European Large Scale Demonstration Projects

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IEA Greenhouse Gas R&D Programme
7th Carbon Annual Carbon Capture and Sequestration Conference
Pittsburgh, USA
May 5th to 8th 2008
Introduction

• Time line for CCS demonstration in Europe
• Regulatory developments in Europe
• Range and type of projects being developed
• Where will the first demonstration be?
Time line for CCS deployment in Europe

- **2008**
  - EC CCS Directive Agreed 2009
  - National Regulations In Place
  - CCS can be ‘opted in’ ETS Phase II
  - CCS Fully Included in ETS

- **2012**
  - First Demos Operational

- **2016**
  - 12 Demonstration Projects Implemented

- **2020**
  - Full Scale Commercial Deployment

ETS Phase II

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EC Draft CCS Directive

- Enabling regulatory framework to ensure environmentally sound CCS
- Focuses on storage component
  - Consistent with OSPAR and IPCC GHG Guidelines
  - Objective is permanent storage
  - Permits required for exploration and storage
  - Storage permit only if “no significant risk of leakage”
  - Emphasis on site selection, characterisation, risk assessment, monitoring
  - Corrective measures
  - Financial security required from operator
  - Liability transfer to regulatory authority “when evidence indicates contained for indefinite future”
  - Removes regulatory barriers in other Directives – IPPC, Waste, LCPD, Water, EIA, ELD
- Capture-ready

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ETS Directive

- EC plans to strengthen, expand and improve the ETS from 2013
- CCS can already be included in Phase II (2008-2012) by ‘opt-in’
- CCS fully included from 2013
  - Site and operation will need to comply with CCS Directive
  - Needs monitoring and reporting guidelines
- No free allocation to CCS (same as electricity)
- Separate permitting of capture, transport and storage
- If any leakage – surrendering of allowances

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Efficiency Increase & CCS Combined

clean coal technologies (improvements in conversion efficiency) can help to reduce emissions, but are insufficient on their own to meet the CO₂ reduction demands of climate change. Indeed, neither the implementation of Clean Coal technologies alone (further improvement of energy efficiency in coal-fired power plants), neither the adoption of CCS technologies alone can provide an economic and environmentally sound approach. The technological solution must combine the advantages of further increasing the conversion efficiencies in power plant with those of the CCS processes;

COMMISSION STAFF WORKING DOCUMENT

accompanying document to the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels

IMPACT ASSESSMENT

{COM(2008) 13}
{SEC(2008) 48}
Development of Efficiency in Coal fired PP in Germany

- **Nickel Based Alloys**
  - (350 bar, >700°C)

- **Austenites**
  - (290 bar, 600°C)

- **Ferrites and Martensites**
  - (260 bar, 545°C)

- CCS makes efficiency increase very important

- CCS Energy Penalty

**Graph:**
- Net efficiency vs. Start-up
- 1950 - 2030
- 30% - 55%

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European Utility Position on CCS

- European utilities co-operating in EU research activities and national R&D programmes
- Technology preferences do differ - all options still on the table
- One position can be considered as:
  - Post combustion capture for near term application and retrofit
  - Second generation PCC technology needed
- Other technologies favoured by some and not others for future applications
  - Oxyfuel – Vattenfall
  - RWe, E.On and NUON - IGCC
### Demonstration Project Initiatives

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Action</th>
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<tbody>
<tr>
<td>Europe</td>
<td>Plans to support up to 12 demonstration projects under its 2007 Directive on Sustainable development of energy from fossil fuels</td>
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<tr>
<td>Norway</td>
<td>Incoming Government defined new policy to introduce new NGCC plant with CCS</td>
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<tr>
<td>UK</td>
<td>Demonstration programme announced with direct financial support for CCS component</td>
</tr>
<tr>
<td>Germany</td>
<td>Demonstration projects supported through national research programme COORETEC in combination with commercial activities</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Demonstration programme supported by Ministry of Economics with commercial support</td>
</tr>
<tr>
<td>Denmark</td>
<td>Commercial developments will initiate a demonstration project</td>
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**IEA Greenhouse Gas R&D Programme**

- **Pre-combustion**
- **Post-combustion**
- **Oxyfuel**

### Commercial
- **500 MW**
  - **Nuon - Magnum**
  - **Mongstad**

### Demonstration
- **100 MW**
  - **E.on**
  - **UK Competition**
  - **Vested - Vattenfall**

### Pilot
- **0 MW**
  - **Vattenfall**

- **COAL**
- **Lignite**
- **Natural Gas**

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IEA Greenhouse Gas R&D Programme

- Pre-combustion
- Post-combustion
- Oxyfuel

500 MW

BP – DF4

BP – DF3
E.on
FutureGen
GreenGen

100 MW

100 MW

Nuon – Magnum
ZeroGen

0 MW

NATURAL GAS
LIGNITE
COAL

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## Which Will Succeed?

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Project</th>
<th>Political Will</th>
<th>Financing</th>
<th>Regulations</th>
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<td>Karsto Mongstad</td>
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<td>DF-1</td>
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<td>Vaestad</td>
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<td>?</td>
<td>?</td>
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Thank You
Any Questions?

General - www.ieagreen.org.uk
CCS - www.co2captureandstorage.info
GHGT-9 – www.mit.edu/ghgt9