Future Developments at Drax Power Station, (Oxyfuel and Biomass)

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April 2012
Agenda

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What triggered the Drax biomass project

Strategic decision to embark on a CO2 reduction programme

- Included turbine retrofit
- Biomass co-firing
Biomass Co-firing: Potential to Reduce CO2 Emissions

World largest co-firing project - 1.5 million tonnes/year biomass co-firing at 10% heat input

400 MWe of green power

2 million tonnes/year CO2 avoided

Process works commissioned early 2010

- Phase 1, 4 month Design Study, Drax engaged at all stages of project development, inc HAZOP
- Phase 2, (EPC) Engineer contract, design, supply and installation of equipments associated with the main processing works (road unloading, storage & biomass milling) inc civils, mechanical & electrical installation and commissioning

Potential to retrofit existing power plant
Utilising existing assets - Quick solution to meet renewable energy targets
Drax Challenges

Largest co-firing project in the world

- Throughput and processing requirements

Biomass fuels challenges:

- Spontaneous combustion
- ATEX/DSEAR (*local directives*)
- Dust emissions

Retrofit project

- Existing footprint
- Live Plant- constructability
- Health and Safety
Alstom’s European experience

- Alstom has been active in biomass power generation for over 18 years
- Alstom has experience in working on a wide variety of biomass fuels
- Most co-firing projects look at 10% to 20% biomass by heat input
- Co-firing is one of the most cost effective ways to reduce CO2 in existing assets

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- No interruption of existing plant performance or operation during construction and commissioning
- Plant fully commissioned and operational since April 2010
- CO2 savings per year = > 2million tonnes (based on 100% capacity)
- Green House Gases reduction of >70% v coal
- Plant consistently delivers rated output
- Capable of processing 40 tonnes of biomass per hour on each of the six boiler units, alongside some 230 tonnes per hour of coal.
- Multiple fuels (being received, stored, processed, sampled and fired
  - Forestry residues
  - Agricultural by-products
  - Energy crops (including UK grown)
Conclusion - Drax Biomass Co-firing

- Successful project delivered safely, on time and on budget.
- Forms the basis for further (increased) biomass firing
- Makes a significant contribution to the UK renewables target
- An economic means of CO2 reduction
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What triggered the CCS project

- Alstom has a global ambition to develop CCS technology
- Drax has a long term vision that is focussed around low carbon electricity generation
- Retrofitting an existing coal plant with CCS is unlikely to deliver a competitive power plant in the UK market
Project Snapshot

- A new modern supercritical 426MWe Gross Oxy-fuel Power Plant
- Clean power generation with the entire flue gas treated to capture 2 Million t/y CO₂
- Biomass co-firing leading to zero (or negative!) CO₂ emissions
- Located at the Drax Power Station Site, Selby, North Yorkshire
- Associated with National Grid’s (NG) regional CO₂ transport & offshore storage network
- Project development activities on-going
- NER funding application under EC evaluation.
- UK Demo funding application planned

Largest Oxy-fuel CCS Demonstration Project Worldwide
PRODUCT VALIDATION PLAN
Oxy-Roadmap Overview

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>2006</td>
<td>Concept, bench &amp; laboratory tests, CFD model development</td>
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<tr>
<td>2007</td>
<td>Additional tests</td>
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<tr>
<td>2008</td>
<td>30 MWth Schwarze Pumpe pilot</td>
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<td>2009</td>
<td>30 MWth Lacq pilot</td>
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<tr>
<td>2010</td>
<td>CCS tests</td>
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<tr>
<td>2011</td>
<td>Sept 08</td>
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<tr>
<td>2012</td>
<td>Jul 09</td>
</tr>
<tr>
<td>2013</td>
<td>15 MWth BSF Windsor</td>
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<tr>
<td>2014</td>
<td>Sept 09</td>
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<tr>
<td>2015</td>
<td>Large demos to validate oxy-boiler but also the full integrated oxy-chain</td>
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<tr>
<td>2016</td>
<td>Studies</td>
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<tr>
<td>2017</td>
<td>250 MWe - Oxy-PC indirect firing - T-firing demo - dried lignite</td>
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<tr>
<td>2018</td>
<td>Commercial scale</td>
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Alstom activity on CO2 capture
Oxy-Combustion

Status

- Currently tested at
  - Schwarze Pumpe (30MWth, Germany)
  - Alstom Boiler Simulation Facility Windsor (15MWth, US)
  - Lacq (30MWth, France)

- Coming soon:
  - Jänschwalde (250MWe, Germany),
    - pre-selected by EU Commission,
    - Alstom did the feasibility study
  - Drax (300MWe net, UK)
    - Application for NER 300 funds 2010
    - Application for DECC funds 2012

Invited by the Commission to negotiate award agreements for EEPR funding
## Project Promoters

### Drax
- Owner and operator of the UK’s largest, cleanest, most efficient coal-fired power station; meets 7% of the UK’s electricity needs
- Produces more renewable power than any other UK facility
- Committed to reducing Drax and UK power generation carbon footprint

### ALSTOM
- A global leader in the world of power generation, power transmission and rail infrastructure
- A pioneer in large-scale and efficient CCS technologies

### BOC
- The largest provider of industrial gases in UK
- A member of the Linde group, a world leading gases and industrial company

### National Grid
- An international electricity and gas company and one of the largest investor-owned energy companies in the world.
- Expert in running high pressure natural gas system in a safe, reliably and efficient manner.

## A strong consortium
Partner Roles

Location: Drax Power Station, North Yorkshire, UK

Project Promoters

- Oxy-fuel Power Plant
- CO₂ Transportation & Storage

- ALSTOM
- DRAX
- BOC-Linde
- NATIONAL GRID

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Oxy Technology

• Reliable: main components exist; requires only adaptation to power and scale-up
• Fuel Flexibility: applicable for all types of boilers, firing systems and fuels
• Scale-up: no constraints anticipated for larger commercial units
• Emissions: No new chemicals introduced to the power plant.

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CO₂ Transport and Storage Solution

Storage Development

Regional assessment completed
- All Southern North Sea (SNS) gas fields and saline formations
- Petroleum Geo-Services SNS Megasurvey 3D seismic (25,000 sq. km)
- Supplemented by Western Geco 3D & 2D seismic for in-fill of gaps

Assessed 257 wells in target area (full database setup and selected petrophysics)

Key sites short-listed

Technical programme to identify prime target (2 front runners) developed

Developing appraisal plan; to include formation drilling

Transport Development

R&D programme:
- Vapour phase programme completed
- Dense phase programme underway

Onshore route planning - public consultation started

Offshore route planning ongoing

On- & Off-shore operational options prepared

Offshore facilities options prepared

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• 426 MWe gross output / 390MW in air mode / 304MW in full Oxy-mode
• Gross efficiency 44 – 46%, net efficiency 35-36%
• CO2 Capture 90%
• Steam quality 260bar / 600C / 620C
• As a demonstration project it is expensive on a /MW basis but has significantly less risk when scaled up to commercial size
Conclusion – CCS Oxy project

- An exciting technology
- A lot of hurdles to get over before it happens but with..
- A solid group of companies supporting it..
- And Government backing CCS it provides..
- Excellent opportunity to demonstrate that coal can be used for clean power generation for years to come