UPDATE ON HELE COAL POWER DEVELOPMENTS WORLDWIDE

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CLEAN COAL CENTRE

SCOPE OF PRESENTATION

- Revised remit and operating approach for the IEA Clean Coal Centre
- Status of HELE coal power and other systems
- Potential for further technology introduction
- Drivers for deploying HELE coal power
- IEACCC assessment of HELE coal power deployment challenges and opportunities (work underway)

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General Manager

OUR MISSION STATEMENT

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

IEA CCC AND UN SUSTAINABLE DEVELOPMENT GOALS

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, thereby countering any unwanted impacts to ensure the wellbeing of societies worldwide.

We consider policy and regulatory issues as well efficiency improvements, lowering greenhouse- and non greenhouse-gas emissions, reducing water stress, financial resourcing, market issues, technology development and deployment, ensuring poverty alleviation through universal access to robust and reliable electricity, sustainability, and social licence to operate

HOW DO WE ADDRESS THESE SUSTAINABLE DEVELOPMENT GOALS FOR COAL

Four interlinked activities within our work programme:

- Assessment studies for the sustainable use of coal in a carbon constrained world, covering policy and regulatory considerations, global funding options, markets, social acceptance and a wide range of technology related issues. Output of each study includes a comprehensive report and a separate policy relevant executive summary
- Outreach activities, increasingly in developing and industrialising countries, often in collaboration with like-minded organisations
- Dissemination activities via website, the press and other media sources
- Provision of specialist support upon request to individual members

WORKING TOWARDS NEAR ZERO EMISSIONS TO AIR, LAND AND WATER

- GHG emissions (e.g. HELE technologies, sCO2 systems, CCUS/CCS options)
- Non-GHG emissions (e.g. SOx, NOx, particulates, mercury control)
- Coal-water nexus and water stress
- Wastes, discharges and land rehabilitation

HELE Perspectives for selected Asian countries, CCC/287

Power generation from coal using supercritical CO2 cycle, CCC/280

An overview of HELE technology deployment in the coal power plant fleets of China, EU, Japan and USA, CCC/273

China – policies, HELE technologies and CO2 reductions, CCC/269

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NOx control for high ash coals CCC/285
Emerging markets for pollution control retrofits, CCC/274
Wastewater regulations and issues for coal fired power plants, CCC/283
Water conservation in coal fired power plants, CCC/275
Water availability and policies for the coal power sector, CCC/256
Potential water sources for coal-fired power plants, CCC/266
Environmental and other effects of coal mining and transport, CCC/281
Coal beneficiation, CCC/278
Low quality coals: key commercial and environmental and plant considerations, CCC/270
Assessing and managing spontaneous

HELE ONGOING DEPLOYMENT AND DEVELOPMENT ACTIVITIES UNDERWAY

POLICY AND MACROECONOMIC DRIVERS

Environmental Policy	• Climate targets • Technology neutral policies
Electricity sector expansion	• Planned GW • High dependency on single/dual fuels • High annual growth • Electricity ‘starvation’ • Reserve margins
Macroeconomic issues	• Higher population growth • Low per capita income • Financial and business drivers; sovereign risk, record of inward investment

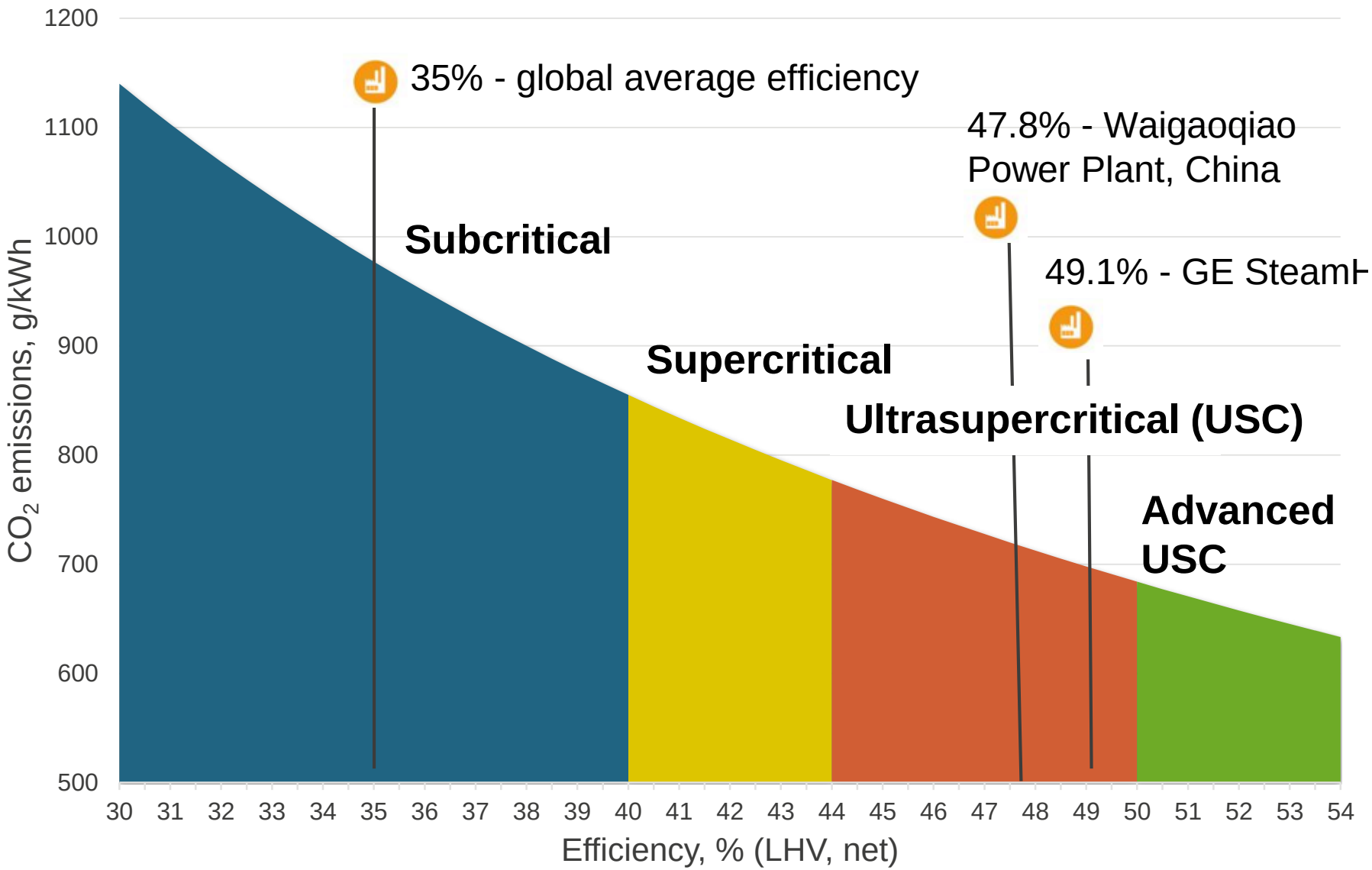
USC COAL POWER CAPACITY WORLDWIDE

(PLATTS, JUNE 2017 AND JUNE 2018)

REGION	IN OPERATION (MWe)		UNDER CONSTRUCTON (MWe)	
	2017	2018	2017	2018
Asia	201,413	224203	94,575	88228
Europe	24,133	19208	6045	4970
Middle East	0	0	3786	2400
Eurasia	300	300	0	0
North America	665	665	0	0

HELE EFFICIENCY AND CO2 EMISSIONS

- 30% saving in CO_2 emissions intensity between state-of-the-art and current average
- Potential for >3 Gt annual CO_2 saving



GENERIC ADVANTAGES OF USC COAL POWER

- Lower specific capital cost than alternative coal power options
- Lower operating costs
- Lower carbon emissions intensity
- Scope to minimise non-GHG emissions
- Can provide a robust means to ensure grid stability when chaotic renewables are included in the energy mix

MEANS TO IMPLEMENT HELE TECHNOLOGY

- Introduce efficiency performance standards
- Tighten air quality standards
- Ensure strong monitoring and verification
- Gain financial support, if it is a developing and industrialising country that wishes to introduce such technology

POTENTIAL FOR MORE HELE COAL POWER

- Many developing countries are undergoing an economic transition through urbanization and industrialization
- Major opportunities in fast growing economies, especially Greater Asia, with support from China and Japan, and possibly Southern Africa with support from the African Development Bank
- However, this potential deployment faces challenges
- Without a government commitment to build HELE coal power plants, public acceptance, and appropriate local regulatory, policy, economic and environmental circumstances, it will be difficult to realise the benefits

COAL AND THE PARIS AGREEMENT

- 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 Vietnam all identified a role for HELE in their NDCs. Between them they account for over half of global coal power emissions

- 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 (currently representing in principle 28 countries) and USA made either direct or indirect reference to CCS in their NDCs

FURTHER INNOVATION FROM CHINA

- Retrofit subcritical coal power units by increasing the steam temperature (but not the pressure) to supercritical level by means of selective component upgrades

- Gain some efficiency benefit, which can be readily deployed, but is it cost effective?

- Xuzhou demonstration project has shown that a net efficiency of 42.8% can be achieved by retrofit of subcritical units. Further work ongoing

BEYOND USC

Advanced USC

- Ni superalloys to achieve 700°C steam and 50% efficiency, with testing underway in USA, Europe, Japan, China and India
- Large component test facilities operating in China and Japan, with a USA unit to be operational late in 2018
- India has recently committed significant funding to AUSC – first commercial units being taken forward
- Operational developments going forward to demonstration phase in China

Supercritical CO_2 turbine cycles

- Much smaller than steam turbines
- More efficient heat recovery
- Can be indirect or direct cycle
- 'Allam Cycle' – 51% for coal
- *IEA CCC report* – Qian Zhu, 2018

Integrated gasification fuel cell

- 166 MW Osaki CoolGen project starts 2019 (Japan)
- Take H_2 from oxy-blown gasifier
- Incorporates CO_2 capture
- *IEA CCC report* – Xing Zhang, 2018

ADVANCES IN COAL POWER BASED ON MATERIAL SCIENCE

- Key differences of materials for HELE plant are for tubing and welds used in the hottest parts of the boiler – steam superheaters and reheaters

- GE's new SteamH technology uses nickel superalloys, including HR6W and Inconel. They will offer a 670°C SteamH system capable of 49.1% (net) efficiency

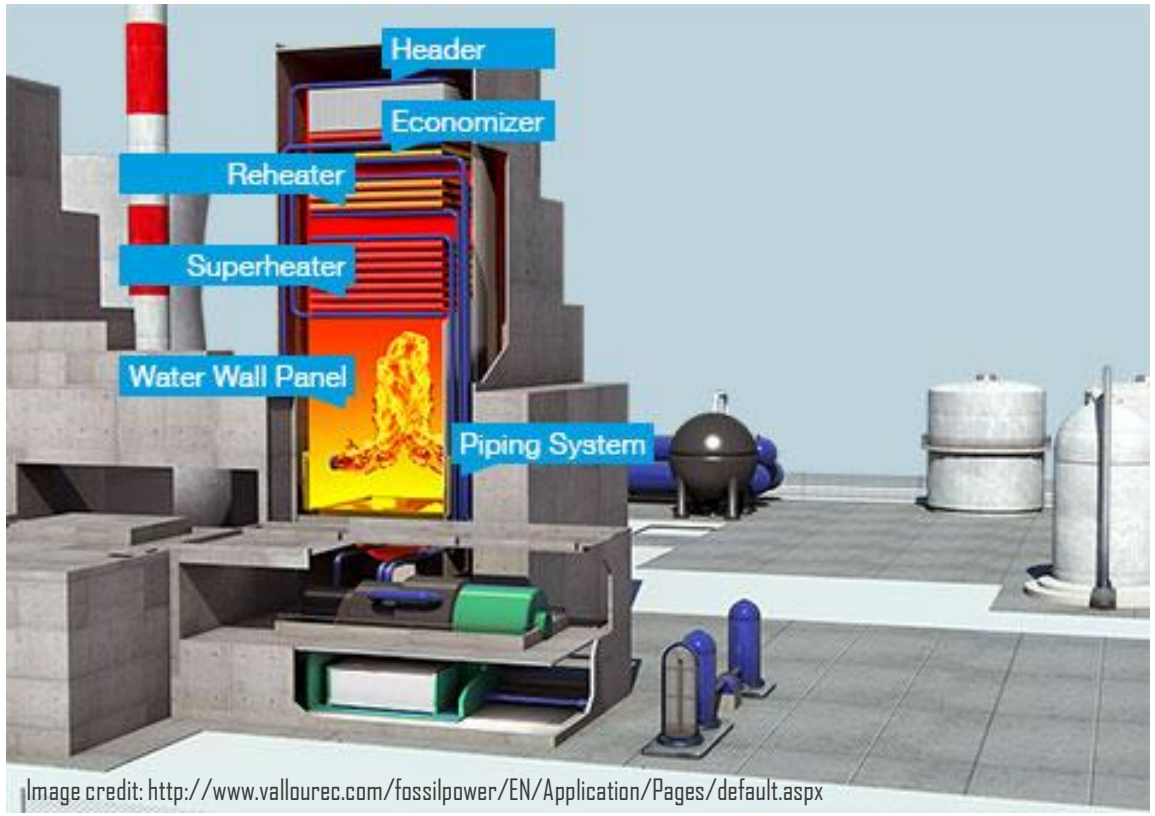
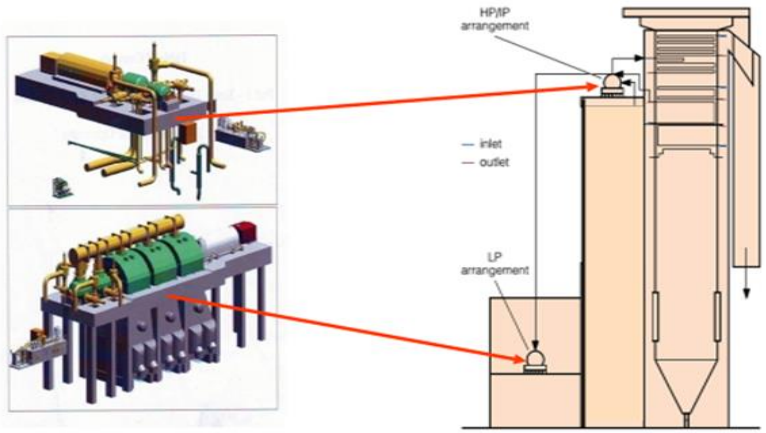


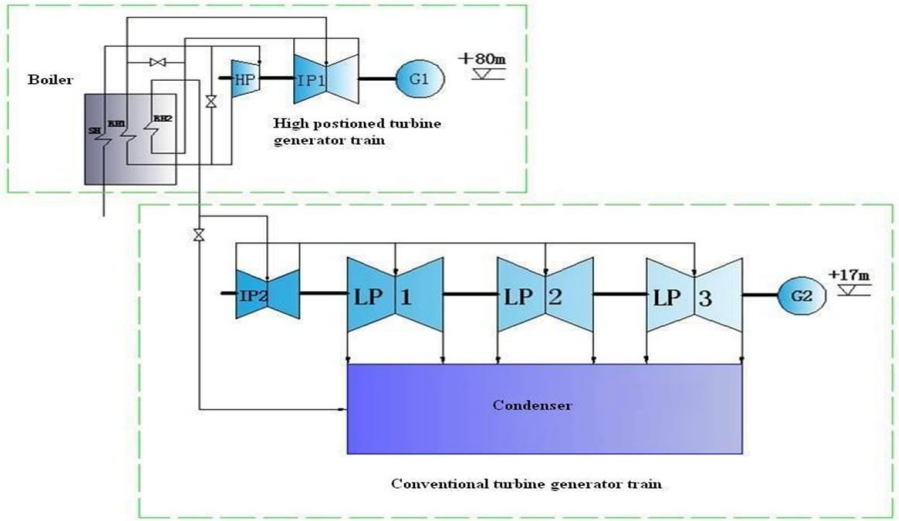
Image credit: http://www.vallourec.com/fossilpower/EN/Application/Pages/default.aspx

AN ALTERNATIVE APPROACH (YAO 2017)

Pingshan 1350MWe double reheat USC with adapted steam turbine layout

- Rated output：1350MWe
- Rated main steam flow：3229T/h
- Max main steam flow ：3416T/h
- Main steam pressure/reheat steam I pressure/reheat steam II pressure：30MPa/9.17MPa/2.25MPa
- Main steam temperature/reheat steam 1 temperature/reheat steam 2 temperature：600℃/610℃/620℃
- Cooling water temperature：19℃





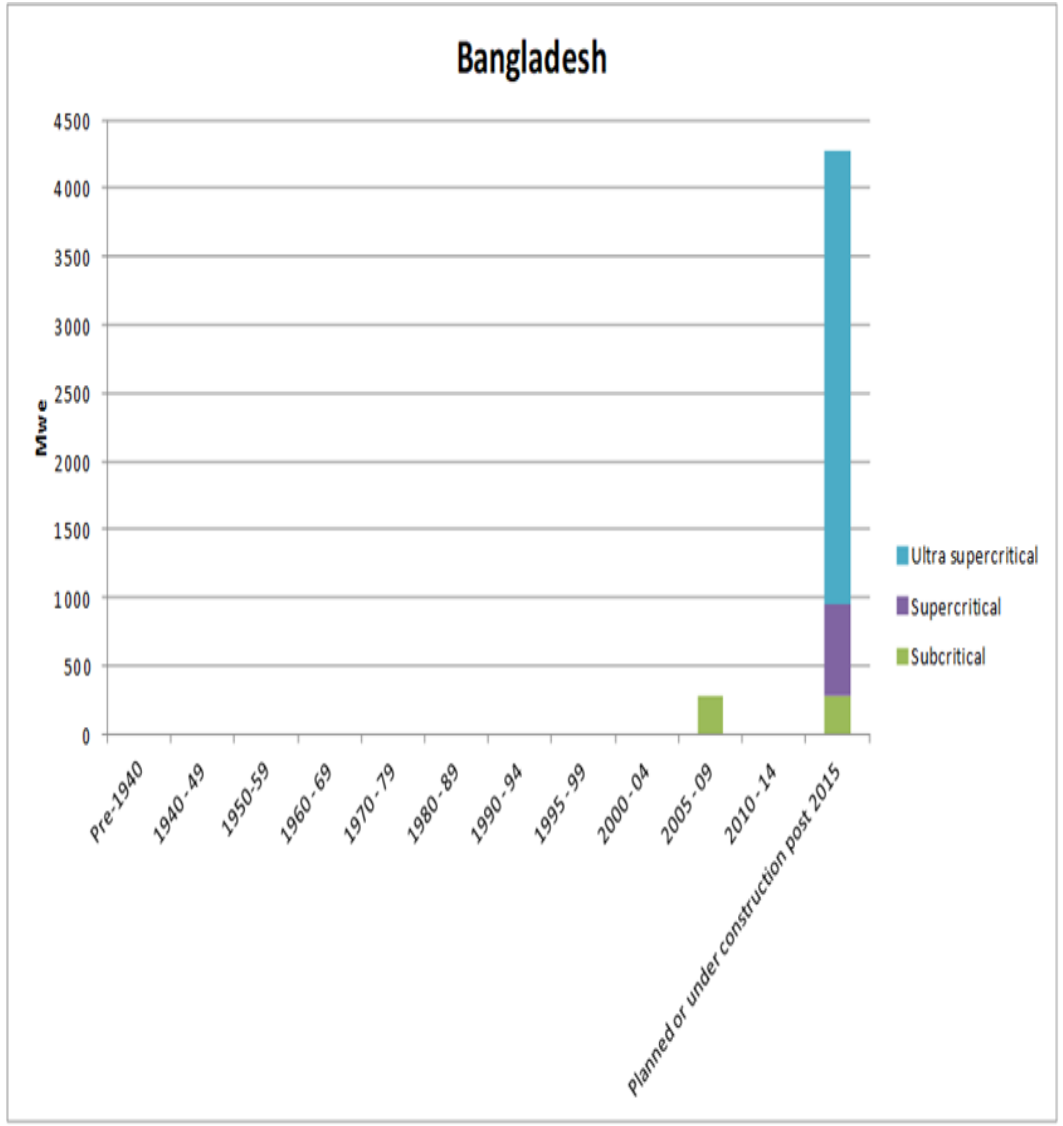
HELE IMPACT ASSESSMENT STUDIES AT IEACCC

- Stage 1: Australia, China, Germany, India, Japan, Poland, Russia, S Africa, S Korea, USA
- Stage 2: China, EU, Japan and USA (in-depth assessment)
- Stage 3 India (in-depth assessment)
- Stage 4 Bangladesh, Indonesia, Malaysia, Philippines, Thailand, Viet Nam (in-depth assessment)
- Stage 5 Preliminary study on the prospects for implementing High Efficiency Low Emissions technologies, focusing on other countries with nationally determined contributions that include coal utilisation via either HELE or with CCS/CCUS (underway)

SELECTED COAL POWER OPTIONS IN ASIA

Country	Current and planned capacity (MWe)		
	Subcritical	Supercritical	Ultra-supercitical
Bangladesh	561	680	3320
Indonesia	26780	3580	2315
Malaysia	8529	0	4160
Philippines	9901	1336	0
Thailand	5181	1300	0
Viet Nam	16545	5532	1800

BANGLADESH IS A POSITIVE CASE STUDY



- GDP has more than doubled since 2000 to over US$150bn in 2016. For the same time period, electricity consumption has tripled from 102 kWh/capita to 350 kWh/capita
- Some 62% of the population has had access to electricity since 2014
- Gas power currently dominates, generating 60 TWh in 2016 but this domestic resource is close to depletion
- The country is building 4.2 GWe of new coal power capacity, most being USC, which could boost the national generating capabilities by 50%.
- BHEL, Triveni, GE, Harbin and Shanghai power equipment suppliers are already delivering coal-fired steam systems for the growing fleet. Further opportunities for cooperation with overseas partners including JICA/JPower are good, and there are recent announcements of further collaboration with China

THE WAY FORWARD FOR HELE DEPLOYMENT

- Deploying HELE technologies rather than subcritical units for new and retrofit applications must be a key near-term step in those developing countries where coal is the preferred energy source
- There are many factors that must be considered
- Countries for which HELE should be an attractive option have key similarities but can also have significant differences, which will determine the realistic prospects for coal-based power generation deployment
- This needs to be better understood to ensure that coal can be targeted to be used in a sustainable manner for the foreseeable future

SUMMARY

- New coal power growth continues extensively in Asia, with both state of the art technology and access to finance being available

- Original major market has been China but various initiatives are ensuring technology introduction is occurring in smaller counties within the region

- Technology development is continuing, to take cycle efficiency well beyond the 50% milestone while ensuring strong operational flexibility

CCT2019 IN HOUSTON!

- The 9th International Conference on Clean Coal Technologies will be in Houston, USA, 3-7 June 2019
- A leading international event on the cleaner use of coal, covering high-efficiency plant, CCS, pollutant controls, cofiring, alternative uses of coal, and much more
- Join around 250 delegates from industry, research institutes, and government
- Site visits and venue to be announced shortly
- https://www.cct-conferences.org/

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THANK YOU FOR LISTENING

ANY QUESTIONS?

Dr Andrew Minchener OBE