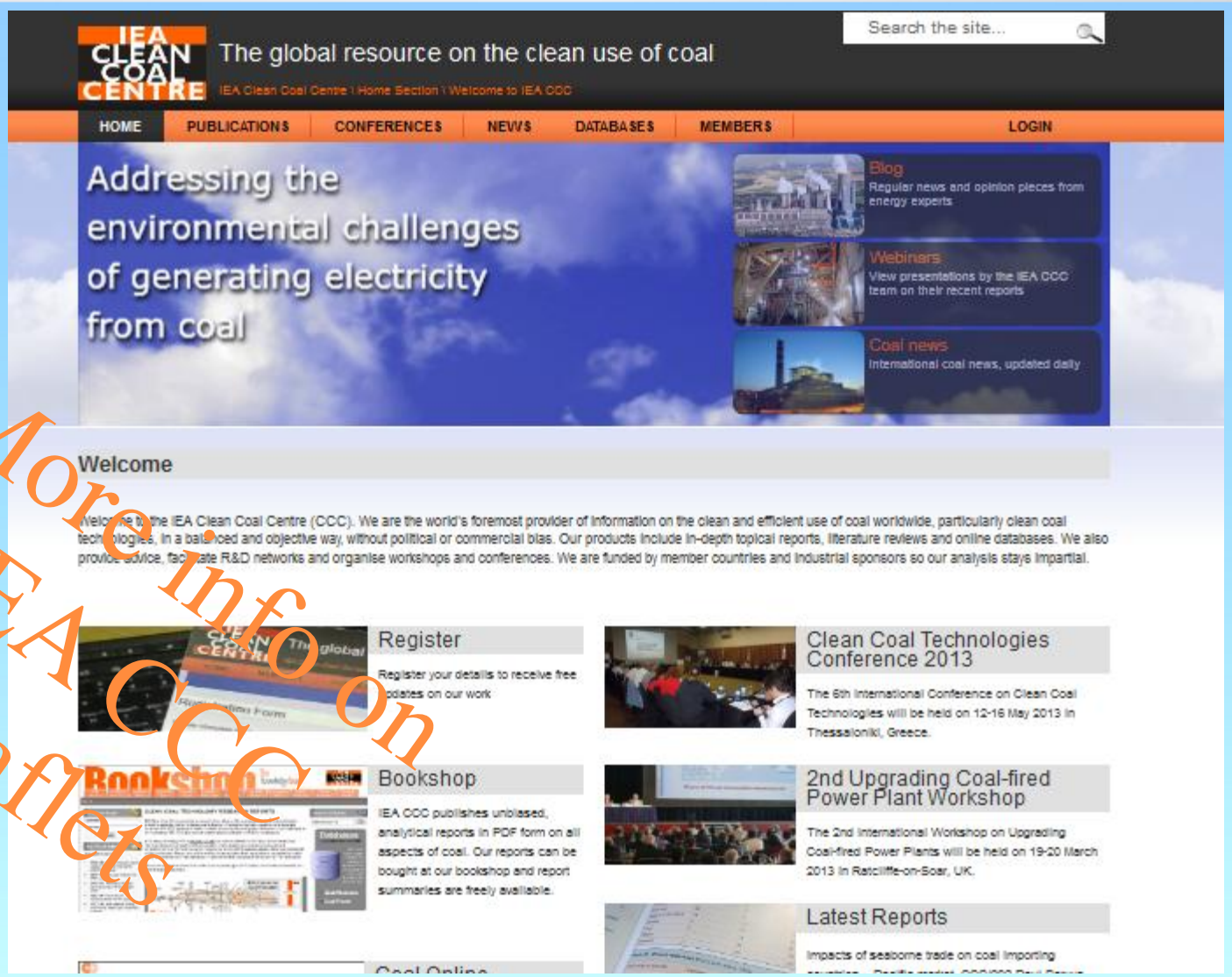
IEA Clean Coal Centre



More info on IEA CCC leaflets

www.iea-coal.org.uk

IEA Clean Coal Centre

Chinese members

电力规划设计总院
Electric Power Planning & Engineering Institute

recently joined IEA CCC as a ***sponsor*** member

煤炭科学研究总院北京煤化工研究分院
Beijing Research Institute of Coal Chemistry,CCRI
BRICC
国家科技部对国际能源署联络办公室

Have been a ***sponsor*** member of IEA CCC since 2005

How Can Efficiency Improvement Contribute to CO_2 Emissions Reduction in Coal-fired Power Plants?

NEET Workshop, Beijing, 27 Nov 2012

Nigel Dong

Power Generation Specialist

IEA Clean Coal Centre

IEA World Energy Outlook – Choice of 3 Futures

2DS

a vision of a **sustainable** energy system of reduced Greenhouse Gas (GHG) and CO_2 emissions

The 2°C Scenario

4DS

reflecting pledges by countries to cut emissions and boost energy efficiency

The 4°C Scenario

6DS

where the world is NOW heading with potentially **devastating** results

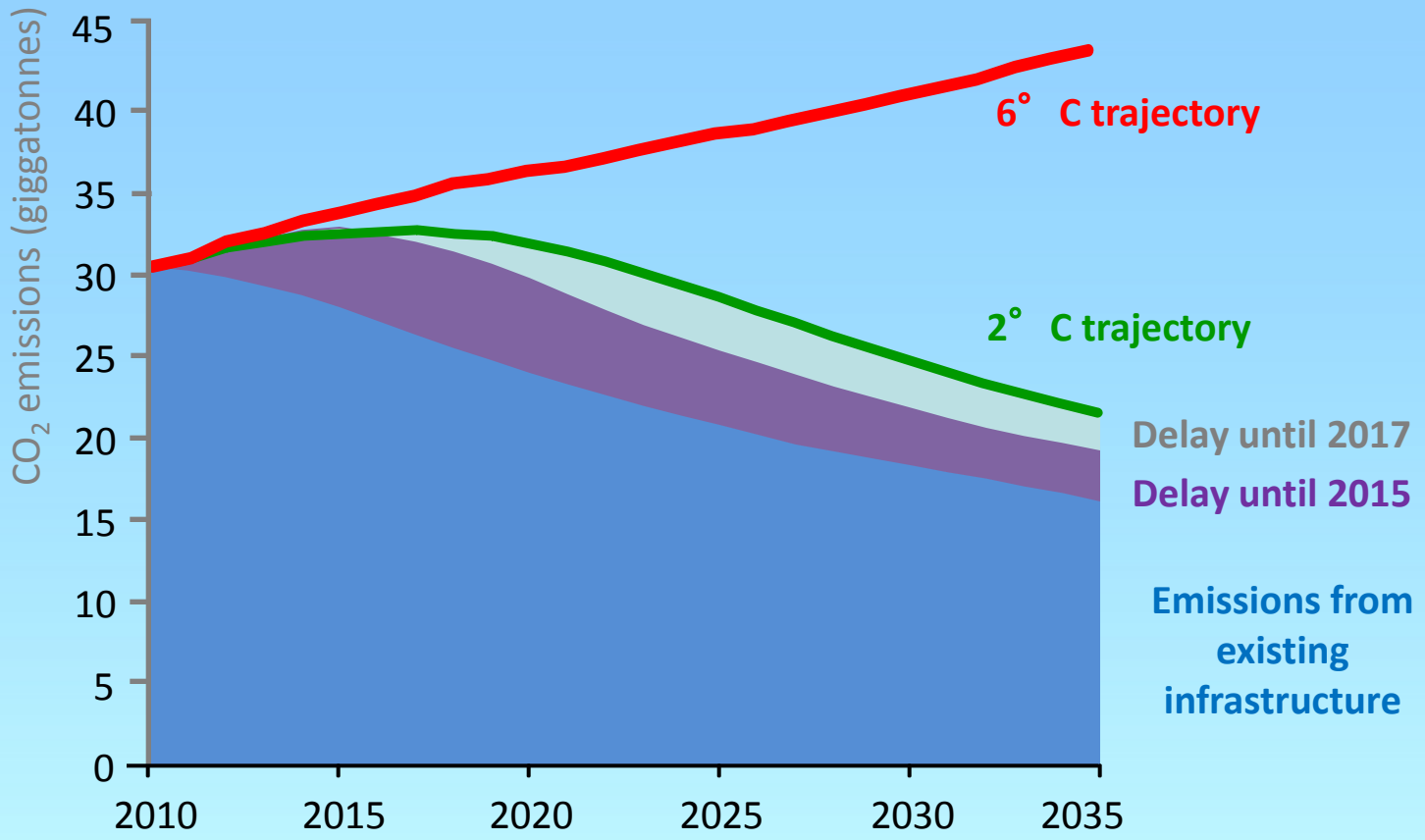
The 6°C Scenario

International Energy Agency

The door to 2° C is closing, but will we be "locked-in" ?

WORLD ENERGY OUTLOOK 2011

Source: IEA 2011

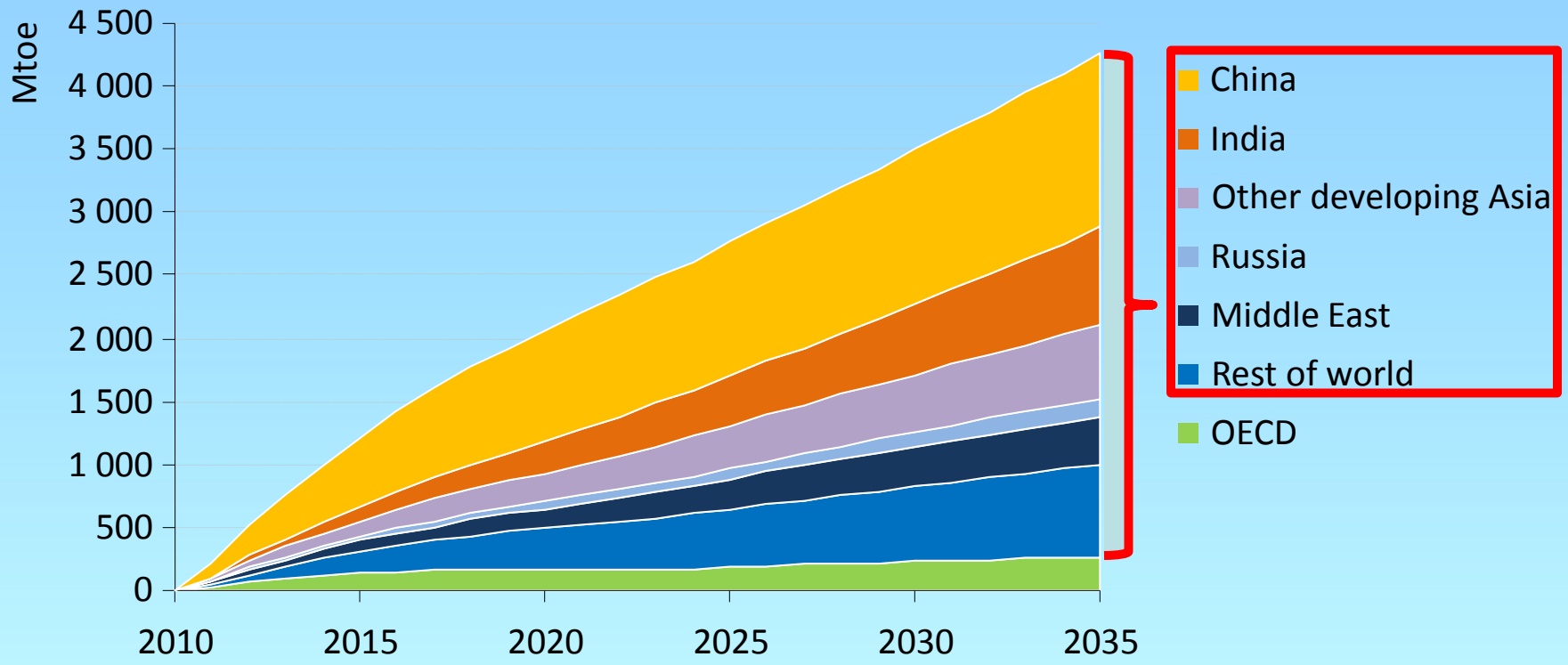


Without further action, by 2017 all CO_2 emissions permitted in the 2DS will be "locked-in" by existing power plants, factories, buildings, etc

IEA WEO 2011: Emerging economies continue to drive global energy demand

Source: IEA 2011

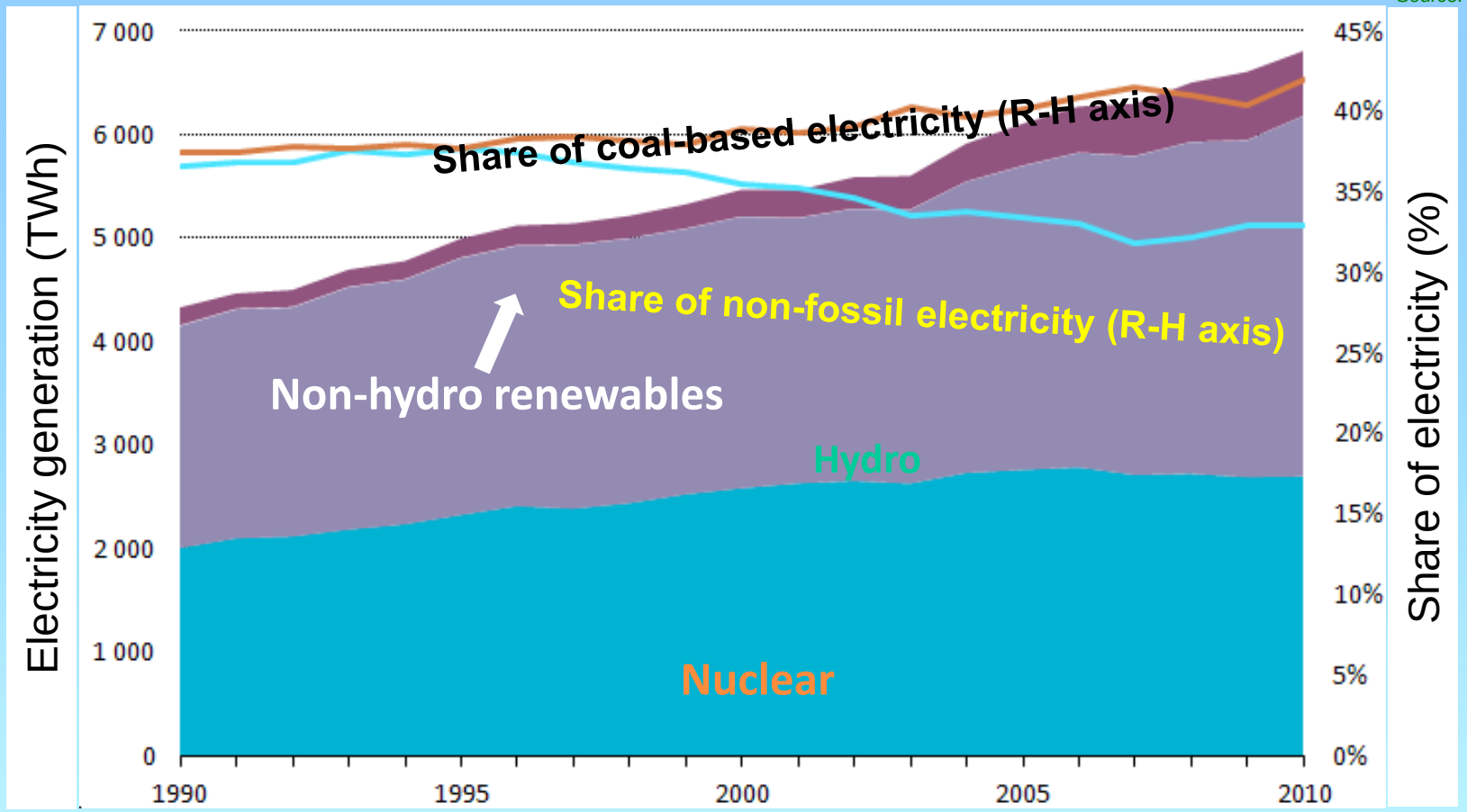
Growth in primary energy demand



Global energy demand increases by one-third from 2010 to 2035, with China & India accounting for 50% of the growth

Electric Power Generation: Fossil vs Non-fossil

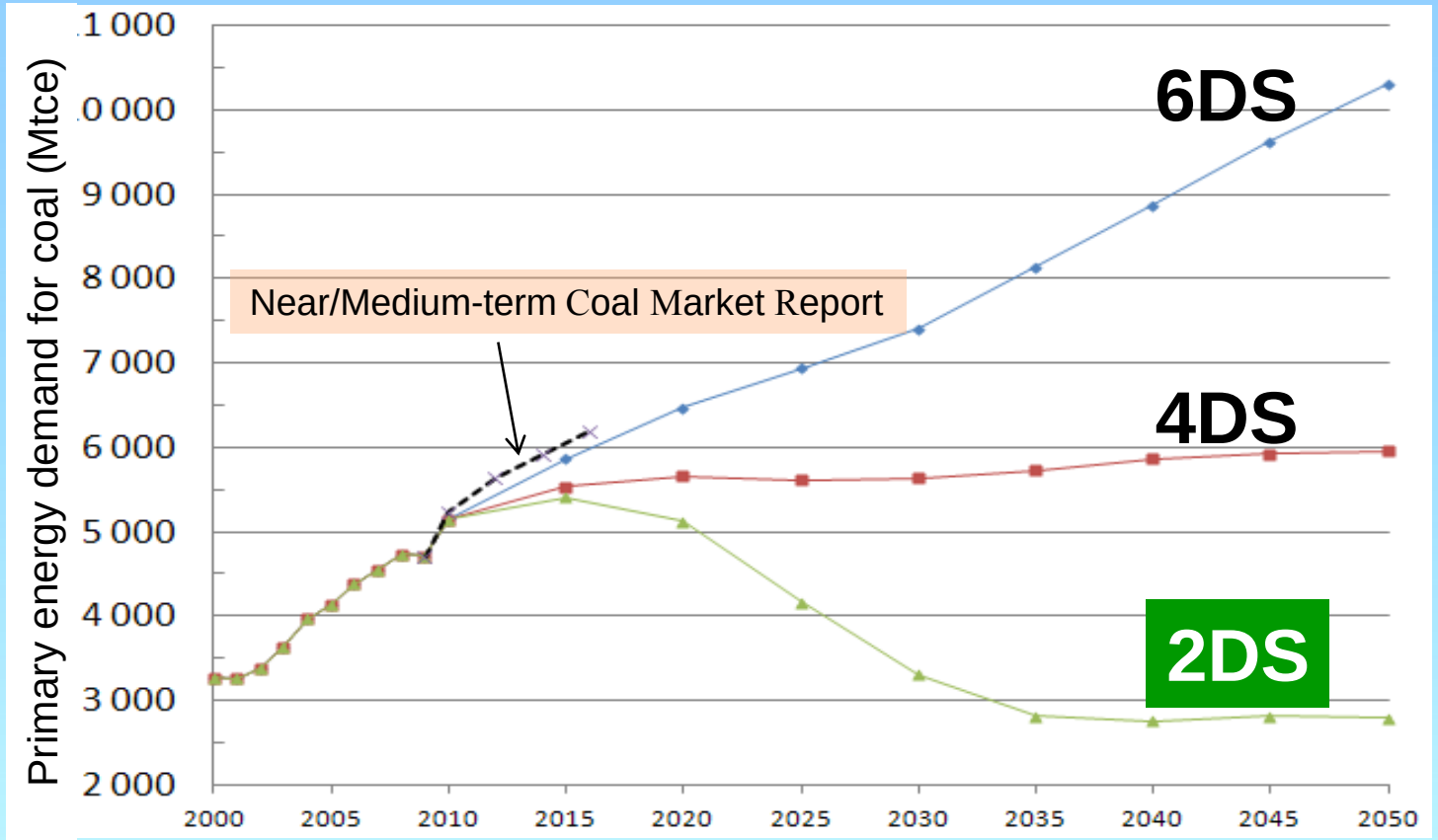
Source: IEA 2012



The share of non-fossil generation has failed to keep pace with the growth in fossil-based generation, particularly coal, in 1990-2009. In 2009, coal-fired power plants accounted for 73% of total CO_2 emissions from the power generation sector.

Projection of Coal Demand: The scale of the challenge is clear

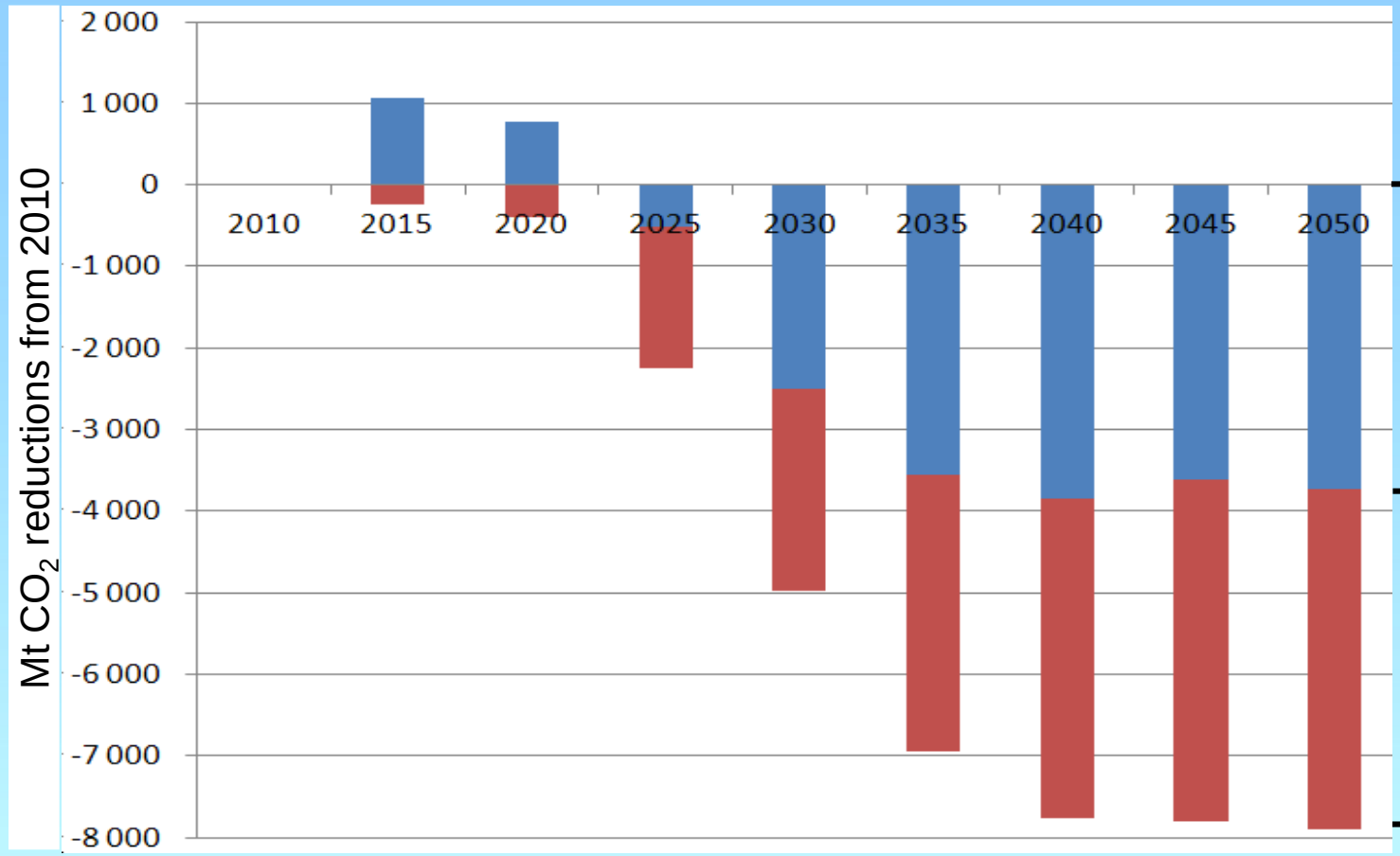
Source: IEA 2012



Near/medium-term projections for coal consumption are <u>NOT</u> consistent with a low-carbon scenario

8 Gt CO_2 Reduction needed by 2050

Reduction of CO_2 emissions needed from 2010 to 2050 to comply with the 2DS



Source: IEA 2012

Reducing output from coal-fired power stations driven by policy and regulation

Decreasing CO_2 intensity factor – driven by technology development

Note: CO_2 emissions is calculated based on the average carbon intensity factor (1000 gCO_2/kWh) in coal-fired power plants

Technology improvement coupled with targeted policy and regulation are essential to realise the low carbon future target, i.e. 2 DS

Efficiency improvement is VITALLY IMPORTANT

Cleaner coal power

Nuclear power

Renewable power

CCS in power

CCS in industry

Industry

Buildings

Fuel economy

Electric vehicles

Biofuels for transport

Rationale

- the IEAs 450ppm scenario (2C temp rise by 2050) extremely challenging due primarily to humungous coal-fired power generation capacities in China and India [To comply with the 2DS, CO_2 emissions from coal-fired power plants must have to peak by 2020]

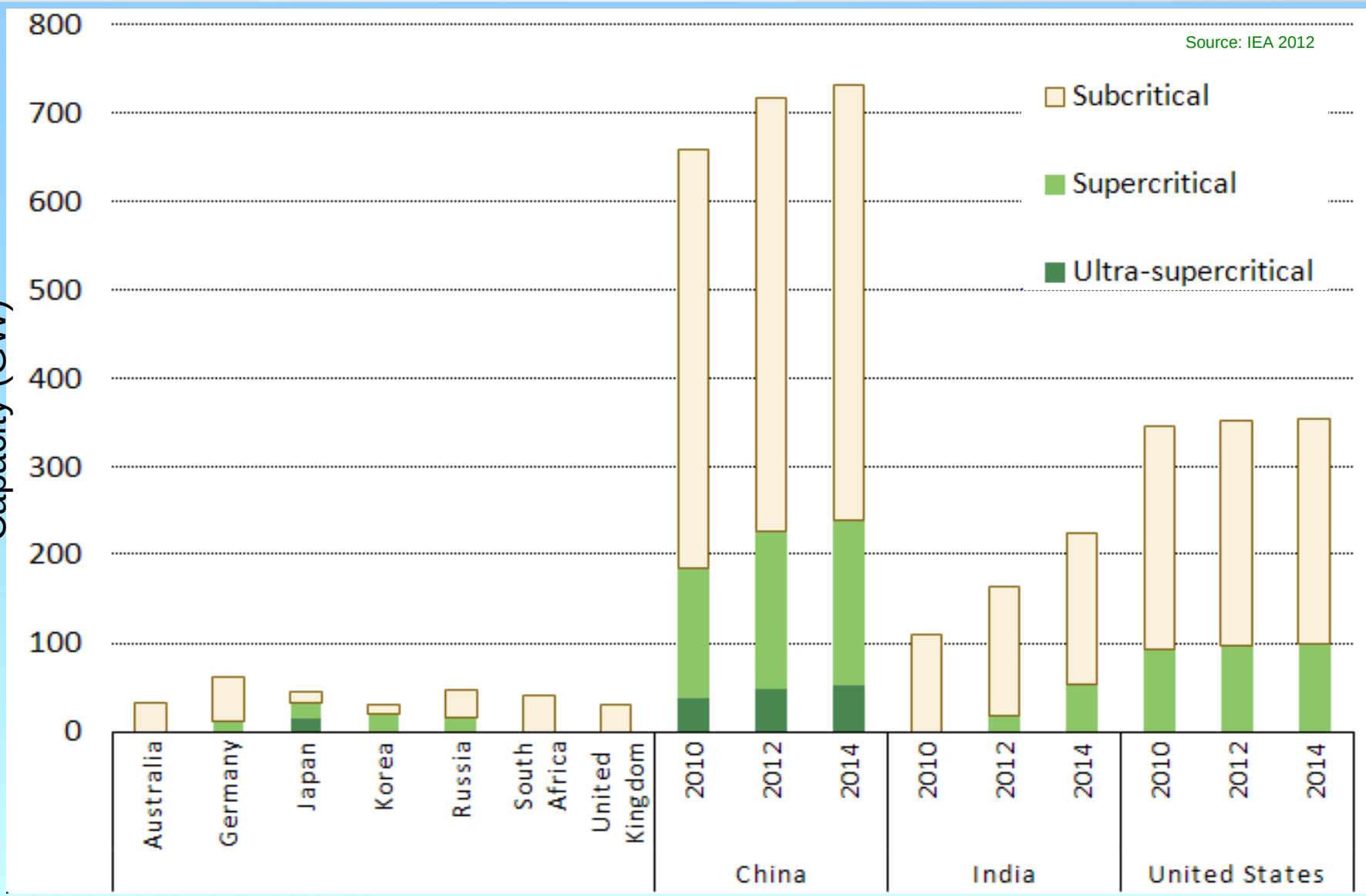
•CCS deployment is essential to have any chance of achieving this target, but progress so far is disappointing – primarily for non-technical reasons

•So best practice in terms of efficiency becomes relatively more important – less costly and relatively easy to do, and should be a priority in the short-to-medium term

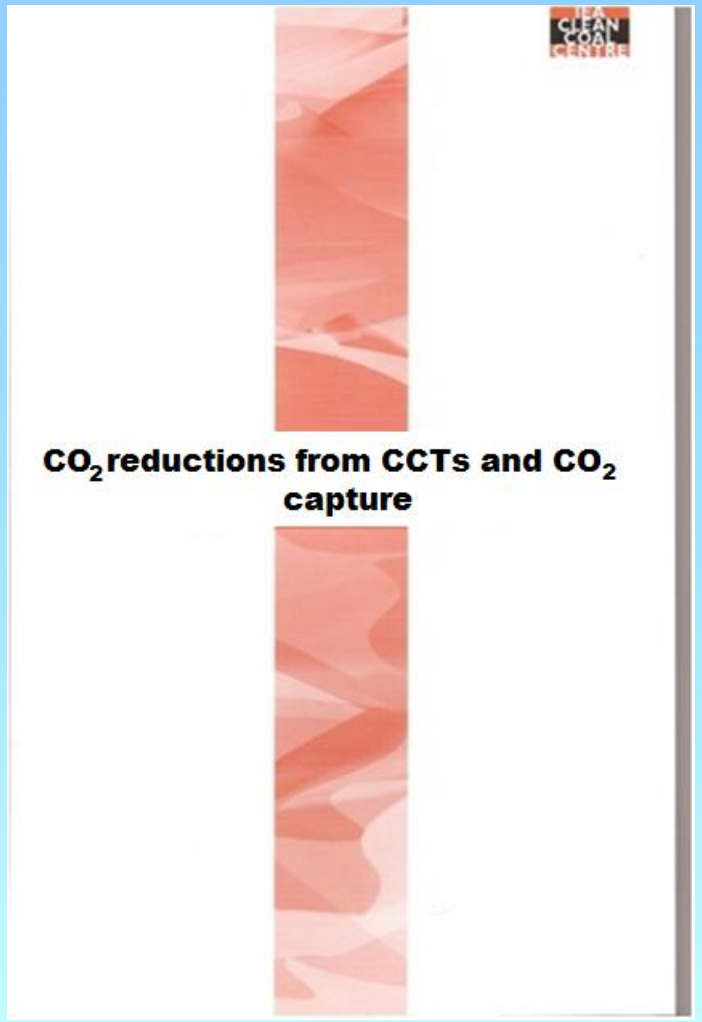
•Clean air is also a driving force for improved design and operation in many polluted urban locations

IEA ETP2012:
Unlock the incredible potential of energy efficiency – the "hidden" fuel of the future

Large candidate plant base
So, large achievable mitigation benefits



Quantify the CO_2 reduction potential in coal-fired power plants – in 2015 | 2030



IEA CCC new study – CCC/200

• IEA CCC published a report in July 2012, which aims to quantify the potential emissions savings through efficiency improvement measures and replacement with new plants of higher efficiency (clean coal technologies) for six coal-consuming countries.

•CO_2 emissions for 2015 and 2030 were estimated using models of coal-fired generating systems for three non-OECD countries (**China, India and South Africa**) and three OECD countries (**Australia, the UK and the USA**), which altogether accounted for 70% of world coal-fired capacity

General conclusions from the CCC/200 study

- The total CO_2 emissions for China, India and South Africa in 2015 are estimated at 5.09 Gt. A total saving of emissions of around 200 Mt/a could follow from increasing the efficiency of all the subcritical plants in these countries by *2 percentage points*
- Estimated CO_2 emissions of the 6 countries in 2015 are ~8.2 Gt. ~1.1 Gt would be saved by replacing subcritical plants by USC or modern IGCC plants. As these countries have 70% of world coal power capacity, >1.5 Gt could be saved globally
- For 2030, there are greater uncertainties in the sizes of fleets and how much they are likely to be used, but greater efficiency changes from introducing the new CCTs as A-USC or advanced IGCC will then be possible
- The CO_2 saving in 2030 was highly dependent on assumptions, but 0.6-1.1 Gt could be saved in 2030 in these countries. CCS on the new plants would increase these savings to well over 3 Gt

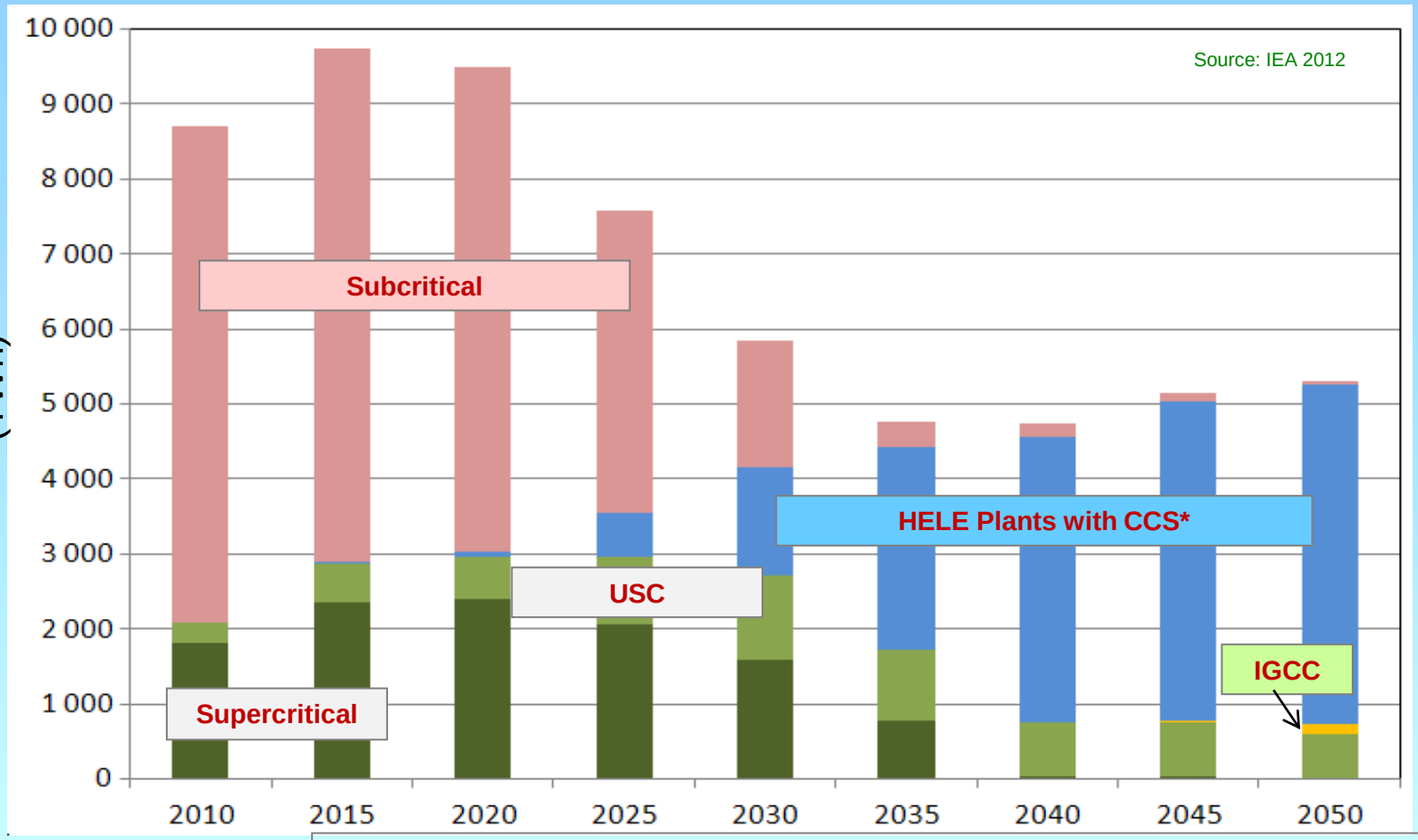
Primary technology pathways to reducing emissions

IEA High Efficiency Low Emission (HELE) Roadmap

(1) Decrease generation from subcritical

(2) Increase generation from high-efficiency technology (SC or better)

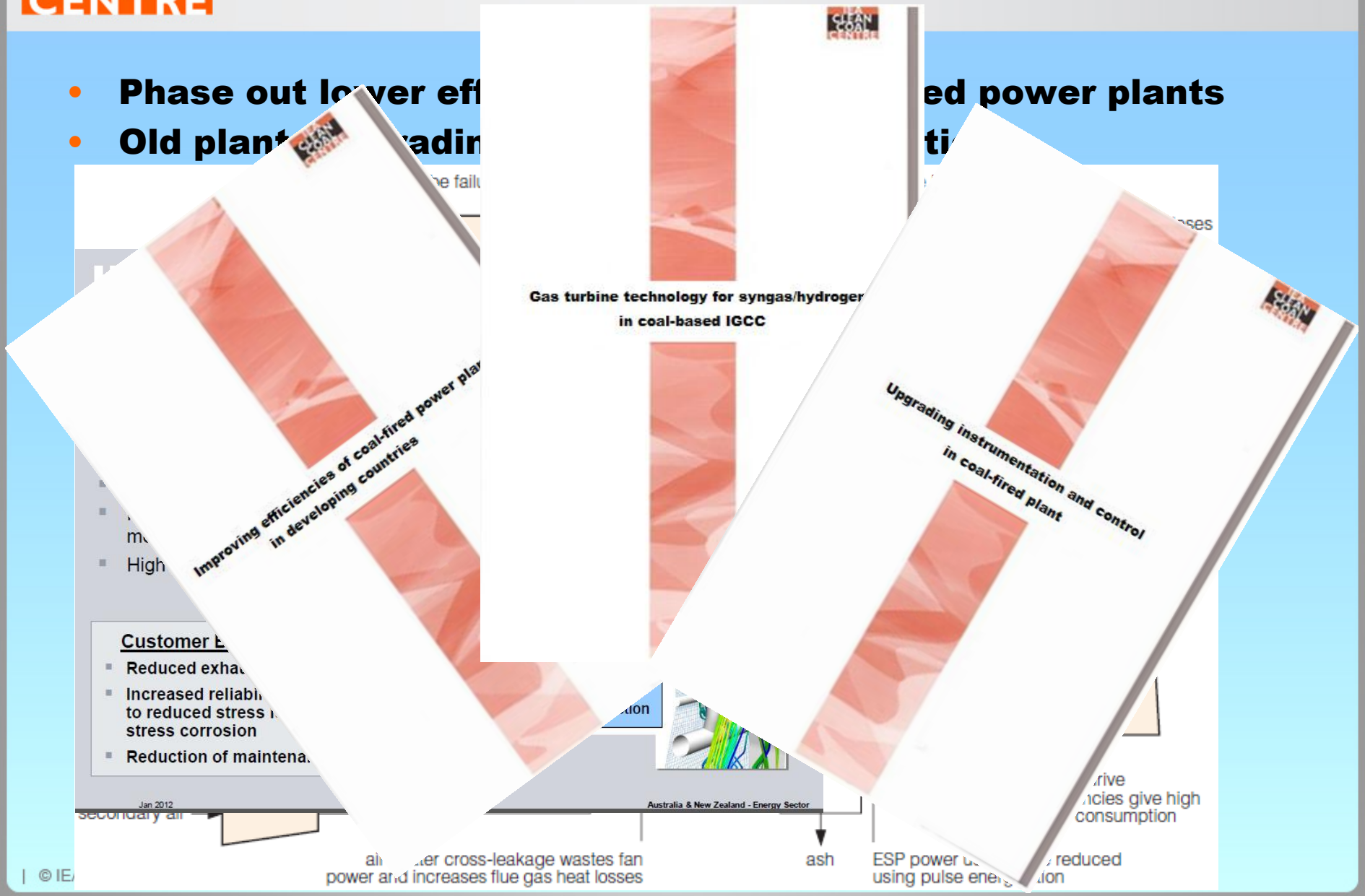
(3) Install CCS* on plants over supercritical



* CCS (Post-combustion, Oxyfuel, Pre-combustion CO_2 capture)fitted to SC (or better) units.

Actions needed

- **Phase out lower eff… …ed power plants**
- **Old plant… …radin… …ti…**



IEA CLEAN COAL CENTRE **WORKSHOP**

Upgrading and efficiency improvement in coal-fired power plants
19-20 April 2012

Workshop on upgrading and efficiency improvement in coal-fired plant

Enter conference system

The Workshop was held at the Stamford Plaza Hotel, Melbourne, Victoria, Australia on 19 and 20 April 2012 immediately following the Second International Industry Symposium on the Sustainable Use of Low Rank Coal, which was held at the nearby Grand Hyatt Melbourne on 16 to 18 April 2012. The Symposium on Low Rank Coals was organised by the Department of Primary Industries, State Government of Victoria, with support from IEA CCC and the Electric Power Research Institute.

The Upgrading Workshop was supported by the Australian Coal Industry Consortium who, together with the Australian Government, form the Australian membership of IEA CCC.

A record of the programme is available on the website. Click on the 'Programme' button after entering the conference system. Presentations and Papers from the Workshop can be downloaded from the Programme by clicking on the 'projector screen' or 'Adobe' symbols respectively.

It is hoped to repeat the event in 2013 at a location to be decided.

Click here for Refund Policy and Terms

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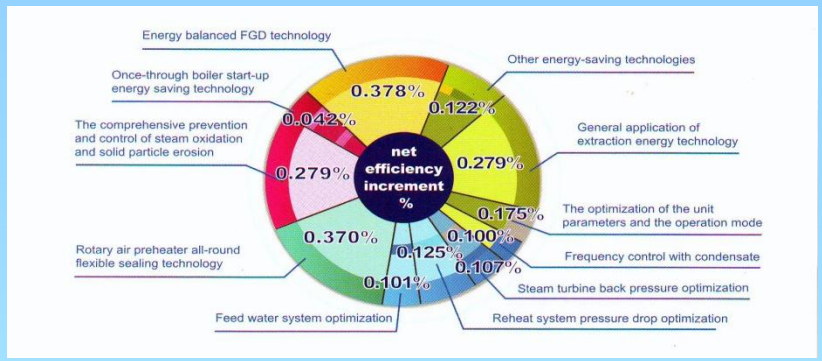
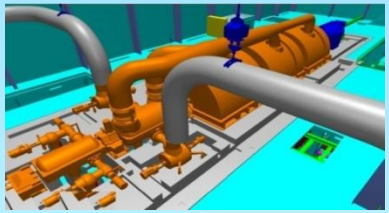
Achieving higher efficiency on existing 600°C SC/USC PCC technology

2 x 1000 MW tower type, ultra-supercritical, single reheat, tangential firing, spiral tube water wall, pulverized coal fired boiler. Commissioned in 2008 by Shanghai Boiler Works through technology transfer from Alstom in Germany. Steam Parameters: 28MPa, 605°C/603°C.

Photo courtesy of SHENERGY Group



Patent Technology: Cross-compound Arrangement at High/Low Position of Steam Turbine/Generator

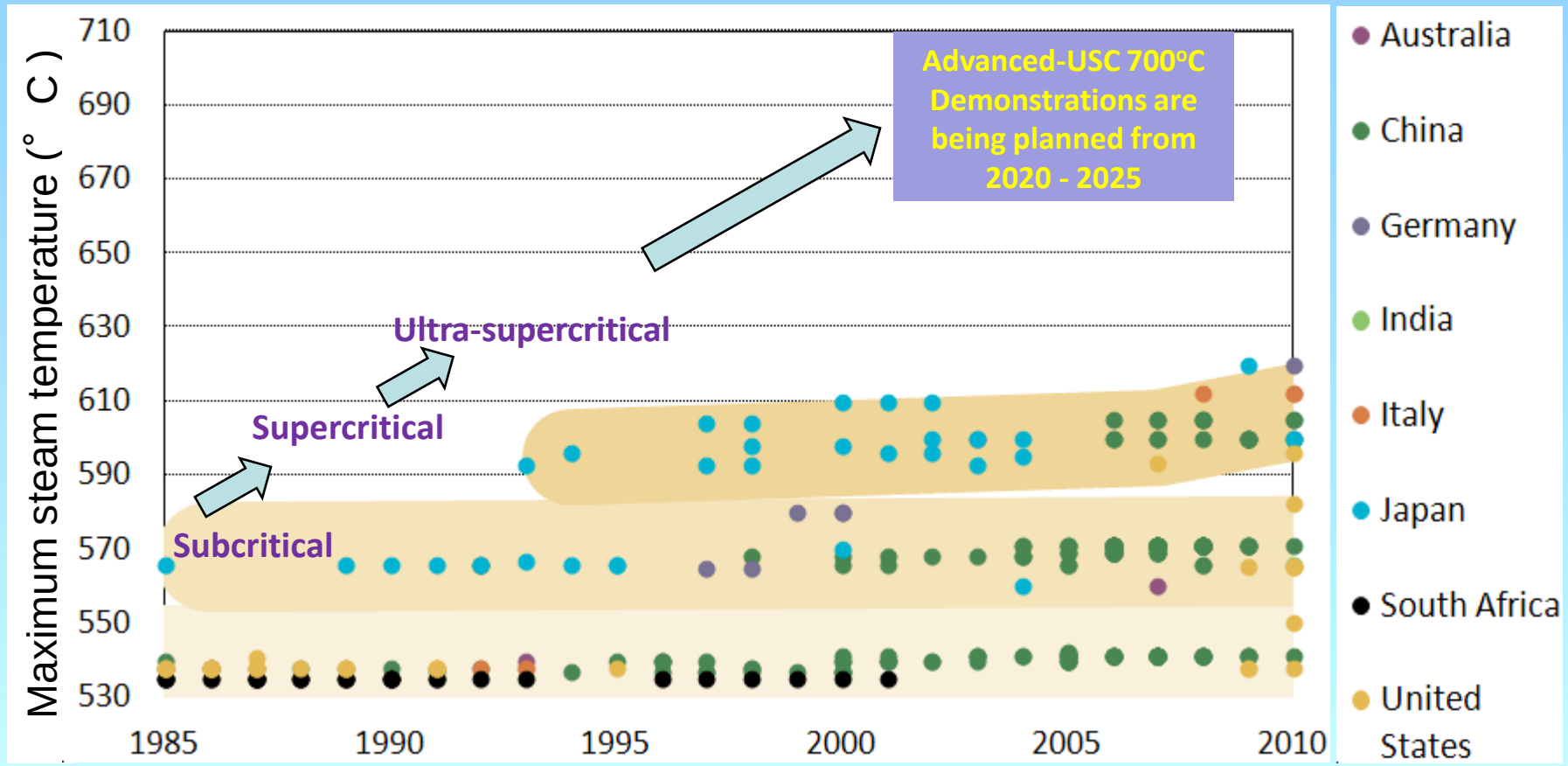


Mitigation of Steam Oxidation and Solid Particle Erosion

year	2008	2009	2010	2011
Actual net efficiency (Including FGD & SCR) [%]	42.73	43.53	43.97	44.50
Actual specific coal consumption [gce/kWh]	287.44	282.16	279.39	276.02

Actions needed (cont.)

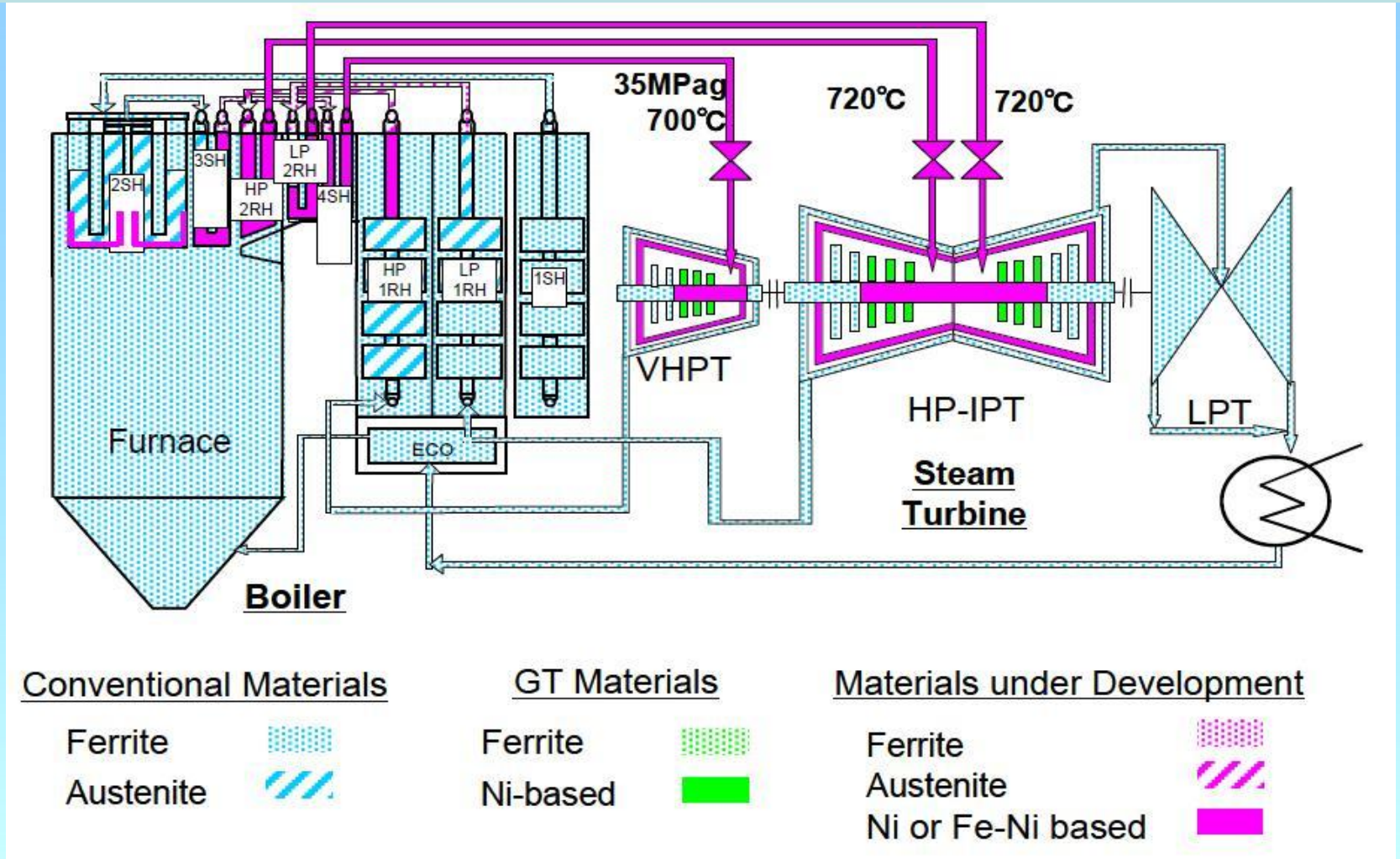
More opportunities should be taken to adopt SC or better technologies in both OECD and non-OECD countries



Source: IEA 2012

Advanced-USC PCC technology

Challenge to A-USC technology: to withstand temperatures of 700+°C Ni-based super alloys will be needed



Source: Fukuda M 2010

IEA CLEAN COAL CENTRE **WORKSHOP**

Advanced ultrasupercritical coal-fired power plants

19-20 September 2012

Workshop on Advanced USC coal-fired power plants

Enter conference system

Vienna, Austria, 19-20 September 2012

The Workshop took place in Vienna on 19-20 September and focused on materials testing and plant design for the highest possible plant efficiencies. Development work is ongoing in China, Europe, India, Japan and the USA where there are plans to design and build demonstration plants over the coming years. This first Workshop brought together those with a common interest in the research and development necessary to bring such plants to fruition. The Workshop was hosted by EVN in Vienna, Austria and was organised by IEA Clean Coal Centre in cooperation with the VGB, Germany.

The first session of the Workshop was dedicated to the IEA's High Efficiency, Low Emissions (HELE) Roadmap. The HELE Coal Technology Roadmap will be an important addition to the series of technology roadmaps the IEA has been publishing since 2009. It will focus on coal use in power generation and consider the role of coal-fired power generation in reducing global energy-related CO_2 emissions substantially bellow current levels.

All Attendees can read and download the papers and presentations. To see them, you must login, then go to the conference programme. Open the sessions by clicking on the arrows at the right hand side of the session title. The written papers are indicated by an Adobe pdf symbol and the presentations by a screen symbol.

EVN

VGB POWERTECH

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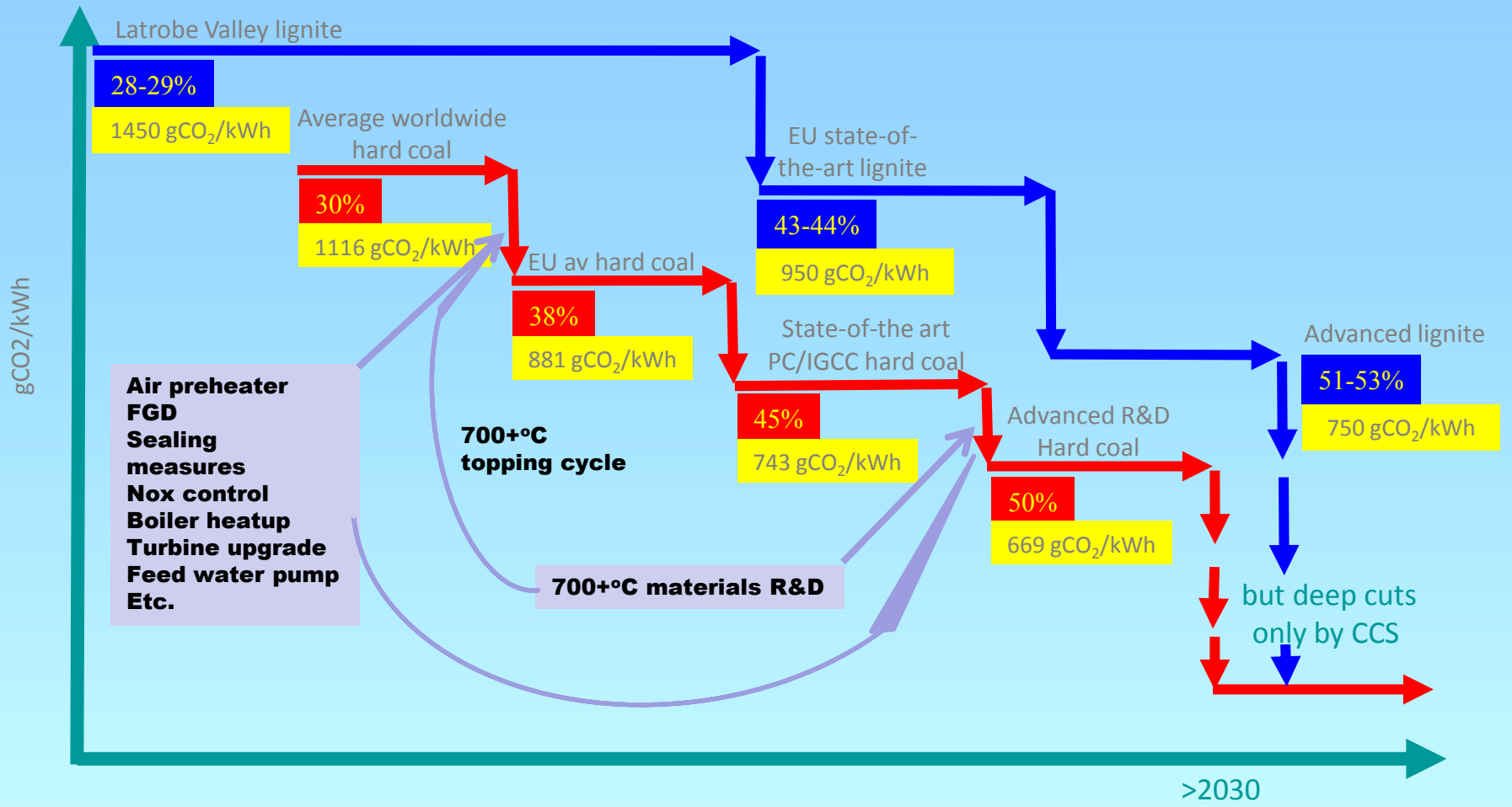
Action needed (cont.)

R&D experience in efficiency improvement in existing coal-fired fleet can feed into R&D in 700+°C technology

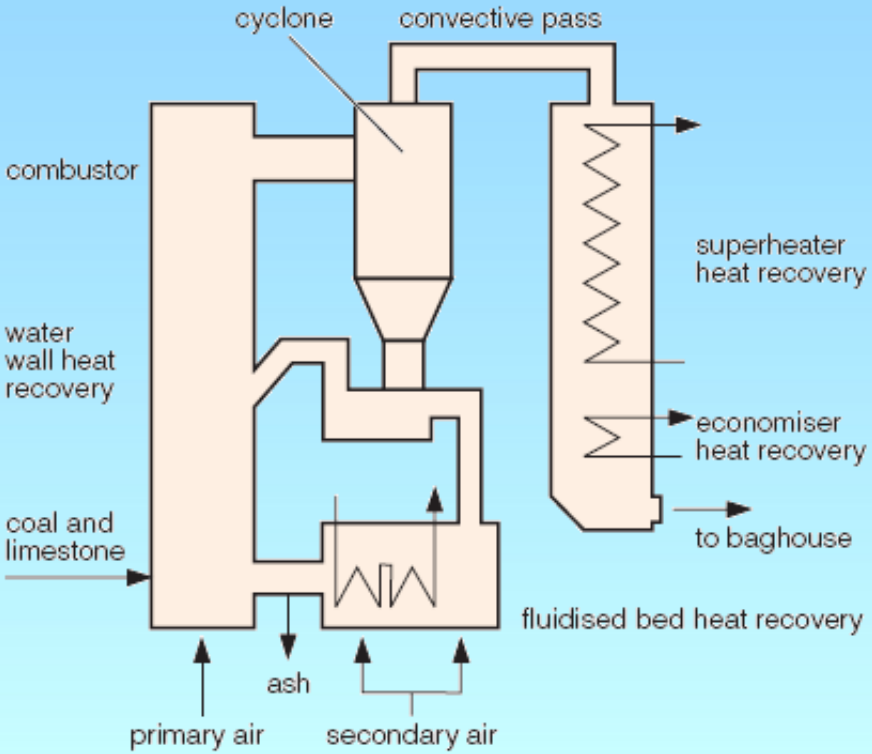


Note: Data for hard coal-fired power plants from VGB 2007, for lignite plants from RWE and C Henderson, IEA Clean Coal Centre; efficiencies are LHV,net

Actions needed (cont.)

CFBC remains important and needs to move to SC/USC

- Well established, the first SC unit in operation since 2009 in Poland
- CFBC with USC conditions in utility applications as alternative to PCC, firing any coal
- Future move to 700˚C steam conditions, taking advantage of materials developments for A-USC PCC
- CCS using advanced flue gas scrubbing, oxygen firing in 2030s, or chemical looping combustion
- Cost-competitiveness will depend on sufficient numbers of plants being deployed.



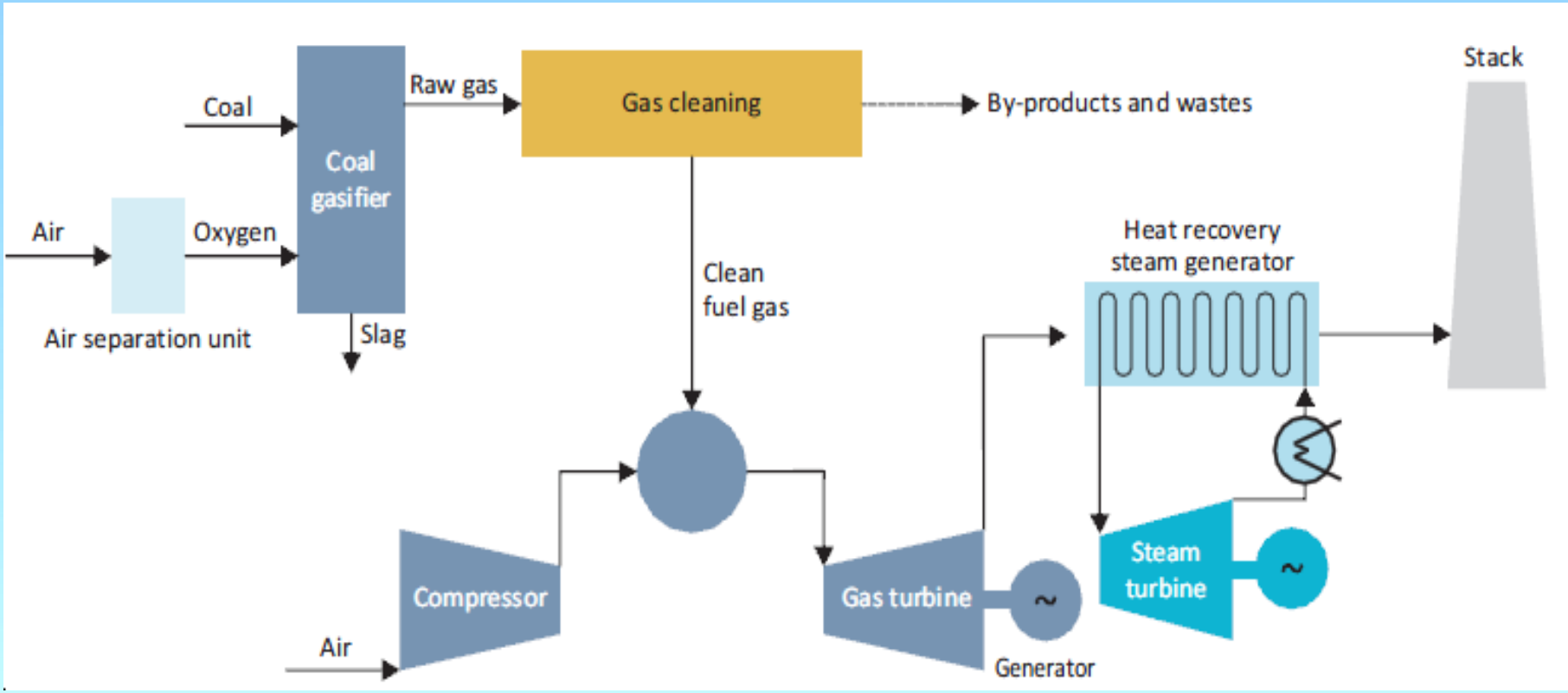
Lagisza 3: 1X 460 MW, the world's first SC CFB power plant

Courtesy of Foster Wheeler

Actions needed (cont.)

IGCC+CCS may be cost effective

- With the latest 1500°C-class gas turbines, efficiencies of 50% (LHV, net) may be achievable;
- Cost-competitiveness will depend on sufficient numbers of plants being deployed.

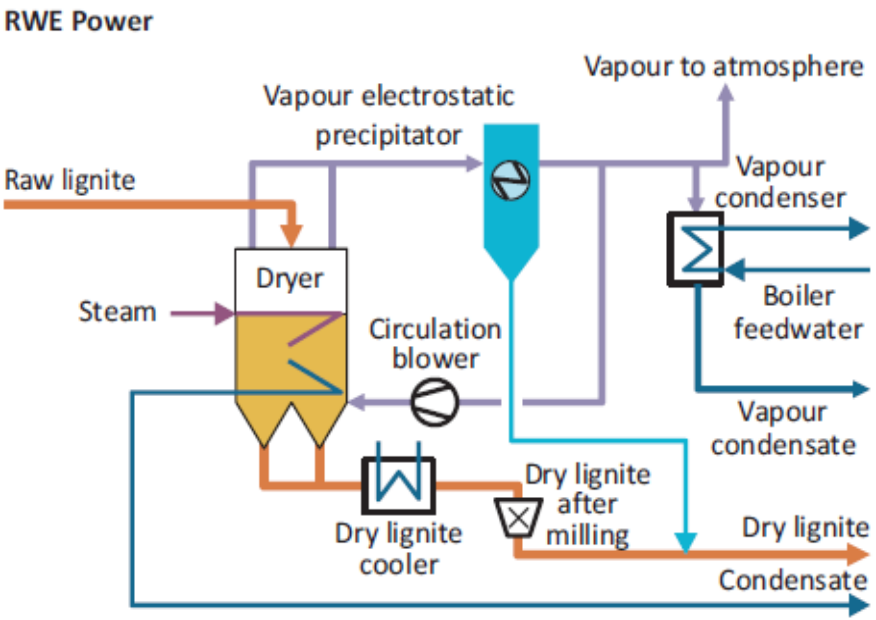


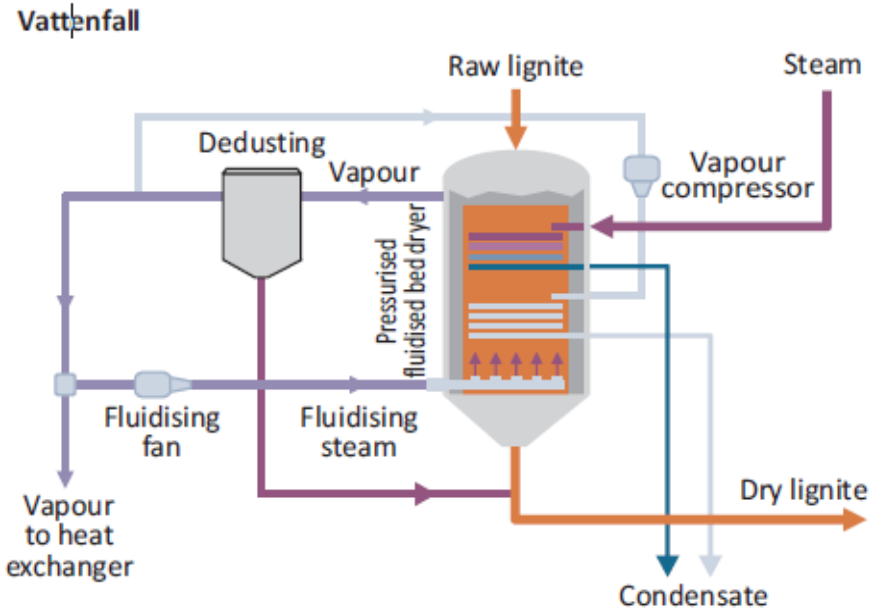
Source: IEA 2012

Actions needed (cont.)

Lignite – pre-drying is essential

- Advanced pre-drying processes have been developed, and some are close to commercialisation
- Can be applied to combustion or gasification-based plants
- Experience is still limited, and cost reduction is required to be attractive





Source: IEA 2012

Recommended actions for near-term

- **Investing in technical improvements/upgrading across the power plant system components where appropriate**
- **Closing down smaller-sized subcritical power generation units**
- **Deploying supercritical and ultra-supercritical technologies, both available now, and further fine-tuning with innovative technologies**
- **Retrofitting advanced pre-drying processes to power plants firing low rank lignitic coals (up to a limited proportion of feed)**
- **Even higher efficiencies will be achieved as A-USC and more advanced IGCC become available.**
- **CCS must be developed and demonstrated rapidly if it is to be deployed at a scale sufficient to achieve the 2DS.**

IEA CCC next workshop on Power plant upgrading/efficiency improvement

The Second IEA CCC Workshop on upgrading and efficiency improvements in coal-fired power plants will take place at E.ON's Power Technology Centre at Ratcliffe-on-Soar, Nottinghamshire, UK on 19-20 March 2013. Anyone interested in attending or keeping informed of further details should create an account on this website after clicking on the 'Enter Conference' button on the top right hand side of this page.

Enter conference system

The First Upgrading Workshop, which was held at the Stamford Plaza Hotel, Melbourne, Victoria, Australia on 19 and 20 April 2012, was supported by the Australian Coal Industry Consortium who, together with the Australian Government, form the Australian membership of IEA CCC. More than 60 people attended the one and a half day event which covered:

- Overview presentations from IEA and IEA CCC
- Policies to encourage efficiency improvement
- Industrial, national and international efficiency improvement programmes
- Reporting, monitoring and verification of such programmes
- Technical issues and case studies, and
- Basic research

Call for papers now ON

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