CIUDEN CFB Boiler
Technological Development

Presented by:

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Presentation Outline

1. Background of CIUDEN demonstration
2. Description of 30 MW_{th} oxy-CFB boiler
3. Testing
4. Future related demonstration activities

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Background of CIUDEN Demonstration Project
CIUDEN: Fundación Ciudad de la Energía

- CIUDEN is a non-profit, collaborative research organization for technological development, established by Spanish government in 2006.

- The facility, located in North-western Spain, will allow collaborative research for international cooperation with industry, universities and research institutions.

- The Technology Development Centre for CO₂ Capture (es. CO₂) includes pulverized coal (PC) and circulating fluid bed (CFB)

- Foster Wheeler is presently executing the design and supply contract for the 30 MWth oxy-CFB equipment
  - Scheduled completion in 2Q/2011
CIUDEN CO2 Technology Development Plant
Aerial View

- CIUDEN CO2 Technology Development Plant
- Aerial View
- Technical & Industrial Buildings
- DCS
- CO2 Compression & Purification
- Flue Gas Cleaning
- Gases Recirculation and Mixture
- PC Boiler
- CFB Boiler
- Fuel Preparation
- Technical & Industrial Buildings
CIUDEN CO2 Technology Development Plant
Aerial View
Foster Wheeler is the technology provider and supplier of the oxy-CFB demonstration unit.

To facilitate carbon capture from utility and industrial steam generators, Foster Wheeler is developing CFB technology that allows operation either under conventional air-fired combustion or under oxy-combustion conditions.

Foster Wheeler refers to this technology as Flexi-Burn CFB.

Flexi-Burn is a trademark of Foster Wheeler Energia Oy, registered in the US, EU, and Finland.
CFB Flexi-Burn Demonstration Timeline

Studies / Modeling / Bench and Pilot Scale Testing

VTT 2 - 100 kW

CANMET 1 MW

Demonstration Projects

CIUDEN 30 MWth Flexi-Burn CFB

Test Programs

Compostilla Oxy-CFB-300 Phase I

Phase II (construction and operation)

Description of 30 MW_{th} oxy-CFB
CIUDEN 30 MWth Flexi-Burn CFB
Design Features

1. Membrane Panel Furnace
2. Cyclone Separator
3. Split Loopseal
4. Intrex Superheater
5. Heat Recovery Area (surface)
6. Heat Recovery Area (enclosure)
7. Economizer

Additional Features:
- SNCR for NOx reduction
- Fly-ash reinjection
### CIUDEN 30 MWth Flexi-Burn CFB

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace dimensions (H x W x D) (ft)</td>
<td>20 x 2.9 x 1.7</td>
</tr>
<tr>
<td>Thermal power (MW&lt;sub&gt;th&lt;/sub&gt;)</td>
<td>15 conventional (air) mode</td>
</tr>
<tr>
<td></td>
<td>30 total oxycombustion mode</td>
</tr>
<tr>
<td></td>
<td>(O&lt;sub&gt;2&lt;/sub&gt; + recirculated flue gases)</td>
</tr>
<tr>
<td>Maximum steam flow (t/h)</td>
<td>47.5</td>
</tr>
<tr>
<td>Superheated steam temperature (°C)</td>
<td>250</td>
</tr>
<tr>
<td>Superheated steam pressure (bar)</td>
<td>30</td>
</tr>
<tr>
<td>Feed water temperature (°C)</td>
<td>170</td>
</tr>
<tr>
<td>Outlet boiler flue gases temperature (°C)</td>
<td>350-425</td>
</tr>
</tbody>
</table>
CIUDEN 30 MWth Flexi-Burn CFB - Combustion Chamber / Furnace
CIUDEN 30 MWth Flexi-Burn CFB Cyclone Separator
CIUDEN 30 MWth Flexi-Burn CFB
HRA / Convection Pass
CIUDEN 30 MWth Flexi-Burn CFB – Economizer
CIUDEN 30 MWth Flexi-Burn CFB
Intrex Superheater
First coal fire on the Sept 2nd
Testing
Oxy-Fuel CFB Technology
Main Advantages

- The established CFB advantages (air-fired) also exist in oxy-combustion applications.
- Multi-fuel capability in CFB (coal, petroleum coke, lignite, biomass, etc.)
- Emission control technology, e.g. $\text{SO}_x$ and $\text{NO}_x$ reduction (performed better in oxy-mode)
- Flexi-Burn technology: Boiler capable of both air-firing and oxy-fuel-firing (low oxygen concentrations).
Test Activities on Oxyfuel Combustion

- First operation and commissioning on oxyfuel combustion 4Q/2011
- First experimental test runs scheduled for 1Q/2012
- First test on integrated operation with CPU start in 2Q/2012
- The CFB pilot is fully booked for testing during 2012-2013
A large variety of fuels to be tested

- Local athrasite
- Petcoke
- Bituminous coal
- Local lignite (high ash and sulfur)
- Biomass cofiring
Test Objectives

• Demonstrate oxy-combustion in a CFB of 30 MWth.
• Generate data for models validations.
• Generate the knowledge base for the scale-up.
• Determine optimum operating parameters to allow sizing of new full scale oxy-fired units.
• Obtain data on the combustion behaviour of different coals in conventional and oxycombustion conditions.
• Compare the performance between air and oxy combustion modes in order to be able to relate the air combustion experience to oxy conditions.
• When operating in air mode, provide the flue gas stream for testing and demonstration of post-combustion carbon capture equipment.
• When operating in oxycombustion mode, provide a rich CO₂ gas stream for the testing of process equipment used for CO₂ purification and compression.
• Obtain data to evaluate the impact that oxycombustion might have on the combustion, emissions and corrosion of boiler heating surfaces.
Test Programs

Test programs are designed to investigate the effects of the following parameters:

- Bed and furnace temperature
- Excess O₂ concentration
- Oxidant concentration
- Fluidization velocity
- Flue gas recycle
- Effect of bed inventory
- Emissions
- SO₂ capture
- Corrosion / fouling / agglomeration
Future Related Demonstration Activities
CO₂ CAPTURE

• Basic engineering of a Capture OXYCFB 330MWe Unit
• Design, construction and operation of a Capture TDC at pilot scale (30 MWth)
• Validation tests at Capture TDC in order to scale up the technology
• Develop models for optimising the final design for oxy-combustion
• Capture Economic and Risk Assessment studies
Thank You

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