the global research community to the growing demands for cleaner coal technologies. On behalf of the IEA Clean Coal Centre and the United States Department of Energy, I hope you will enjoy what promises to be a thought-provoking four days.



Dr Andrew J Minchener OBE
General Manager | IEA Clean Coal Centre



Andrew Minchener



IEA
CLEAN
COAL
CENTRE



Keynote and plenary session speakers



MI SHUHUA



LOU HRKMAN



GOPALAKRISHNAN VENU



GREG KENNEDY

Mi Shuhua – Executive Vice President, China Energy Investment Corporation (China Energy)

Mi Shuhua is in charge of the company's power generation business, procurement management and R&D efforts. The company's power business has a total installed capacity of 239 GW, including 179 GW thermal capacity, 38 GW wind capacity, and 19 GW hydro capacity. Mr. Mi graduated from Northeast Electric Power University in 1984. After graduation, he worked at Tongliao Thermal Power Plant until 2001 and became general manager of the plant. After that, Mr. Mi held many senior positions successively including General Manager of Guodian Northeast Power Co. Ltd., General manager of GD Power Development CO. Ltd., and Executive Vice President of China Guodian Corporation. After the merger of China Guodian Corp. and China Shenhua Group in late 2017, he became Executive Vice President of the newly formed China Energy Investment Corporation (China Energy).

Lou Hrkman – Deputy Assistant Secretary for Clean Coal and Carbon Management

Lou Hrkman is the Deputy Assistant Secretary (DAS) for Clean Coal and Carbon Management. As DAS for Clean Coal and Carbon Management, Mr. Hrkman oversees research, development, and demonstration of advanced coal-based power systems, and carbon capture, sequestration, and storage. Mr. Hrkman has more than two decades of experience in the energy industry, including work in both the public and private sectors. Most recently, he served as a Policy Adviser to Congressman David D. McKinley, who was the Chair of the House Coal Caucus and the Vice Chair of the Energy and Commerce Subcommittee. In this role, Mr. Hrkman advised Congressman McKinley on various policy issues and pending legislation pertaining to energy and the environment. He also previously served as a Legislative Fellow for Congressman Gus Bilirakis, assisting on Energy and Power Subcommittee issues. Prior to his service in the U.S. House of Representatives, Mr. Hrkman was a Regional Manager at Ingersoll Rand Inc. In this role, he led efforts to provide energy-efficient and sustainable business solutions. Additionally, from 1993 to 2010, Mr. Hrkman held several management positions at Siemens Industry Inc., including National Sales Manager and Director within the energy and environmental sector. His experience included all aspects of power generation, transmission and energy efficiency solutions within the building envelope. He has extensive experience in public-private partnerships and government affairs. He was an Officer in the United States Air Force. Mr. Hrkman earned his BA in Political

Science and Government from Miami University, his MPA from the University of South Dakota, and his MBA from the College of William and Mary.

Gopalakrishnan Venu – Executive Director (Engineering), NTPC

Gopalakrishnan Venu is presently working in NTPC as Executive Director (Engineering) at the Engineering Office Complex in Noida, Uttar Pradesh. He is a Mechanical Engineer by profession and has been working in NTPC for the past 36 years. He has been handling various divisions of the engineering functions of NTPC, right from concept to commissioning of coal and gas Thermal Power Projects, as well as Hydro Projects. He has also spearheaded the Renewable Energy Division of NTPC in the early stages to establish three Mega Solar PV Plants (250 MW each) in NTPC. Further, the policy advocacy for implementation of New Environmental Regulations (on SOx and NOx) were undertaken under his leadership and presently an elaborate program for implementation of FGDs (on about 60 GW of coal plant) is on-going. In addition, the pilot testing of SCR/SNCR technologies for DeNOx suitability (for use with high-ash Indian coals) in eight NTPC Power Stations are also in progress as per the plan envisaged. He is involved in various new initiatives of NTPC such as IGCC, biomass co-firing in existing coal-fired boilers, setting up of waste-to-energy plants, development of the advanced ultrasupercritical (AUSC) plant at Sipat, air-cooled condensers (ACC) for power plants, implementation of zero liquid discharge (ZLD) plants etc. He is nominated Director in Joint Ventures of NTPC such as NHPTL, NGSL and Anushakti VNL.

Conor Begley (Dave) – Managing Director Steam Power Americas, GE Power

Dave Begley is Managing Director of the GE Steam Power business in the Americas region. Dave joined GE through the Field Engineering Program in 1993, working as a Field Engineer at various customer power generation plants globally. His experience includes numerous positions within GE including Steam Services Manager in Spain, Global Generation Upgrades Leader, Project Leader for the "Company to Country" initiative, Outage Productivity Leader and most recently the Managing Director for the North America Nuclear, Boiler and Projects portfolio. Dave holds a B.S. degree in Mechanical Engineering from the University College Galway, Ireland and an MBA from Carnegie Mellon University, Pittsburgh. He currently resides in Atlanta, GA with his wife and daughter.



CHARLES McCONNELL



DAVE BEGLEY



KENNETH B. MEDLOCK III



BARRY K. WORTHINGTON

Greg Kennedy – Sr. Project Director for NRG Energy, Inc. and serves as the Asset Manager for the Petra Nova Project

In that capacity, Mr. Kennedy also serves as the President of Petra Nova Parish Holdings, LLC and its subsidiary companies. Additionally, Mr. Kennedy serves as the President of TCV Pipeline, LLC. Mr. Kennedy is responsible for the management of Petra Nova's assets and the many commercial agreements needed to manage the carbon capture project. Mr. Kennedy has almost 40 years of industry experience starting with Houston Lighting & Power Co. and the subsequent owners of the company's wholesale power division. In that role, he managed several large projects and prior to joining the Petra Nova project in 2013, he was responsible for asset management of GenOn's southeast fleet of assets. Mr. Kennedy has a Bachelor of Science degree from Purdue University and a Masters in Business Administration from the University of Houston.

Charles McConnell – Executive Director of the Center for Carbon Management and Energy Sustainability at the University of Houston

Prior to joining UH Energy, McConnell was the Executive Director of the Energy and Environment Initiative at Rice University. McConnell served as the Assistant Secretary of Energy in the US Department of Energy from 2011-13 and was responsible for the Office of Fossil Energy's strategic policy leadership, budgets, project management, and research and development of the department's coal, oil and gas, and advanced technologies programs, as well as for the operations and management of the U.S. Strategic Petroleum Reserve and the National Energy Technologies Laboratories. McConnell also previously served as Vice President of Carbon Management at Battelle Energy Technology in Columbus, Ohio and with Praxair, Inc. serving in a variety of operations, sales and global business and technology roles including hydrogen, gasification and energy as the Global VP of Energy and Hydrogen. McConnell is currently a board member of the Energy & Environmental Research Center (EERC) Foundation in North Dakota, is a member of the National Coal Council, has served on the Society of Petroleum Engineers and National Petroleum Council subcommittees, and has held a number of board positions including chairmanships of the Gasification & Syngas Technologies Council and the Clean Carbon Technology Foundation of Texas. McConnell holds a bachelor's degree in chemical engineering from Carnegie-Mellon University (1977) and an MBA in finance from Cleveland State University (1984).

Kenneth B. Medlock III, Ph.D – Senior Director, Centre for Energy Studies, Baker Institute

Dr Medlock is the James A. Baker, III, and Susan G. Baker Fellow in Energy and Resource Economics at the Baker Institute and the senior director of the Center for Energy Studies. He is also the director of the Masters of Energy Economics program, holds adjunct professor appointments in the Department of Economics and the Department of Civil and Environmental Engineering, and is the chair of the faculty advisory board at the Energy and Environment Initiative at Rice University. Medlock is also a Distinguished Fellow at the Institute of Energy Economics, Japan, holds a fellowship at King Abdullah Petroleum Studies and Research Center and is a member of the Advisory Board of the Payne Institute at Colorado School of Mines. In 2001, he won (joint with Ron Soligo) the International Association for Energy Economics Award for Best Paper of the Year in the Energy Journal. In 2011, he was given the USAEE's Senior Fellow Award, and in 2013 he accepted on behalf of the Center for Energy Studies the USAEE's Adelman-Frankel Award. In 2012, Medlock received the prestigious Haydn Williams Fellowship at Curtin University in Perth, Australia. He is also an active member of the American Economic Association and is an academic member of the National Petroleum Council. Medlock has served as an advisor to the U.S. Department of Energy and the California Energy Commission in their respective energy modeling efforts. Medlock received his Ph.D. in economics from Rice University in May 2000.

Barry K. Worthington - Executive Director of the United States Energy Association (USEA)

Through its membership, USEA represents 150 members across the U.S. energy sector from the largest Fortune 500 companies to small energy consulting firms. In his role, Mr. Worthington represents the broad interests of the U.S. energy industry and meets with domestic and international energy leaders to advance information and unearth partnerships to develop energy infrastructure projects across the world. Mr. Worthington is a resource to industry stakeholders, lawmakers, the media and the Trump administration on energy development and the role of our various energy resources to meet a growing global demand. He chairs the United Nations Economic Commission for Europe's (UNECE) Group of Experts for Cleaner Electricity Production from Fossil Fuels, and he sits on the UNECE's Committee on Sustainable Energy. He has served as executive director of USEA for 29 years. Before that, he was vice president of the Thomas Alva Edison Foundation and served in several capacities with Houston Lighting & Power, now CenterPoint Energy. Mr. Worthington holds a Bachelor of Science degree in man & environmental relations from the Pennsylvania State University and a Master of Science degree in studies of the future from the University of Houston.

ROOM 1

ROOM 2

ROOM 3

08:50-09:00 WELCOME – IEA Clean Coal Centre, US Department of Energy

09:00-10:25 KEYNOTE SESSION I

Lou Hrkman – Deputy Assistant Secretary, US Department of Energy

Mi Shuhua – Executive Vice-President, China Energy

Gopalakrishnan Venu – Executive Director of Engineering, NTPC

COFFEE BREAK - 10:25-10:50

10:50-12:30 Power plant optimisation and upgrading Chair: Scott Smouse

The high-temperature retrofit of subcritical units – **Li Li, Shanghai Shenergy Technology Co.**

Techno-economic modeling analysis on power plant performance optimizations – **Bin Xu, NICE America Research Inc.**

Plant operation optimisation supported by an intelligent control system – **Kazuhiro Domoto, MHPS**

Reducing costs, increasing reliability and meeting the latest ELVs by improving combustion – **Larry Berg, RJM**

The progress of CFB in China - efficiency and emission control – **Hai Zhang, Tsinghua University**

Biomass cofiring Chair: Samson Bada

Comparison of the blending effects of three types of biomasses with low rank lignite on pyrolysis and combustion processes – **Arzu Kanca, Ataturk University**

Modelling the emissions from a fuel flexible power plant and the impact on NOx emissions of coal with biomass ash in co-combustion – **Richard Birley, University of Leeds**

The realization of low emissions of briquette combustion in a coal-fired stove by decoupling combustion technology – **Nan Zhang, Institute of Process Engineering, Chinese Academy of Sciences**

Transformation characteristics of K/Cl/S/N during coal/biomass blend combustion under oxyfuel conditions – **Wei Li, Institute of Engineering Thermophysics, Chinese Academy of Sciences**

Uses of coal waste Chair: Paul Baruya

Rare earth elements from coal and coal by-products – **Mary Anne Alvin, NETL**

Recovery of rare earth elements from acid mine drainage – **Paul Ziemkiewicz, West Virginia University**

Porous carbon materials from South Africa coal wastes for gas storage applications: synthesis and characterization – **Jibril Abdulsalam, University of Witwatersrand**

CO₂ adsorption capacity of zeolites synthesised from coal fly ash – **Thiago Fernandes de Aquino, SATC**

LUNCH - 12:30-13:30

13:30-15:10 Developments in USC and AUSC power plant Chair: Gopalakrishnan Venu

Development of HELE technology at China Energy – **Zhang Wenjian, China Energy**

United States advanced ultra-supercritical project including full-scale 760°C superheater and steam turbine components – **Horst Hack, EPRI**

The Indian AUSC programme – **Shri Anil Kumar, BHEL**

A new degree of all turbine casings elevated arrangement for high-efficiency double reheat units – **Li Li, Shanghai Shenergy Power Technology Co., Ltd.**

Application of INCONEL alloy 740H in High Pressure - High temperature Power Systems – **Stephen McCoy, Special Metals**

Oxyfuel combustion Chair: Pilar Gayan

Demonstration and current activities for commercialisation of oxyfuel technology toward zero-emission coal-fired power plants – **Mizuki Nishimura, IHI Corporation**

Advanced exergetic analysis of a coal-fired cryogenic oxyfuel power plant with 700°C technology – **Jorge Renzo Castillo Paz, Institute for Energy Engineering, TU Berlin**

Lab-scale experimental characteristics of an oxy-coal combustion with steam moderation – **Ana I. Escudero, University of Zaragoza**

Combustion characteristics of an anthracite coal in 2 MWe oxy-CFB boiler – **See Hoon Lee, Chonbuk National University**

The impact of burner staging on NO reburning during oxy-coal combustion – **Thomas Yelland, University of Sheffield**

IGCC and gasification technologies Chair: Heather Nikolic

The progress of NEDO's IGCC demonstration project – **Yoichi Takahashi, NEDO**

IGCC with carbon capture: A comparison of technologies, efficiencies and cost for underground storage of hydrogen and substitute natural gas for flexible power generation – **Ruby Ray, Wood**

Pulverised coal injection at 500 psi – GTI Dry Solids Pump development and testing for gasification applications – **Timothy Saunders, Gas Technology Institute**

Modular gasification systems – coal-based energy systems for new applications – **David Lyons, NETL**

COFFEE BREAK - 15:10-15:40

15:40-17:20 Advanced sensors and simulation Chair: Bin Xu

Digital twin technology for clean coal – **Anirudh Deodhar, Tata Consultancy Services**

Increasing the load swing capacity of coal fired steam generators by online coal mass flow measurements and DCS modifications – **Stephan Larmann, Promecon USA Inc.**

CFD-based chemistry submodels to design and optimize dry sorbent injection systems for acid gas removal – **Ron Hurst, Ammegen Limited**

Usage of both tunable diode lasers and differential chemiluminescence technologies for NH₃ 'slip' measurement – **Jeremy Whorton, ThermoFisher**

Thermo-optical measuring technique – a highly efficient tool to increase the efficiency of coal combustion and minimize negative emissions – **Andreas Diegeler, Fraunhofer ISC**

Cofiring other fuels Chair: Hai Zhang

Numerical investigation on ammonia co-firing in a pulverized coal combustion facility – **Juwee Zhang, IHI Corporation**

Supporting the migration from coal to a new generation of engineered fuels using a mix of biogenic and non-recyclable waste materials for thermal power plants – **John Goldring and Christopher Biggs, RJM**

Physico-chemical characteristics and co-firing of *Searsia lancea* and *Tamarix usenoides* with high ash coal – **Samson Bada, University of the Witwatersrand**

Development of coal-fired power generation technology in China – **Huang Jingjing, China Power Engineering Consulting Group Co.**

CO₂ utilisation Chair: Kipp Coddington

The latest status of CO₂ utilisation technologies – **Qian Zhu, IEA Clean Coal Centre**

CO₂ to SNG pilot plant at Tauron's coal-fired power plant: initial results and further opportunities – **Adam Tatarczuk, Institute for Chemical Processing of Coal**

Developments, promise, and research needed to enable the use of algae to monetize CO₂ from coal power plants – **Robert Falco, SolarClean Fuels LLC**

Nano-engineered catalyst for the utilisation of CO₂ in dry reforming to produce syngas – **Shiguang Li, Gas Technology Institute**

ROOM 1

ROOM 2

ROOM 3

08:30–09:20 KEYNOTE SESSION II - Focus on Petra Nova

Greg Kennedy – Senior Project Manager, Petra Nova, NRG

Charles McConnell – Executive Director, Centre for Carbon Management in Energy, University of Houston

09:25–10:55

CCS: policy and economics
 Chair: Noel Simento

Can the Paris agreement facilitate CCS/CCUS projects? Lessons learned from the Kyoto Protocol and COP24 – **Kipp Coddington**, University of Wyoming

The economic costs and financial risks of carbon capture and sequestration – **David Schlissel**, Institute for Energy Economics and Financial Analysis

Enabling a gasification and carbon capture economy in India: An integrated techno-economic analysis – **Atanu Mukherjee**, M.N Dastur and Co.

CCUS Policy Parity: Mechanisms to overcome the disparity – **Will Polen**, United States Energy Association

Pollutant controls

Chair: Connie Senior

Environmental and health impact assessment of past technology incorporated in coal-fuelled plants: A global perspective using EDGAR-FASST model – **Gabriel David Oreggioni**, JRC Ispra

Multipollutant emission control with ClO₂-based technology – **Anette Heijnesson Hultén**, Nouryon

Computational modeling of a laboratory-scale ESP – **David Branken**, North-West University

Modelling of the unsteady state absorption of sulphur dioxide in an aqueous limestone slurry with precipitation of calcium sulphite – **Raymond Everson**, North-West University

Fundamental combustion studies

Chair: Sarma Pisupati

A mathematical model to determine ignition of a single solid fuel particle – **Tejas Ashar**, University of Sheffield

Modelling of trace element fate in an entrained-flow solid fuel combustion unit – **Wahyu Meka**, Imperial College London

Experimental and Numerical Study of the Effect of CO₂ on the Ignition Delay Times of Methane and Ethane under Different Pressures – **Chun Zou**, Huazhong University of Science and Technology

Study of ultra-low NO_x emission of char and lignite in a circulating fluidized bed with post combustion – **Tuo Zhou**, Institute of Engineering Thermalphysics, Chinese Academy of Sciences

COFFEE BREAK - 10:55–11:20

11:20–13:00

CCS: pilot and demonstration projects
 Chair: Lynn Brickett

Boundary Dam 3: Upgrades, updates and performance optimization of the world's first fully integrated CCS plant on coal – **Corwyn Bruce**, International CCS Knowledge Centre

Status update of US Department of Energy major fossil energy carbon capture and geologic storage demonstration projects in operation and lessons learned – **Venkat Venkataraman**, NETL

Project status update of the Wyoming Integrated Test Center – **William Morris**, Wyoming Integrated Test Center

Real-time aerosol measurements in post-combustion capture at National Carbon Capture Center (NCCC) – **Abhijit Bhagavatula**, Southern Company Services

Pilot testing of an amine-based solvent at a low-rank coal-fired power system – **Jason D. Laumb**, University of North Dakota, Energy & Environmental Research Center

Mercury and trace metals

Chair: Lesley Sloss

Monitoring of Mercury Emissions to optimize sorbent injections in Power and Cement Producing Plants – **Joseph Siperstein**, OhioLumex

Mercury re-emission and its mechanism – research in full-scale lignite-fired power plant – **Renata Krzyżyńska**, Wrocław University of Science and Technology

Mercury emissions from combustion of coal and lignite in large combustion plants in the Czech Republic – **Lukas Pilar**, Czech Technical University in Prague

Migration and identification of mercury species in wet flue gas desulfurization system using temperature programmed decomposition – **Yongchun Zhao**, Huazhong University of Science and Technology

Emission of lead is controlled in co-combustion by mineral blending of blended coal – **Shenghui Yu**, Huazhong University of Science and Technology

Coal conversion technologies

Chair: Andrew Michener

Technological innovation & practices in modern coal conversion by China Energy – **Wu Xingbin**, China Energy

R-GAS coal gasification technology – **Eric Z. Zhou**, Gas Technology Institute

High-sulfur petroleum coke gasification for hydrogen-rich syngas production – **Jiantao Zhao**, Institute of Coal Chemistry, Chinese Academy of Sciences

Development of catalytic microchannel reactor technology for hydrogen-based gas processing – **Raymond Everson**, North-West University

LUNCH - 13:00–14:00

14:00–15:20

CCS: next steps
 Chair: Erik Meuleman

2nd generation CCS – a case study for implementing CCS technology on SaskPower's Shand Power Station at reduced capital costs and increased performance flexibility – **Brent Jacobs**, The International CCS Knowledge Centre

Reducing CO₂ capture cost by 30% using the Advanced KM CDR Process – **Takashi Kamijo**, Mitsubishi Heavy Industries

Development of CO₂ capture technologies for coal-fired power plants in China: Idealized test challenges for China-specific conditions – **Pingjiao Hao**, NICE America Research

Design and costing of ION's CO₂ capture plant retrofitted to a 300 MW slipstream of a coal-fired power plant – **A Awtry**, ION Engineering

Small modular systems

Chair: David Lyons

An overview of clean coal technologies in the DOE transformative power generation program – **John Rockey**, NETL

DICE-gas turbine compound reheat combined cycle – **John Gulen**, Bechtel Infrastructure and Power

Making coal relevant for small-scale applications: modular gasification for syngas/engine CHP applications in challenging environments – **Chilkoot (Charles) Ward**, University of Alaska Fairbanks

Modular coal gasification – **Heather Nikolic**, University of Kentucky Centre for Applied Energy Research

Alternative uses of coal

Chair: Richard Horner

HUMAXX MicGAS™ Coal Bio Refinery Techno-Economic Analysis for Deployment in Wyoming – **Prasad Dhurjati**, University of Delaware

Hg and SO₂ emission control potential of activated carbons based on brown coal and influence of material structure and composition – **Stefan Thiel**, TU Freiberg

Development of X-MAT® coal core composite for building materials applications – **Bill Easter**, Semplastics

A novel integrated solution for making valuable high carbon content products from coal with near zero carbon footprint – **Richard Horner**, University of Wyoming

COFFEE BREAK - 15:20–15:40

15:40–17:10

Panel session: Driving CCUS deployment in the US – Chair: **Holly Krutka** – Peabody

Lynn Brickett – National Energy Technology Laboratory

Shannon Angielski – Carbon Utilization Research Council

Charlene Russell – Occidental Petroleum

CONFERENCE DINNER - 18:30 in the plenary hall

Thursday 6th June

ROOM 1

ROOM 2

ROOM 3

08:40-09:05 KEYNOTE SESSION III

Dave Begley – Managing Director Steam Power Americas, GE Power

09:10-10:50

Future pathways for global coal research and technology development (CoalTech2051) Chair: Brian Ricketts

Introduction to the European Research Fund for Coal and Steel's CoalTech2051 project – Coordinated by the IEA Clean Coal Centre and Euracoal

Panel discussion

Hisanori Nei, GRIPS, Japan
Luc Janssen, European Commission
Scott Smouse, US DOE
Anthony Ku, NICE America Research
Noel Simento, ANLEC R&D

CCS technology overviews Chair: Corwyn Bruce

US DOE/NETL large pilot-scale testing of advanced carbon capture technologies – **Thomas Sarkus**, NETL

An update of CO₂ capture technologies for coal power plants, their potential to reduce costs and the flexible integration in the electricity grid – **Monica Garcia**, IEA Greenhouse Gas R&D Programme

Updating the benchmark post-combustion CO₂-capture technology – **Paul Feron**, CSIRO

Carbon emissions management: technology innovation and the path to commercialization – **Christopher Hessler**, The Institute of Clean Air Companies

Power plant flexibility Chair: Horst Hack

Evaluation of a contribution of coal-fired power plant's flexibility to a power system during increasing shares of renewable energies – **Fumihiko Yoshida**, Central Research Institute of Electric Power Industry

Better fuel distribution to improve combustion during flexible load operation – **Ron Hurst**, Ammegen Limited

Power plant efficiency and flexibility improvements with AdvX™ – **Blake Stapper**, Ljungström

Coal plant in the ERCOT electricity market – **Warren Lasher**, Electricity Reliability Council of Texas

COFFEE BREAK - 10:50-11:20

11:20-12:50

Novel power generation systems Chair: Chun Zou

Allam Cycle Coal - a novel clean coal supercritical CO₂ power cycle – **Xijia Lu**, 8 Rivers Capital

The STEP 10 MWe sCO₂ Pilot Plant TX demonstration – **John I. Marion**, Gas Technology Institute

Developing a large pilot demonstration of flameless pressurized oxy-combustion – **Joshua Schmitt**, Southwest Research Institute

21st Century high-efficiency coal-fired steam generator with integral emissions control – **Keith Moore**, CastleLight Energy Corp

Water Chair: Ayaka Jones

Satisfying thirsty power: The water-energy nexus – **Vincent Tidwell**, Sandia National Laboratory

Water neutral heat rejection system for a 2nd generation CCS facility: novel process optimizations using additional recovered water while maintaining the water balance – **Stavroula Giannaris**, The International CCS Knowledge Centre

Water issues and wastewater treatment – **Lesley Sloss**, IEA Clean Coal Centre

Water and ground control measures from Sub-Technical/SealGuard in karstic terrain and low cover crossings results in lower operating costs – **Stephen Reidell**, Sub-Technical/SealGuard Inc

Advanced post-combustion capture technologies Chair: Monica Garcia

Graphene oxide-PEEK hybrid membrane process for CO₂ capture – **Shiguang Li**, Gas Technology Institute; **Yong Ding**, Air Liquide

Reaction enthalpy conversion in amine-based post-combustion CO₂ capture – **Paul Feron**, CSIRO

Retrofit CO₂ capture membranes: effect of performance and capture rate on plant efficiency cost – **Timothy Fout**, NETL

Catalyst-promoted solvent reduces the capital and expenditures for CO₂ capture from coal flue gases – **Ahmed Aboudheir**, Aboudheir Consulting

LUNCH - 12:50-14:00

14:00-15:40

Social issues Chair: Hisanori Nei

The economic and strategic value of coal – **Paul Baruya**, IEA Clean Coal Centre

The importance of CCU and CSR for coal's survival in the EU – **Vladimir Budinsky**, Svereroceske doly a.s.

Coal in the 21st Century – **Liam McHugh**, World Coal Association

Environmental and social responsibility in the coal supply chain – **Gavin Rowson**, Bettercoal

Chemical looping Chair: John Marion

Moving Bed Chemical Looping System for Coal Combustion and Gasification: Process Development and Assessment – **Andrew Tong**, Ohio State University

Comparison of a full range of oxygen carrier materials for chemical looping combustion – **Pilar Gayan**, Instituto de Carboquimica

An investigation of bimetallic Cu-Fe and Mn-Fe oxygen carriers for coal chemical looping assisted by oxygen uncoupling (CLaOU) – **Ping Wang**, NETL

Evaluation of different strategies to improve the efficiency of coal conversion in a 50 kWth chemical looping combustion unit – **Alberto Abad**, Instituto de Carboquimica

Reduced chemical mechanism for a chemical looping combustion system – **Hong-Shig Shim**, Reaction Engineering International

Coal gasification and UCG Chair: Alberto Pettinau

Unconventional methane production from deep seams through combined coal bed methane and underground coal gasification technologies: Project MEGAPlus – **Krzysztof Kapusta**, Główny Instytut Górnictwa

The eUCG™ technology with ultra-low carbon emissions – **Michael Blinderman**, Ergo Exergy Technologies

Reactivity of petcoke chars generated in a high-pressure, high-temperature, flow reactor under various gaseous environments – **Sarma Pisupati**, The Pennsylvania State University

Gasification characteristics of coke prepared by blending caking coal with more low rank coal – **Jiejie Huang**, Institute of Coal Chemistry, Chinese Academy of Sciences

COFFEE BREAK - 15:40-16:00

16:00-17:00

Closing plenary session

Kenneth Medlock – Senior Director, Centre for Energy Studies, Baker Institute
Barry Worthington – Executive Director, United States Energy Association
Andrew Minchener – General Manager, IEA Clean Coal Centre

Visits to the NET Power and Petra Nova demonstration plants

On Friday 7th June, technical visits to two projects of global significance for carbon capture technology are available to delegates who have successfully reserved a place.

Tours of the NET Power demonstration plant in LaPorte will take place over the morning only, with the first tour departing at 7.15 am from the Hyatt Galleria.

A morning visit to Petra Nova will depart at 7.15 am and return to the hotel by 11 am, while an afternoon tour will leave at 12.15 pm and return by 4.30 pm.

Delegates joining either of these tours will be notified of their exact schedule by email.



The **NET Power** facility at LaPorte is a 50 Mwt demonstration of the innovative 'Allam Cycle' process – a form of supercritical CO₂ power cycle which could potentially achieve carbon capture at zero additional cost. The plant achieved first fire in May last year, and is currently undergoing a test programme to underpin eventual scale-up to a 300 MW power plant. Whilst the NET Power plant is fired with natural gas, parent company 8 Rivers Capital have also designed a process based on gasified coal, which will be presented at the conference in the 'Novel Power Generation Systems' session. With both gas and coal systems projecting costs in line with unabated power plants, the Allam Cycle is hotly anticipated as a potential game-changer for CCS.



Commissioned in January 2017, **Petra Nova** is the world's largest CCS facility on a coal-fired power plant, and one of only two such plants currently operating. The project uses MHI's Kansai Mitsubishi CO₂ recovery process (KM CDR) to treat the equivalent of 240 MW of flue gas from a unit at NRG's WA Parish Power Plant. The resulting 1.4 Mt/year of CO₂ is used for enhanced oil recovery in the nearby West Ranch Oil Field, in part owned by the project itself in order to maximise value. Assisted by a \$167 million grant from the US Department of Energy, Petra Nova is notable for having been completed on budget and on schedule. It represents the state-of-the-art in commercial, large-scale CO₂ capture from coal power.

Driving CCUS deployment in the US – plenary panel session



HOLLY KRUTKA



LYNN BRICKETT



CHARLENE RUSSELL



SHANNON ANGIELSKI

Holly Krutka (Chair) – Vice President Coal Generation and Emissions Technologies at Peabody

In this role, Dr. Holly Krutka works to help protect and enhance the existing U.S. coal fleet as well as promote the use of high-efficiency, low-emissions (HELE) technologies. This includes working on public policy proposals, technical working groups and other initiatives that advance the development and commercialization of carbon capture use and storage (CCUS) technologies.

Prior to her role with Peabody, Holly spent the last decade on research and development, analysis, communications, advocacy, and policy related to CCUS and other clean coal technologies. She is a member of the National Coal Council, the lead inventor on several patents for a novel CO₂ capture technology, the co-chair of the Carbon Utilization Research Council and is a judge for the NRG COSIA Carbon XPRIZE competition. Dr. Krutka holds a PhD and a BS in Chemical Engineering from the University of Oklahoma.

Lynn Brickett – Carbon Capture and Carbon Use and Reuse R&D Technology Manager at the National Energy Technology Laboratory for the U.S. Department of Energy

Lynn Brickett is the In this position, she manages an annual R&D portfolio of over \$100M. Her career has focused on environmental issues associated with coal-fired power plants including: by-products, water, nitrogen oxides, mercury and carbon dioxide. Ms. Brickett has been with NETL for 18 years, working as the Director of the Capture Division, federal project manager in the Innovations for Existing Plants Project Management Division and a researcher studying the environmental impacts of coal by-products. Prior to NETL, she worked for The US Bureau of Mines conducting research on bioleaching of copper ores, bio-oxidation of gold ores and remediation of acid mine drainage. Ms. Brickett received her B.S. degree in Environmental Science and her M.S. degree in Environmental Science and Management.

Charlene Russell – Vice President Low Carbon Strategies at Oxy Low Carbon Ventures, LLC, a wholly owned subsidiary of Occidental Petroleum

Ms. Russell has over 30 years of commercial and project development experience in the chemicals and oil and gas

business. In her current role, Ms. Russell's responsibilities include leading Occidental's efforts with external stakeholders in strategic policy development and implementation to connect Occidental's commercial and carbon mitigation strategy.

Previously, Ms. Russell was Vice President Commercial Development responsible for leading Occidental's Permian Enhanced Oil Recovery (EOR) Strategic Sourcing and Carbon Capture CO₂ teams in developing and implementing CO₂ sourcing strategy for the world's largest portfolio of EOR floods.

She also served as Senior Director and Business Director Strategic Sourcing for Occidental's Permian EOR business unit. Before joining Occidental's oil and gas business in 2012, Ms. Russell worked as a Business Director at Occidental Chemical Corporation (OxyChem), a wholly owned subsidiary of Occidental Petroleum. Joining OxyChem in 1997 as Marketing Manager, she progressed through positions of increasing responsibility in the areas of commercial and business development for multiple segments of the chemicals business with significant international presence.

Ms. Russell holds a Bachelor of Science degree in Chemical Engineering from the University of Kentucky.

Shannon Angielski – Principal, Governmental Affairs, Van Ness Feldman, Carbon Utilization Research Council

Shannon Angielski is a principal at Van Ness Feldman LLP, a Washington D.C. based law firm that specializes in energy, environment and natural resource policy and law, and serves as the Executive Director of the Carbon Utilization Research Council (CURC), an organization comprised of industry, NGOs, academia and state agencies focused on technology solutions for the responsible use of our nation's fossil energy resources to support our nation's need for reliable and affordable energy. CURC is a leading advocate for identifying policy pathways in support of the technologies that will enable us to benefit from the use of our fossil fuels in a manner consistent with societal needs and goals.

Shannon earned her M.S. in Environmental Science and Public Policy from Johns Hopkins University in 2000 and her B.A. in Political Science and International Affairs from the University of New Hampshire in 1994. She is a member of the National Coal Council and serves on the board of the Washington Coal Club.

CCT 2019 - Poster presentations

CO₂ CAPTURE AND BIOMASS CO-FIRING IN A 100 KWTH OXY-CFB COMBUSTION SYSTEM

Tae-Young Mun, Ji Hong Moon, Sung-Ho Jo, Nguyen Hoang Khoi, Sung-Jin Park, Jae-Goo Lee, Myung Won Seo, Ho Won Ra, Sung-Min Yoon, Sang Jun Yoon - Korea Institute of Energy Research

HYDRODYNAMIC AND SOLID CIRCULATION TESTS OF OXYGEN CARRIER FOR 0.5 MWTH CHEMICAL LOOPING COMBUSTION SYSTEM

Ho-Jung Ryu - Korea Institute of Energy Research

NUMERICAL SIMULATION OF AMMONIA-COAL CO-FIRING IN BOILERS WITH DETAILED CHEMISTRY

Sakiko Ishihara - IHI Corporation

DESIGN OF 2ND GENERATION CCS FACILITY FACILITATES INTEGRATION WITH RENEWABLE ENERGY WHILE PRODUCING HIGHER CAPTURE RATES; IMPROVING THE ECONOMICS AND ENVIRONMENTAL FOOTPRINT OF THE CCS FACILITY

Stavroula Giannaris - International CCS Knowledge Centre

HEAT INTEGRATION STRATEGIES FOR PERFORMANCE OPTIMIZATION OF A 2ND GENERATION CCS FACILITY BY MAXIMIZING FLEXIBILITY AND MINIMIZING PARASITIC LOSSES

Stavroula Giannaris - International CCS Knowledge Centre

NUMERICAL MODELING OF CHEMICAL COMPONENTS' CONCENTRATION IN POWER PLANT INSTALLATIONS

Paweł Regucki - Wrocław University of Science and Technology

SIMULTANEOUS IN-FURNACE REDUCTION OF SO_x AND NO_x USING LIMESTONE AND UREA SOLUTION IN OXY-FUEL CFB COMBUSTION

Min Kyu Jeon, Jin Han Yun, Chung Kyu Lee, Sang In Keel - Korea Institute of Machinery and Materials



ITC

WYOMING
INTEGRATED
TEST CENTER

The Wyoming Integrated Test Center (ITC) is a research test facility designed to foster the next generation of energy technology.



RESEARCH | PILOT | COMMERCIALIZATION

Wyoming has the environment to help CCUS projects be successful - no matter their development stage.

Wyoming Opportunities

ITC

- Carbon Capture Research
- Carbon Utilization Research

Wyoming CarbonSAFE

- World class Geologic Reservoirs for Saline Storage
- .5 miles south of the ITC
- Developing commercial scale geologic storage sites for CO₂ from industrial sources

Enhanced Oil Recovery

- 100+ potential CO₂-EOR opportunity sites within 25 miles of the ITC

CO₂ Pipeline

- Existing CO₂ pipeline infrastructure within 25 miles of the ITC

Testing at the ITC

Services Provided

- Service water (350 GPM Total)
- Flue gas (87,500 ACFM Total)
- Power (3,000 kW large bay, 750 kW small bay)
- Power to ITC booster ID fan (200 kW)
- Office space and meeting room

Services Not Provided (but available)

- Process steam
- Demineralized water
- Compressed air
- Common flue gas exhaust
- Public display building

