INNOVATIVE APPROACHES TO LOWER EMISSIONS FROM COAL POWER

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IEA CLEAN COAL CENTRE
SCOPE OF PRESENTATION

• The IEA Clean Coal Centre
• High efficiency low emissions (HELE) coal power
• Innovations on the horizon
• The way forward
OUR MISSION STATEMENT

To provide our members, the IEA Working Party on Fossil Fuels and other interested parties with independent information and analysis on all coal related trends compatible with the UN Sustainable Development Goals

How we achieve this:

• Assessment studies for the use of coal in a carbon constrained world
• Outreach activities, increasingly in developing and industrialising countries
• Dissemination activities via website, the press and other media sources
• Specialist support upon request to individual members
CUTTING CO$_2$ WITH HELE TECHNOLOGIES

- Over 30% saving in CO$_2$ emissions intensity between state-of-the-art and average
- Potential for >3 Gt CO$_2$/y saving (similar to India)
- CCS will be best applied to high-efficiency plant
ADVANTAGES OF HELE COAL POWER

• Lower carbon emissions intensity

• Lower operating costs

• Scope to minimise non-GHG emissions with state of the art technology

• Can ensure grid stability when intermittent renewables are included in the energy mix

Waigaoqiao No. 3 Power Plant
Photo: Prof. Feng Weizhong, used with permission
<table>
<thead>
<tr>
<th>REGION</th>
<th>IN OPERATION (MWe)</th>
<th>UNDER CONSTRUCTION (MWe)</th>
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</thead>
<tbody>
<tr>
<td>Asia</td>
<td>224,203</td>
<td>88,228</td>
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<tr>
<td>Europe</td>
<td>19,208</td>
<td>4,970</td>
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<td>Middle East</td>
<td>0</td>
<td>2,400</td>
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<tr>
<td>Eurasia</td>
<td>300</td>
<td>0</td>
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<td>North America</td>
<td>665</td>
<td>0</td>
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Japan and Western Europe led the deployment of USC – the majority is now in China, following rapid fleet renovation and growth in 2006-2010 (~200 GW built)
Materials for HELE plant are used in tubing and welds in hottest parts of the boiler – superheaters and reheating steam tubes.

Steel based alloys used universally, even in the latest USC

Cost-conscious markets led to newer advanced steels, T23 and T24

GE’s new SteamH technology uses Ni superalloys, HR6W and Inconel - 670°C systems capable of 49.1% (net) efficiency

Combined with 700°C AUSC nickel alloys could deliver efficiencies >50-52% LHV
Pingshan Phase 2 Demonstration

- GE SteamH boiler technology used (33 MPa/600°C/620°C/630°C)
- Novel approach to enhance performance to **49.8% efficiency**
- Cross compound at high/low position arrangement (CCHLPA); *elevated turbine-generator* unit - HP and IP turbines mounted at same level as boiler outlet steam headers
- High mounted turbines reduces pressure drop, temperature loss, and component costs
OTHER INNOVATIONS

**Supercritical CO\textsubscript{2} turbine cycles**
- Allam Cycle – 51% efficiency for coal power
- Much smaller footprint
- More efficient heat recovery

*IEA CCC report, Qian Zhu, 2017*

**Gasification technologies**
- Integrated gasification combined cycle
- Integrated gasification fuel cell
- Coal to chemicals/transport fuels

*IEA CCC report, Xing Zhang, 2018*

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Echogen’s 10 MWe sCO\textsubscript{2} power turbine compared to a 10 MWe steam turbine.

Osaki CoolGen project (Nakamura, 2016)
COAL AND THE PARIS AGREEMENT

• Identified a role for HELE coal in their NDC:
  Afghanistan, Bangladesh, Bosnia and Herzegovina, China, Egypt, Georgia, Ghana, India, Indonesia, Japan, Kazakhstan, Kenya, Mongolia, Montenegro, Myanmar, Nigeria, North Korea, Pakistan, Philippines, Republic of Macedonia, South Africa, Turkey, United Arab Emirates and Viet Nam. Account for over half of global coal power emissions

• Made direct or indirect reference to CCUS in their NDC:
  Many major coal using nations including Bahrain, Canada, China, Egypt, Iran, Iraq, Malawi, Montenegro, Norway, Malawi, Saudi Arabia, Egypt, South Africa, United Arab Emirates, EU (28) and USA
THE WAY FORWARD

• HELE coal power technologies are key - where coal is the most affordable and available energy source, in developing countries

• Higher efficiencies and lower CO$_2$/kWh developments are underway

• Several innovative gasification technologies are being developed to integrate fuel cells and expand hydrogen economy

• Carbon capture utilisation and storage
THANK YOU FOR LISTENING

ANY QUESTIONS?

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