IEA Activities
in
Cleaner Fossil Fuels

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Cleaner Fossil Fuels

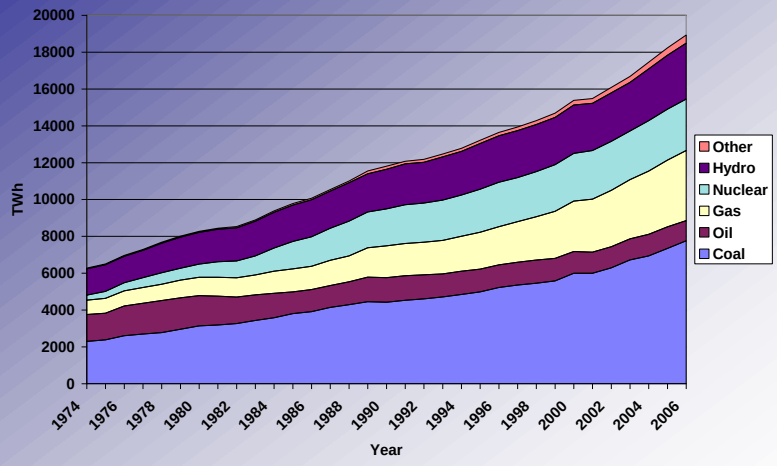
Based on G8 – Gleneagles and Heiligendamm mandate

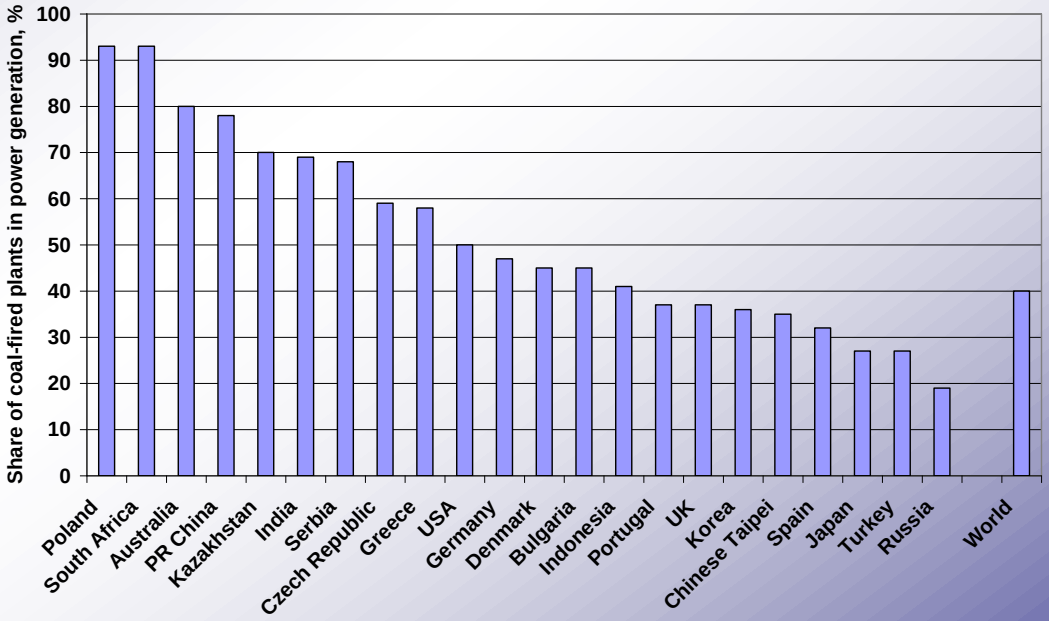
- Global database – IEA CCC
- Report on efficiency reconciliation – IEA CIAB
- Case studies on recently constructed coal and gas-fired plants
- Prospects of upgrades and replacement
- Developments in coal-fired power generation – potential for higher efficiencies

- Case studies on recently constructed supercritical or ultra-supercritical coal-fired units
- Assessment of full coal process chain for efficiency improvement in power generation
- Discussion paper – policies required to facilitate upgrading older coal-fired plants in G8 + 5 countries

  - *Largely based on coal-fired plants*
  - *Covers both technical and policy aspects*

Role of Coal in Power Generation

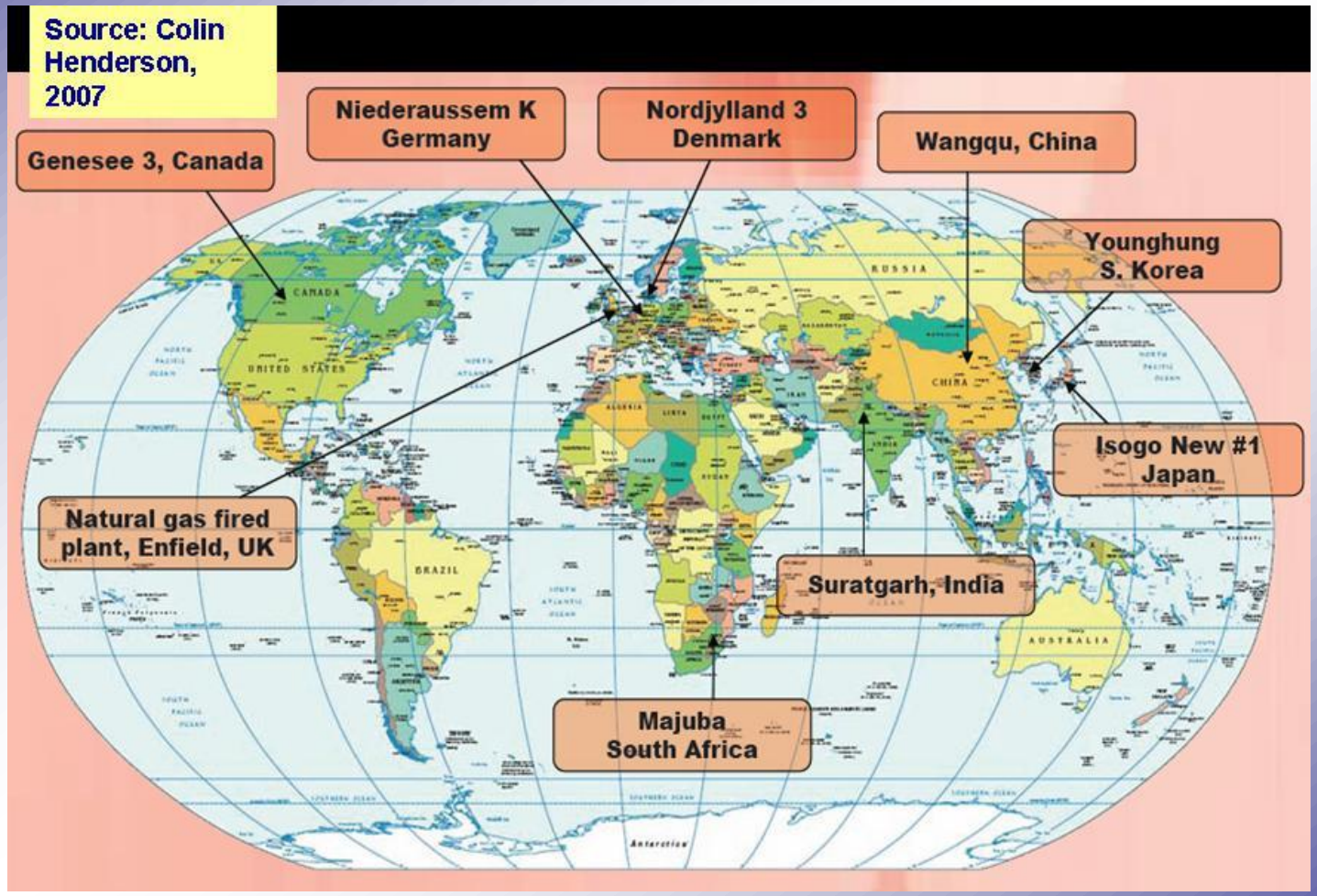




- coal's demand for power generation has grown over the years
- its importance set to continue to 2030 and beyond
- significant proportion of power generation in several countries

Report: Case Studies on Recently Constructed Plants

- ***Information on efficiency, emissions, costs, construction time and ash use of current state-of-the art coal-fired power stations in major coal using countries***



Case Studies – Selected Plants

Nordjylland- Denmark, 400 MW
USC, innovative cycle design
Bituminous coals, FGD, SCR
Cold sea water cooling
45.3% HHV efficiency

Niederaussem- Germany, 1000 MW
SC, High Cr material
High moisture lignite, FGD
Water cooling
NO_x control, 37% HHV efficiency

Isogo - Japan, 600 MW
USC, High Cr material
Bituminous coals, S & SCR
Warm sea water cooling
Hg control, 40.6% HHV efficiency

Genesee - Canada, 450 MW
SC, Sliding pressure
Sub-bituminous coals, SO_x & NO_x
Cooling pond
Hg control, 39.6% HHV efficiency

Younghung - Korea, 800 MW
SC, tower type boiler
bituminous coals, SO_x & SCR
Warm sea water cooling
39.7% HHV efficiency

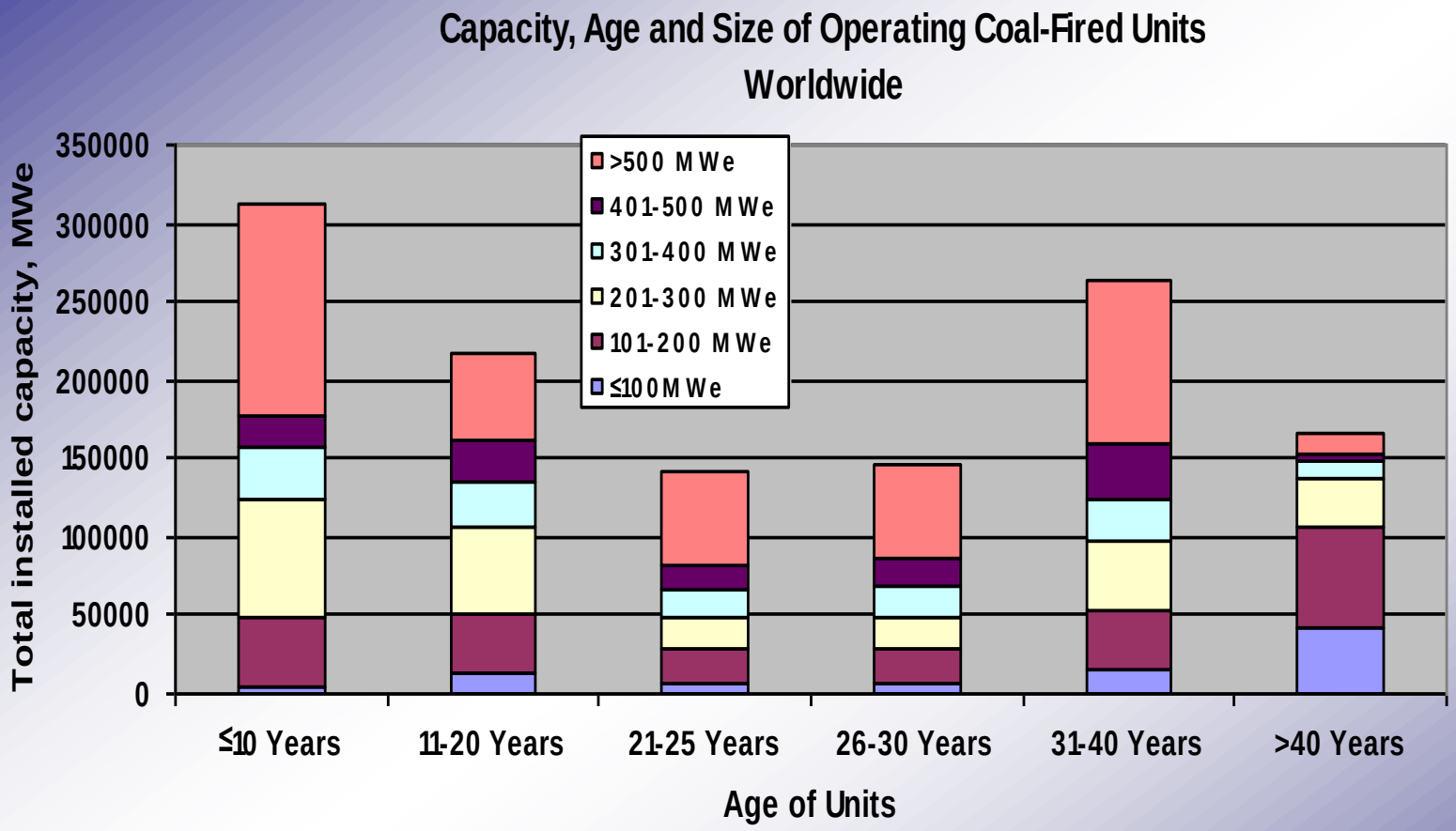
Wangqu - China, 600 MW
First SC, 2-pass boiler
Chinese lean coal, FGD
Cooling tower
40% HHV efficiency

Report: Prospects of upgrades and replacement of coal-fired plants in major coal using economies

- **Country specific analysis - Australia, Brazil, Canada, China, Germany, India, Indonesia, Japan, Korea, Russia, South Africa, Thailand, UK, USA**
  - The likely number of units and capacities that might require upgrade or replacement to bring them at par with benchmark
  - Necessary investments
  - Barriers to such upgrading or replacements
  - Policy measures required to overcome the barriers
  - Potential reduction of energy consumption and CO_2 emissions from such upgrading or replacement
  - Policy recommendations

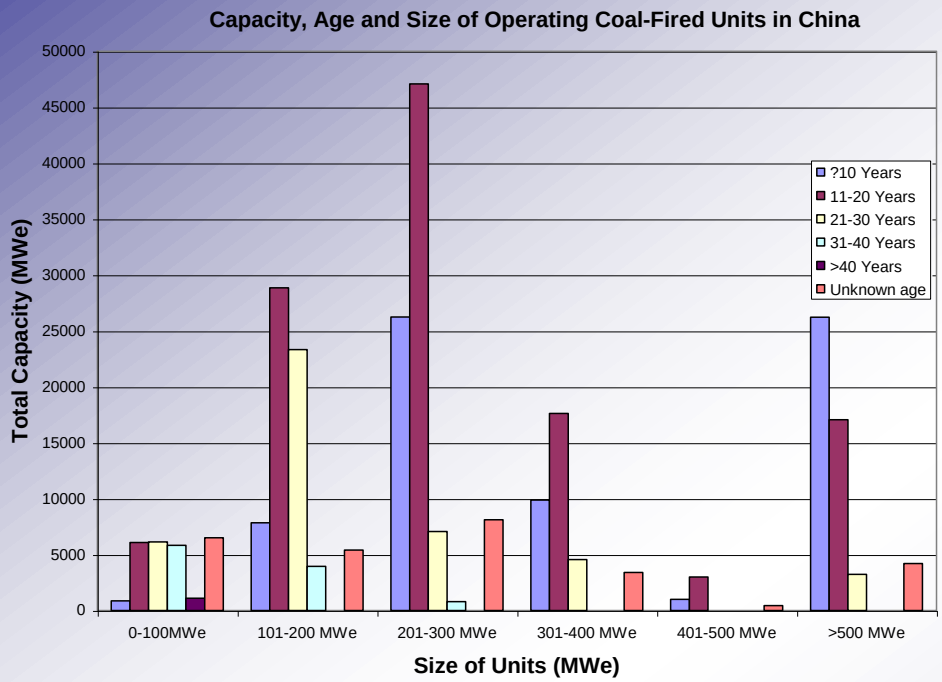
A bottom-up approach to calculate country-specific efficiencies

Acknowledgement: IEA CCC database, World Energy Council, NETL database, IEAGHG CO2 emissions database, Australian Greenhouse Office, EGAT, VGB publications, EU-IPPC, prior work by DTI and Dutch government/KPMG/Jacobs, and information sourced from Utilities and standard organizations in the target countries



Age of the coal-fired fleet…….

… sample observations - *China*



Largest USC 1000 MW units operational in 2007

- Seven such units
- Sliding pressure units

SC Planned

- end 2015 – 114,000 MW

Total coal-fired

- end 2004 – 310,000 MW
- end 2005 – 391,000 MW
- end 2006 – 484, 000 MW
- end 2007 ~ 540,000 MW
- May 2008

Super-critical

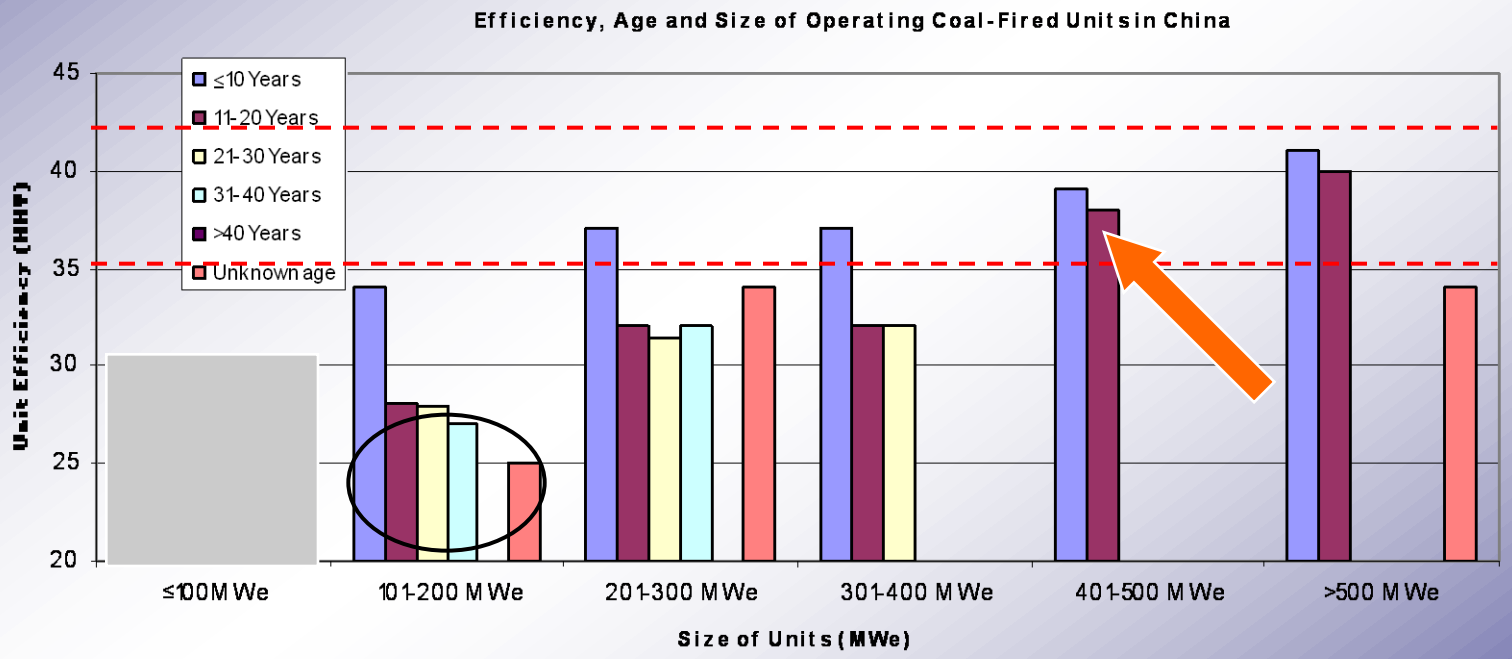
- end 2004 – 13200 MW
- end 2006 – 31780 MW

SC under construction

- end 2009 – 48,500 MW

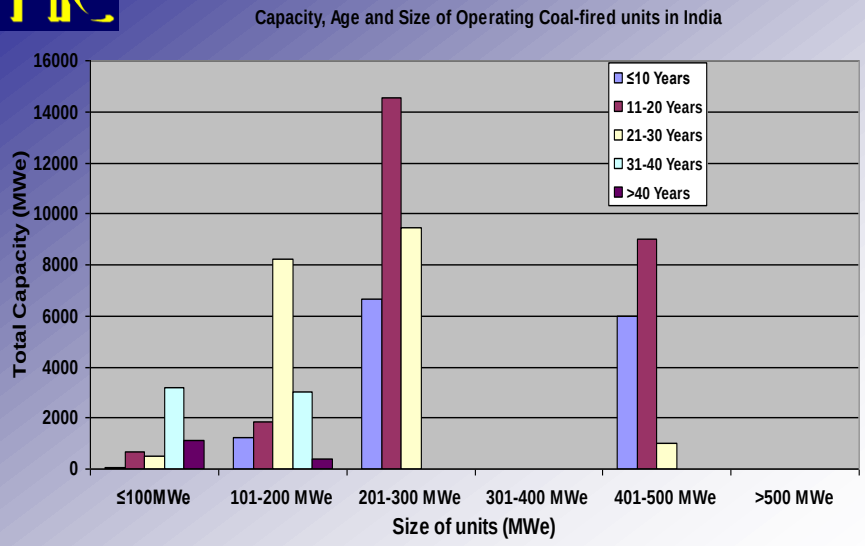
… sample observations – *China* *continued*

Potential efficiency improvements

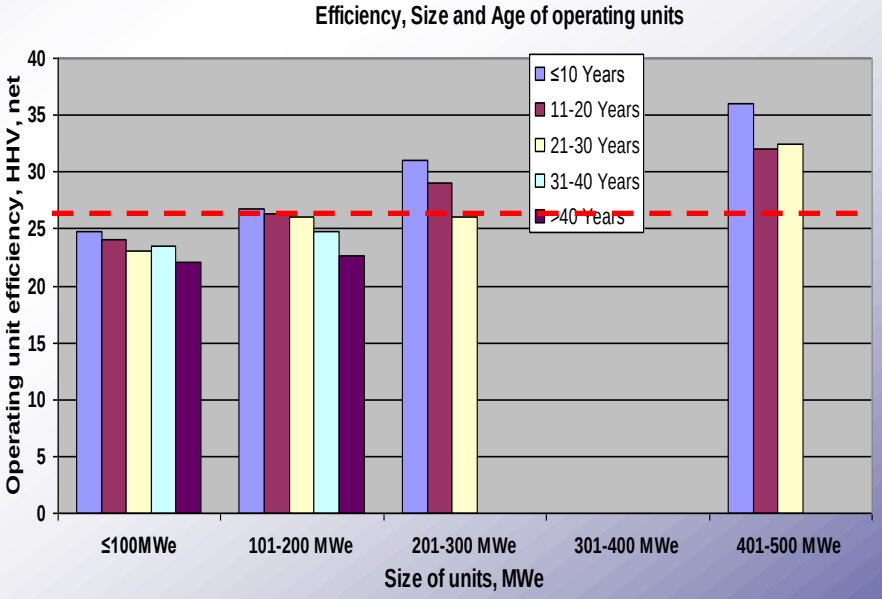


CO2 emission reduction…..savings in coal consumption……
Emission growth is slowing……

… sample observations – *India*



- 70 GW coal-fired in 2004
- all sub-critical



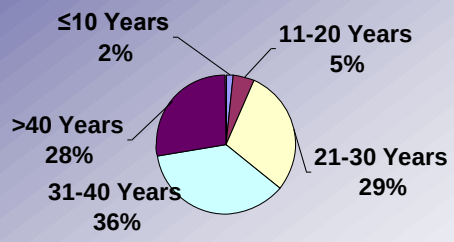
- Average efficiency just over 26% in 2004

- improving with new refurbishments under progress and
- the first supercritical units commissioned
- improve further with the new ultra-mega projects (600 and 800 MW units in 4000 MW stations
- coal quality and temperate climate

Work ongoing…..

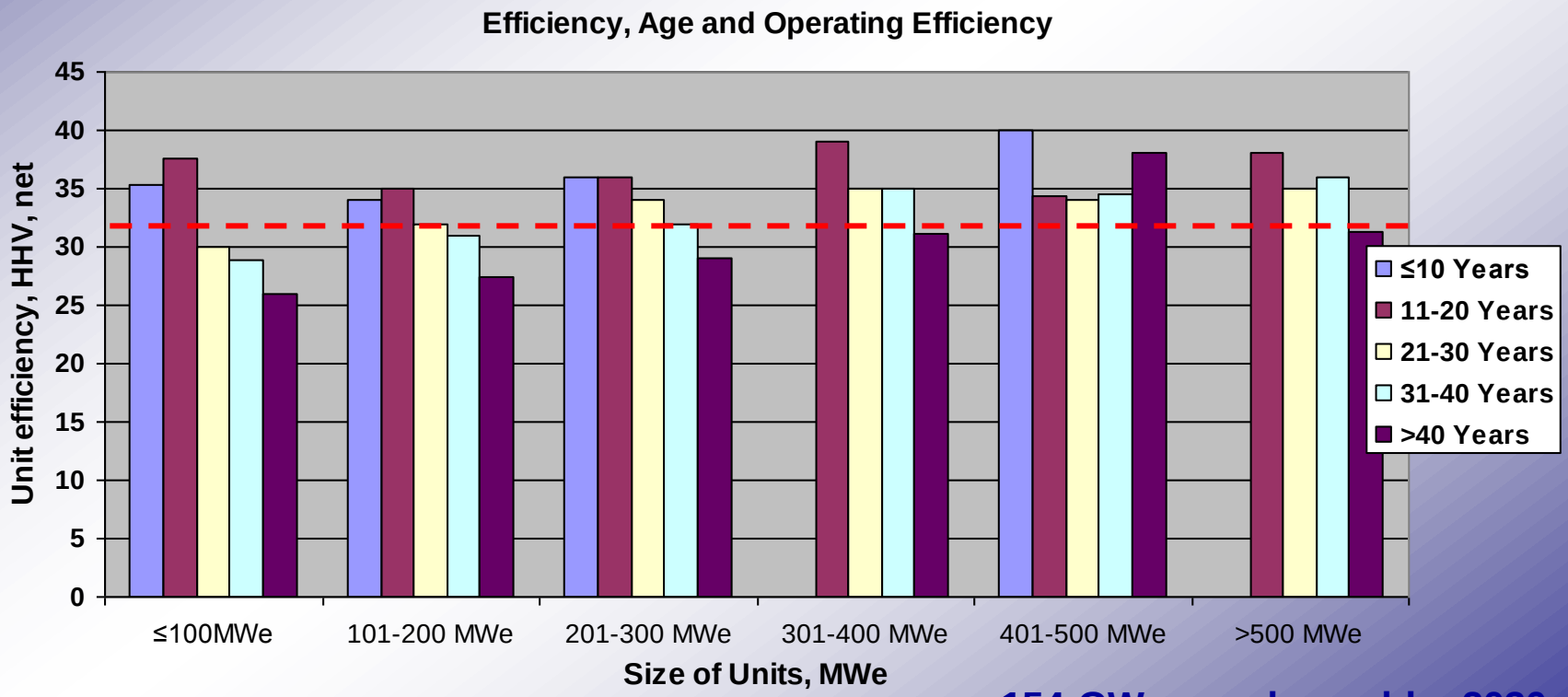
… sample observations- USA

Age distribution of US coal-fired power plants



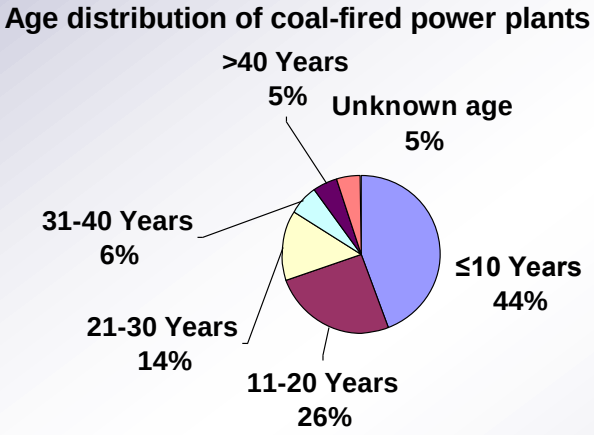
Total – ~325000 MW

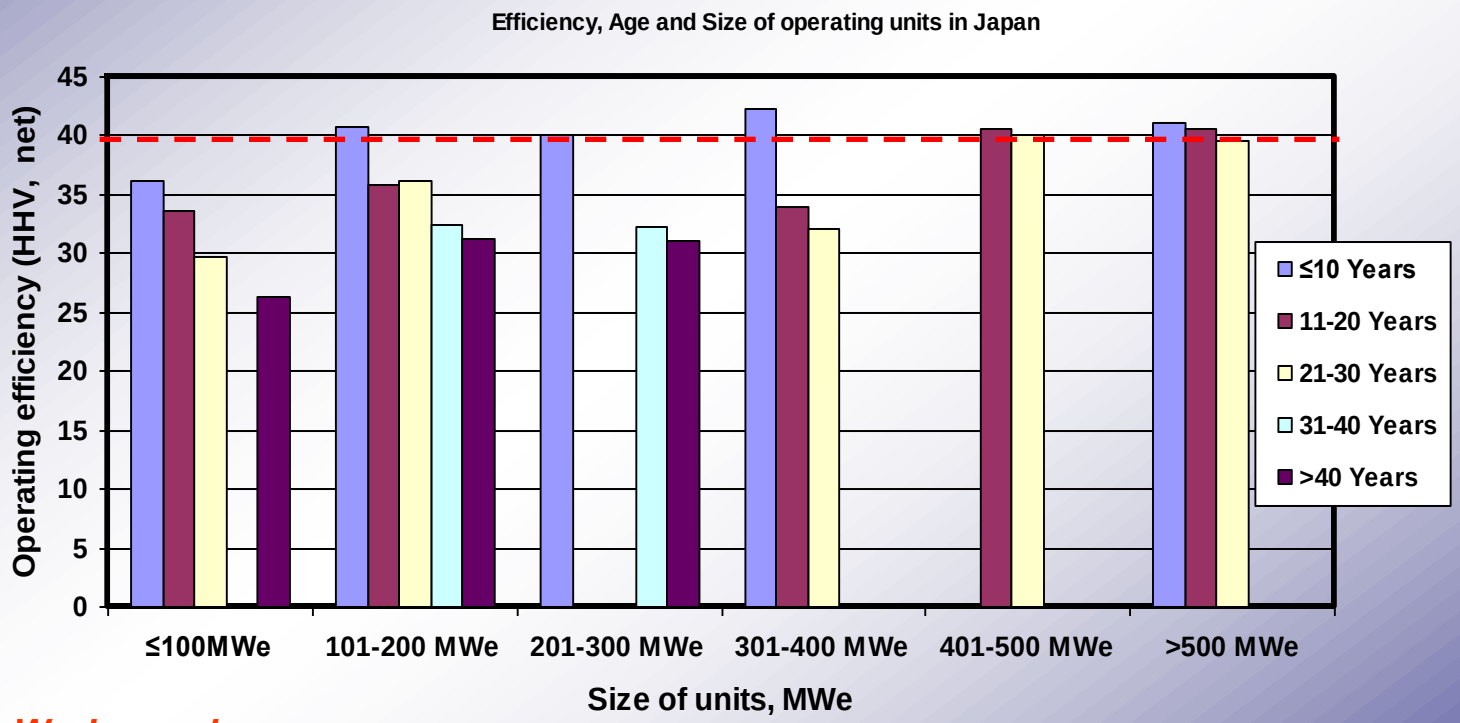
~80% of the fleet sub-critical
>60% of the fleet over 30 years old
~20% of the fleet ≤ 200 MW unit size



154 GW new planned by 2030
~100 GW of 500 MW units

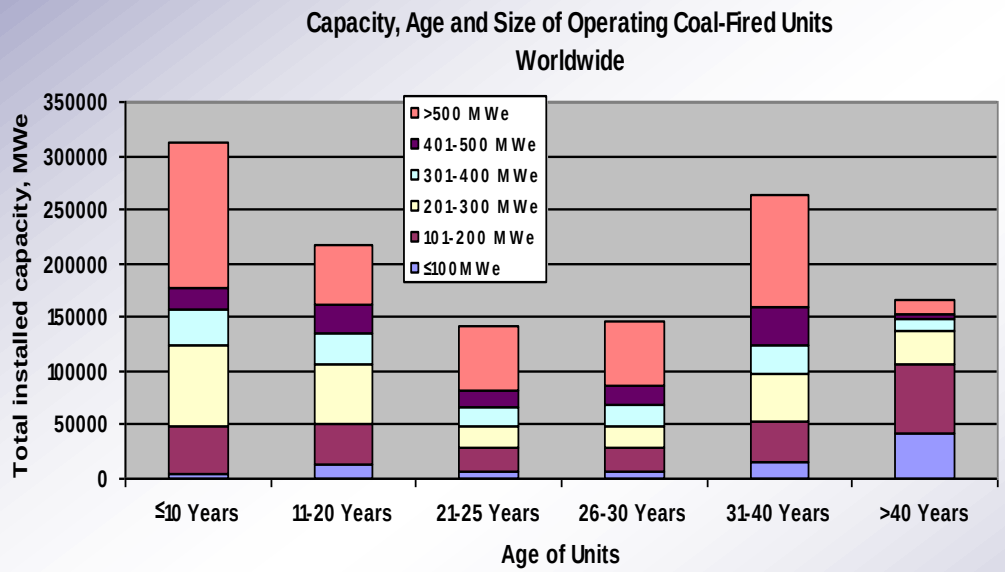
… sample observations – *Japan*





Work ongoing…..

As of 2004…



- ~50% of the operating fleet - >25 years age, ≤300MWe unit size
- >80% of the operating fleet – sub-critical units
- average operating efficiency ~28.4%, HHV, net

Currently available supercritical technology operates around 40% or higher efficiency depending on coal quality and ambient conditions

Efficiency improving…. – where new plants are being commissioned
new plants being planned – China, USA, India

… indications

- coal-fired power and CHP plants worldwide account for ~25% of total CO_2 production
  - *~7.5 billion ton/annum of CO_2 emission* in 2005

- replacement "potential" - ~300 GW
  these are all sub-critical, ≤ 300 MWe unit size, ≥ 25 years age, efficiency 15-30%, HHV, net, located in all major coal-using countries

- upgrade "potential" - up to 200 GW
  these are all sub-critical, ≤ 300 MWe unit size, 15-25 years age, efficiency ≤30%, HHV, net, located in all major coal-using countries

- replacement or upgrade of some units under progress or already planned
  depend on country-specific supply-demand situation
  will require plant-specific techno-economic assessment

- globally 1.35 - 1.7 billion ton/annum of CO2 reduction possible by moving to current state of the art pc-plants – through replacement/upgrade as above, improved plant operation and coal beneficiation
  in excess of 0.5 billion ton/annum of reduction in coal consumption
  higher reduction with possible improvement in higher steam conditions plant – ongoing R&D requires to be accelerated

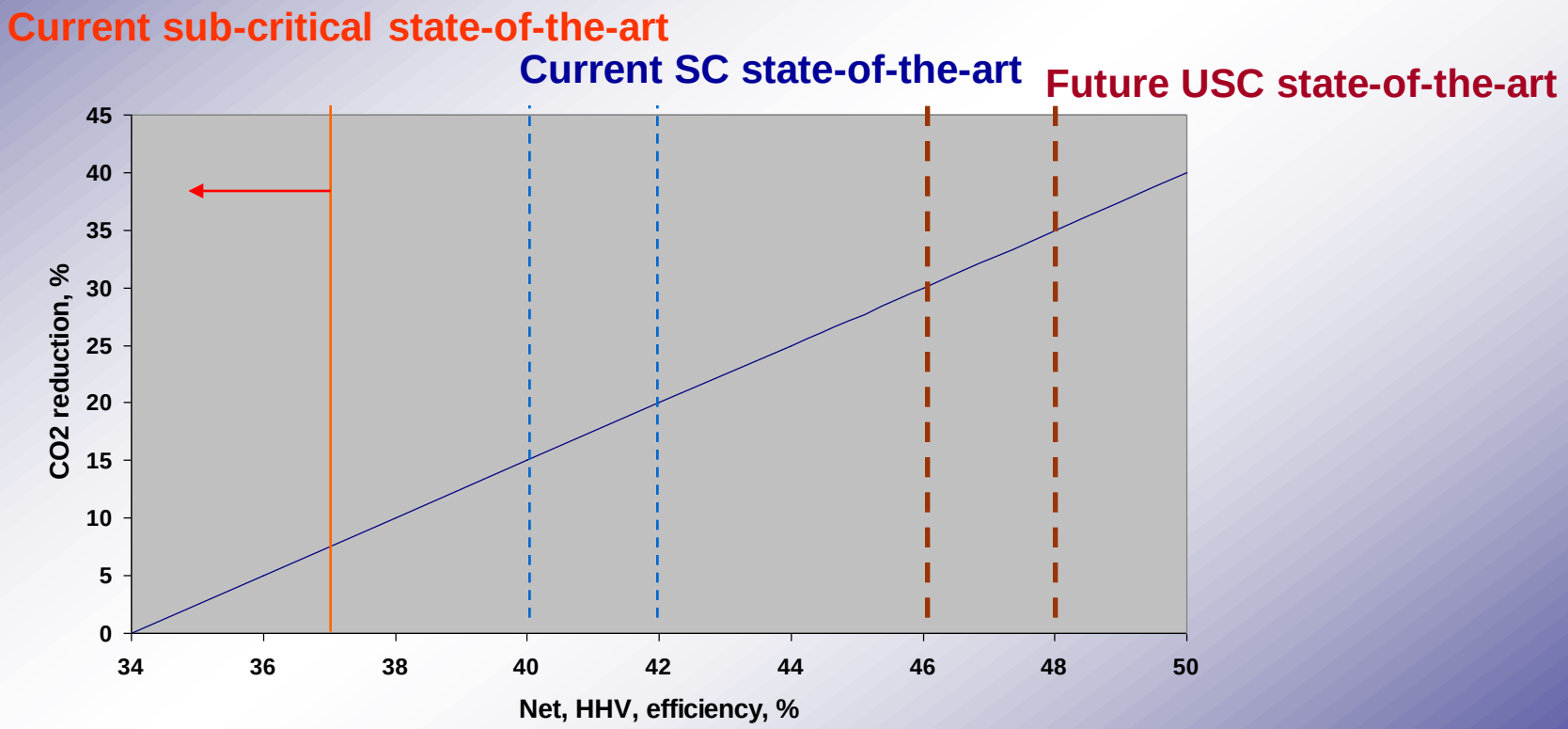
Report: Developments in coal-fired power generation – potential for higher efficiencies

Scope of work

- Summary of recent and ongoing developments in process technology
  - Sub-critical, super-critical and ultra-supercritical *pf* technology
  - Materials developments for high steam conditions
  - Developments in oxy-firing
  - Developments in circulating fluidized bed combustion
  - Developments in drying of high-moisture lignites
- Summary of developments in equipment used in coal-fired generation
- Summary of developments in instrumentation and control
- Prospects of using these developments as retrofit or replacement in existing coal-fired units in the next decade
- Potential of efficiency improvements from using these developments
- Efficiency reconciliation methodology - IEACIAB

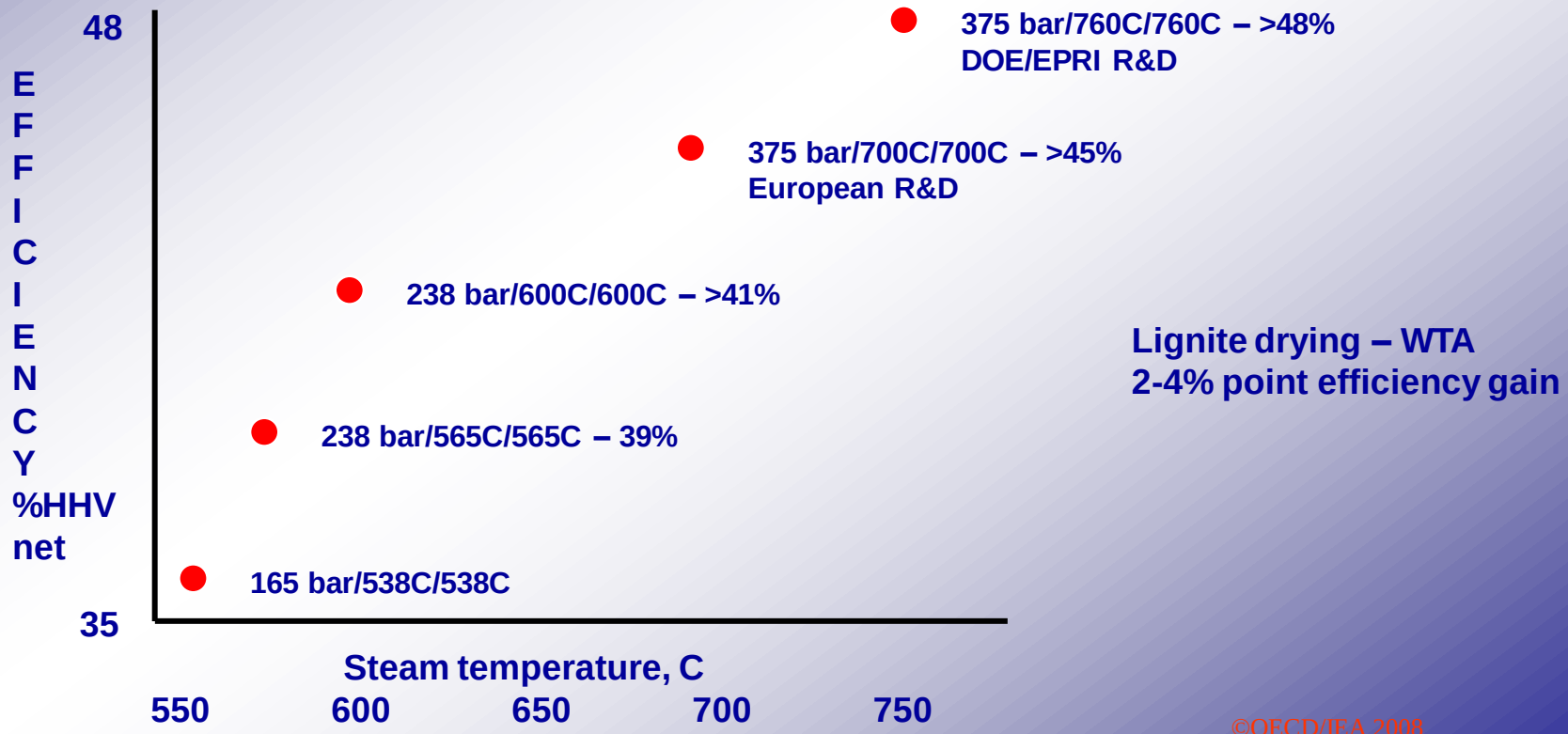
Impetus for Efficiency improvement

- major and immediate effect on reduction of CO_2 emission



1% point efficiency gain > 2.5% point CO2 reduction

Efficiency improvement - developments



Recommendations to G8- Hokkaido

12 recommendations in the following areas:

- **Requirements for newly-built units**
- **Replacement or upgrading of older units**
- **Incentives for replacement and upgrading**
- **Development and diffusion of advanced technologies**

- **Plant maintenance and coal quality control**
- **Use of Coal beneficiation and cogeneration for efficiency improvement**

- **Best Practice in plant operation**
- **Training of plant personnel and plant manufacturers**

- **Need for quality statistics**
- **Renovation of electricity grids**

available at: ***http://www.iea.org/G8/2008/G8_Towards_Sustainable_Future.pdf***

Other forthcoming Publications

Case studies on recently constructed highly-efficient supercritical or ultra-supercritical coal-fired units

- Australia, China, Denmark, Germany, India, Japan, Poland, USA
- technical and cost information
- policies that facilitated their construction

Assessment of full coal process chain for efficiency improvement in power generation

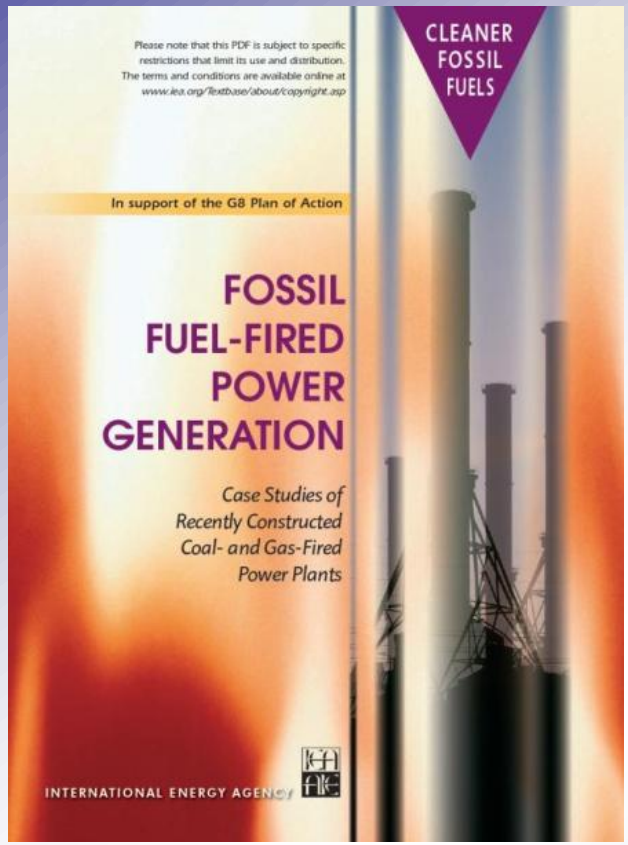
- from mining, coal preparation, boiler and turbine development to ash use

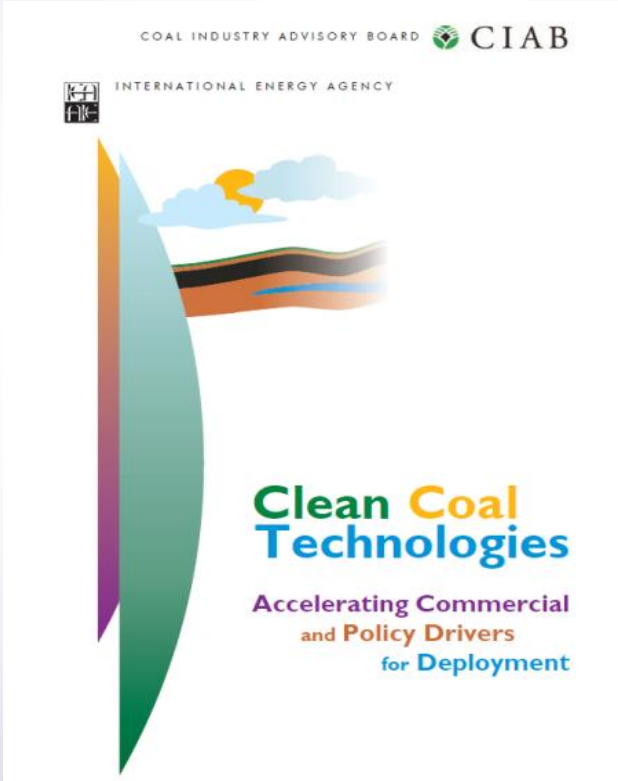
What is required to facilitate upgrading older coal-fired plants in G8 + 5 countries

- regulatory policies, financial incentives and technical issues
- through questionnaire surveys in these countries

By the G8 summit in Italy, 2009

Publications in Cleaner Fossil Fuels





Thank You

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