## Overview of CO<sub>2</sub> Capture and Storage Demonstrations

Dr John Topper IEA Clean Coal Centre and IEA Greenhouse Gas R&D Programme India – UK Workshop on CCS 22-23 January 2008, Delhi

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### **Carbon Capture and Storage**



Recent Plant State-of-the-Art Conditions



- Studstrup (DK) 540/540
- Maatsura 1 (J) 538/566
- Esbjerg (DK) 560/560
- Schwarze Pumpe (D) 547/565
- Maatsura 2 (J) 593/593
- Haramachi 2 (J) 600/600
- Nordjylland (DK) 580/580/580
- Boxberg (D) 545/581
  - Tachibanawan 1 (J) 600/610
- Avedore (DK) 580/600
- Niederaussem (D) 580/600
- + Hekinan (J) 568/593
- X Isogo (J) 600/610
   Yunghung 566/576
   Genesee 3 580/570
- Genesee 3 380/370
- △ Hitachinaka (J) 600/600
- 8 Torrevaldaliga (I) 600/610

Huyan (China)

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Size of plant

Search for location

# E On 50% efficient plant ... 50plus by using new materials

LocationWilhelmshavenEfficiency50 %Capacity500 MW<sub>el</sub>Investment1 billion €Start of operation2014

2007

Material developmen Request for proposal 2010

Construction

Start of operation

2014





### CO2 Capture: in Malaysia

#### 160 T/D CO2 Capture Plant (Supplied by MHI of Japan and using their KS 1 Solvent)

Client:	Petronas Fertilizer (Keda) Sdn. Bhd.
Location:	Kedah Darul Aman, Malaysia
Feed Gas:	Steam Reformer Flue Gas
Capacity:	Flue Gas 47,000 Nm3/H (Max. Capacity = 210 T/D)
Use of CO2	: Urea Production
Start Up:	October 1999



### CASTOR Post-Combustion Pilot Plant

Esbjergværket





Esbjerg power plant Capacity: 1 t  $CO_2$  / h 5000 Nm3/h flue gas (coal combustion) In operation since early 2006





## **UK CCS competition**

- Terms of Reference published 19 November 2007
- Minimum 300MWe;
- Must demonstrate full CCS
- Post Combustion\*\* pre-selected because
  - (\*\* oxy fuel also eligible as a retrofit option)
- Need to do something to support potential retrofits world wide - eyes on China and India
- Hence exportability looks promising
- There are several demonstrations of other carbon capture routes under development
- Good fit with potential UK based suppliers
- Provides one technology block of EU 10-12 demonstrators?



## CO<sub>2</sub> Capture Ready Plant

- > Avoids the risk of stranded assets and 'carbon lock-in'
- Developers must eliminate factors which would prevent installation and operation of CO<sub>2</sub> capture
- > This might include
  - A study of options for capture retrofit
  - Include sufficient space and access for additional facilities
  - Identify reasonable route(s) to storage of CO<sub>2</sub>



### IEA GHG International Post Combustion Capture Network

- A network of international experts from North America, Europe, Japan, Australia
- Has met 10 times since 2000
- 11<sup>th</sup> Meeting in Beijing 20-21 May 2008
- Supported by UK nZEC and MoU with China
- INDIAN PARTICIPATION WELCOME



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IEA Greenhouse Gas R&D Programme



### Callide A – Queensland, Australia





### **Pilot-scale testing by IHI at Aioi (Japan)**

- Test facility:
  - Capacity 1.2 MWt (~ 150 kg coal/h)
  - Furnace size 1.3m dia x 7.5 m
- Objectives:
  - Compare air- vs oxy-firing combustion and emissions
  - Additional validation of Callide A boiler model
  - Investor confidence
  - Ash samples for other CCSD Projects
- Status:
  - Callide & Acland coals tested in Sep. 05
  - Rolleston coal to be tested in Dec. 05
- Measurements:
  - Burnout and temperature profiles
  - Ash deposition tares
  - Emissions including Hg
  - Turn-down effects
  - Fly ash for characterization



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全景 General View





#### The Tampa 250MW IGCC plant in Florida





### RWE is pushing forward the IGCC technology





#### IEA Linenhouse Gas Rep Programmes

IGCC (Integrated Coal Gasification Combined Cycle)

Clean Coal Power R&D Co., Ltd.
Air blown, entrained-flow gasifier
250MW demonstration, 2007-2009
High efficiency (20% CO2 reduction)

#### IGFC (Integrated Coal Gasification Fuel Cell Combined Cycle)

•EAGLE Project

- •Oxygen blown, entrained-flow gasifier
- •150t/d pilot test, 2001-2009
- •High efficiency (30% CO2 reduction)
- •CO2 capture test, 2007-



Bird eye's view of the demonstration plant



Pilot plant at Wakamatsu Res. Inst., JPower



### CO2 storage effectiveness increases with depth



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#### Geological Storage Options for CO<sub>2</sub>

- 1 Depleted oil and gas reservoirs
- 2 Use of CO<sub>2</sub> in enhanced oil recovery
- 3 Deep unused saline water-saturated reservoir rocks
- 4 Deep unmineable coal seams
- 5 Use of CO<sub>2</sub> in enhanced coal bed methane recovery
- 6 Other suggested options (basalts, oil shales, cavities)













### CO<sub>2</sub> Injection and Storage Activities





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### **Information Dissemination**

### **Quarterly newsletter**

## **Topical Reports**







GHGT-9 16<sup>th</sup> – 19<sup>th</sup> November 2009 Washington D.C. www.mit.edu/ghgt9

### **International Summer School**

- New Initiative launched in 2007
- Annual summer school for up to 60 invited students
  - Post grad/post doc students targeted
  - Encouraging developing country participation
- International Steering Committee established
  - IEAGHG, Germany, France, Australia, Japan, Canada, Netherlands and USA
- First summer school was held in Germany in August 2007
  - 54 students from 22 countries attended
  - Next planned for Canada in 2008
- Details available at www.ieagreen.org.uk/summerschool/



## Thank You

# Reference material on IEA GHG can be found at:

www.ieagreen.org.uk

Reference material on CCS can be found at: www.co2captureandstorage.info