ELCOGAS IGCC: Towards zero emissions power plants
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1. ELCOGAS COMPANY

Spanish company established in April 1992 to undertake the planning, construction, management and operation of a 335 MW ISO IGCC plant located in Puertollano (Spain)
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2. PUERTOLLANO IGCC POWER PLANT DESCRIPTION

Process description

- **Coal preparation**
  - Coal
  - Petroleum Coke
  - Limestone

- **Gasifier**
  - Raw Gas
  - Quench Gas
  - Fly ash

- **HP Boiler**
  - HP Steam
  - Coal - N₂

- **MP Boiler**
  - MP Steam

- **Filtration**
  - Clean syngas

- **Water wash**
  - Water
  - Air
  - O₂

- **Sulfur removal**
  - Tail Gas
  - Claus gas
  - Sulfur (99.8%)

- **Sulfur recovery**
  - Waste N₂
  - Compressed air

- **Air separation unit**
  - N₂
  - O₂

- **Heat recovery steam generator**
  - Steam

- **Steam turbine**
  - 135 MWISO

- **Condenser**
  - Hot combustion gas

- **Cooling tower**
  - Flue gas to stack
### 2. PUERTOLLANO IGCC POWER PLANT DESCRIPTION

#### Fuel

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Pet Coke</th>
<th>Fuel Mix (50:50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%w)</td>
<td>11.8</td>
<td>7.00</td>
<td>9.40</td>
</tr>
<tr>
<td>Ash (%w)</td>
<td>41.10</td>
<td>0.26</td>
<td>20.68</td>
</tr>
<tr>
<td>C (%w)</td>
<td>36.27</td>
<td>82.21</td>
<td>59.21</td>
</tr>
<tr>
<td>H (%w)</td>
<td>2.48</td>
<td>3.11</td>
<td>2.80</td>
</tr>
<tr>
<td>N (%w)</td>
<td>0.81</td>
<td>1.90</td>
<td>1.36</td>
</tr>
<tr>
<td>O (%w)</td>
<td>6.62</td>
<td>0.02</td>
<td>3.32</td>
</tr>
<tr>
<td>S (%w)</td>
<td>0.93</td>
<td>5.50</td>
<td>3.21</td>
</tr>
<tr>
<td>LHV (MJ/kg)</td>
<td>13.10</td>
<td>31.99</td>
<td>22.55</td>
</tr>
</tbody>
</table>

#### Power output and emissions

<table>
<thead>
<tr>
<th>POWER OUTPUT</th>
<th>GAS TURBINE (MW)</th>
<th>STEAM TURBINE (MW)</th>
<th>GROSS TOTAL (MW)</th>
<th>NET TOTAL (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>182.3</td>
<td>135.4</td>
<td>317.7</td>
<td>282.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EFFICIENCY (LHV)</th>
<th>GROSS</th>
<th>NET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>47.12%</td>
<td>42.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMISSIONS</th>
<th>g/kWh</th>
<th>mg/Nm³ (6% Oxygen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>0.07</td>
<td>25</td>
</tr>
<tr>
<td>NOₓ</td>
<td>0.40</td>
<td>150</td>
</tr>
<tr>
<td>Particulate</td>
<td>0.02</td>
<td>7.5</td>
</tr>
</tbody>
</table>
## 2. PUERTOLLANO IGCC POWER PLANT DESCRIPTION

### Raw and clean gas data

<table>
<thead>
<tr>
<th></th>
<th>Raw Gas</th>
<th></th>
<th></th>
<th>Clean Gas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual average</td>
<td>Design</td>
<td></td>
<td>Actual average</td>
<td>Design</td>
</tr>
<tr>
<td>CO (%)</td>
<td>59.26</td>
<td>61.25</td>
<td>CO (%)</td>
<td>59.30</td>
<td>60.51</td>
</tr>
<tr>
<td>H₂ (%)</td>
<td>21.44</td>
<td>22.33</td>
<td>H₂ (%)</td>
<td>21.95</td>
<td>22.08</td>
</tr>
<tr>
<td>CO₂ (%)</td>
<td>2.84</td>
<td>3.70</td>
<td>CO₂ (%)</td>
<td>2.41</td>
<td>3.87</td>
</tr>
<tr>
<td>N₂ (%)</td>
<td>13.32</td>
<td>10.50</td>
<td>N₂ (%)</td>
<td>14.76</td>
<td>12.5</td>
</tr>
<tr>
<td>Ar (%)</td>
<td>0.90</td>
<td>1.02</td>
<td>Ar (%)</td>
<td>1.18</td>
<td>1.03</td>
</tr>
<tr>
<td>H₂S (%)</td>
<td>0.81</td>
<td>1.01</td>
<td>H₂S (ppmv)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>COS (%)</td>
<td>0.19</td>
<td>0.17</td>
<td>COS (ppmv)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>HCN (ppmv)</td>
<td>23</td>
<td>38</td>
<td>HCN (ppmv)</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>
2. PUERTOLLANO IGCC POWER PLANT

Project milestones

1992
Main contracts award

Jun 1996
First synchronization of gas turbine

Oct 1996
Commercial operation with natural gas

Jun 1997
Performance test of the Air Separation Unit

Mar 1998
First switch over from natural gas to coal gas

Nov 2000
First 1,000 GWh produced with coal gas as IGCC

Dec 2009
Total: 19,354 GWh
IGCC: 13,002 GWh
2. PUERTOLLANO IGCC POWER PLANT: Operating data

1st 5 years: Learning curve

2003: Major overhaul Gas Turbine findings

2004 & 2005: Gas turbine main generation transformer isolation fault

2006: Gas turbine major overhaul & candle fly ash filters crisis

2007 & 2008: ASU WN\textsubscript{2} compressor coupling fault and repair MAN TURBO
### 2. PUERTOLLANO IGCC POWER PLANT: Operating data

#### Availability 2009

<table>
<thead>
<tr>
<th>Component</th>
<th>Availability (%)</th>
<th>Planned Outages (%)</th>
<th>Unplanned Outages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGCC</td>
<td>64.7</td>
<td>9.9</td>
<td>25.4</td>
</tr>
<tr>
<td>Gasifier</td>
<td>77.7</td>
<td>10.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Power Block</td>
<td>86.0</td>
<td>6.2</td>
<td>7.8</td>
</tr>
<tr>
<td>ASU</td>
<td>89.4</td>
<td>3.1</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Emissions in NGCC & IGCC modes

Natural gas (NGCC)

SO2
- EEC 88/609
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average

NOx
- EU Directive 88/609/EEC
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average

Particles
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average

Coal gas (IGCC)

SO2
- EU Directive 88/609/EEC
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average

NOx
- EU Directive 88/609/EEC
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average

Particles
- EU Directive 88/609/EEC
- ELCOGAS Environmental Permit
- ELCOGAS 2009 average
# Variable costs

<table>
<thead>
<tr>
<th>Fuel mode</th>
<th>Fuel mode</th>
<th>Production (GWh)</th>
<th>Heat rate (GJ$_{HHV}$/GWh)</th>
<th>Fuel cost (€/GJ$_{HHV}$)</th>
<th>Total cost (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT</td>
<td>Natural gas</td>
<td>4,80</td>
<td>17.173</td>
<td>7,86</td>
<td>134,98</td>
</tr>
<tr>
<td>NGCC</td>
<td>Natural gas</td>
<td>11,33</td>
<td>9.430</td>
<td>7,86</td>
<td>74,12</td>
</tr>
<tr>
<td>NGCC + ASU</td>
<td>Natural gas</td>
<td>205,52</td>
<td>9.738</td>
<td>7,86</td>
<td>76,54</td>
</tr>
<tr>
<td>NGCC + ASU + Gasifier (by flare)</td>
<td>Natural gas</td>
<td>54,92</td>
<td>8.629</td>
<td>7,86</td>
<td>78,89</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td></td>
<td>1.747</td>
<td>3,20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petcoke</td>
<td></td>
<td>4.483</td>
<td>1,22</td>
<td></td>
</tr>
<tr>
<td>IGCC</td>
<td>NG auxiliar consumption</td>
<td>1.526,76</td>
<td>154</td>
<td>7,86</td>
<td>15,98</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
<td></td>
<td>2.332</td>
<td>3,20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petcoke</td>
<td></td>
<td>5.986</td>
<td>1,22</td>
<td></td>
</tr>
</tbody>
</table>

Note: Data for the year 2009
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3. FUTURE OF IGCC TECHNOLOGY. CCS & H₂ co-production

Step 1: Syngas production from gasification

Carbon compound + O₂ + H₂O → CO + H₂ + Impurities

Step 2: “Shifting” or water-gas reaction

CO + H₂O → CO₂ + H₂

Step 3: H₂ and CO₂ separation

H₂ & CO₂

H₂ production from fossil fuels involves CO₂ generation ⇒ To talk about “clean” H₂ it is required to consider CCS

- Fly ash
- Char
- Cl⁻
- CN⁻
- SH₂
- COS
- CO₂
- N₂
- ....
3. FUTURE OF IGCC TECHNOLOGY. CCS

CLIMATE CHANGE MITIGATION - IPCC


http://www.ipcc.ch/ipccreports/
3. FUTURE OF IGCC TECHNOLOGY. CCS

CLIMATE CHANGE MITIGATION - IEA

CCS: a Key Part of a Low-cost GHG Strategy

- Without new policies, global emissions increase 130% by 2050, corresponding to a 4-7°C temperature rise
- CCS provides 1/5th of the needed CO₂ reductions in 2050
- Without CCS, cost of stabilisation rises by 70%
- CCS is the only low-carbon solution for coal, cement, and iron & steel sectors

Source: IEA “CCS - Technology Roadmap (2009)”
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4. ELCOGAS R&D INVESTMENT PLAN

PUERTOLLANO IGCC ACTIVITIES:

- Based on the opportunity that an IGCC plant represents, contribution can be relevant in:
  - Climate change mitigation
  - Energy supply reliability

Main lines of R&D plan are:

- CO₂ emission reduction in utilisation of fossil fuels
- H₂ production by gasification of fossil fuels
- Diversification of raw fuels and products
- Other environmental improvements
- IGCC processes optimisation
- Dissemination of results
4. R&D PLAN: Diversification of raw fuels and products

**ORUJILLO CO-GASIFICATION TESTS – CENIT PROJECT (1)**

**ORUJILLO CO-GASIFICATION** consists on the partial substitution of the common fuel (50% mixture of coal and pet coke) by the biomass, that is introduced to the process mixed with the limestone in the required proportion and together with the common fuel.

### Orujillo and design fuel characterisation

<table>
<thead>
<tr>
<th>Parameter (*dry base)</th>
<th>Orujillo received. Average composition</th>
<th>ELCOGAS design fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>13.13</td>
<td>9.40</td>
</tr>
<tr>
<td>Volatile* (%)</td>
<td>68.89</td>
<td>15.92</td>
</tr>
<tr>
<td>Ash* (%)</td>
<td>8.51</td>
<td>20.68</td>
</tr>
<tr>
<td>$C_{\text{fixed}}^*$ (%)</td>
<td>22.52</td>
<td>54.00</td>
</tr>
<tr>
<td>LHV (kcal/kg)</td>
<td>3,693.87</td>
<td>5,386</td>
</tr>
<tr>
<td>C* (%)</td>
<td>49.40</td>
<td>59.21</td>
</tr>
<tr>
<td>H* (%)</td>
<td>5.96</td>
<td>2.80</td>
</tr>
<tr>
<td>N* (%)</td>
<td>1.44</td>
<td>1.36</td>
</tr>
<tr>
<td>S* (%)</td>
<td>0.14</td>
<td>3.21</td>
</tr>
<tr>
<td>Cl$^-$* (mg/kg)</td>
<td>2,735.35</td>
<td>200</td>
</tr>
</tbody>
</table>
4. R&D PLAN: Diversification of raw fuels and products

**ORUJILLO CO-GASIFICATION TESTS – CENIT PROJECT (2)**

Two levels of co-gasification tests were planned:

- **Stage of technical viability to check**, with a reduced amount of orujillo, if the foreseen procedure of handling and consumption is valid from a technical point of view, especially in its reception, storage, mixing and grinding.
- **Productive stage** to operate with bigger biomass and variable ratios (up to 10%) in order to analyse the performance and influence in the process.

**Battery of undertaken tests**

<table>
<thead>
<tr>
<th>Co-gasification test Month/Year</th>
<th>Orujillo dosage ratio in weight (%)</th>
<th>Tons of orujillo (t)</th>
<th>Test duration (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2007</td>
<td>1 %</td>
<td>7.4</td>
<td>9.5</td>
</tr>
<tr>
<td>September 2007</td>
<td>2 %</td>
<td>20.00</td>
<td>7</td>
</tr>
<tr>
<td>November 2007</td>
<td>2 %</td>
<td>81.86</td>
<td>28.5</td>
</tr>
<tr>
<td>August 2008</td>
<td>4 %</td>
<td>100.42</td>
<td>21</td>
</tr>
<tr>
<td>October 2008</td>
<td>4 %</td>
<td>299.36</td>
<td>79</td>
</tr>
<tr>
<td>November 2008</td>
<td>4 %</td>
<td>252.36</td>
<td>54</td>
</tr>
<tr>
<td>February 2009</td>
<td>2 %</td>
<td>518.86</td>
<td><strong>291.3</strong></td>
</tr>
<tr>
<td>March 2009</td>
<td>6 %</td>
<td>395.86</td>
<td>64.4</td>
</tr>
<tr>
<td>March 2009</td>
<td>2 %</td>
<td>512.38</td>
<td><strong>289</strong></td>
</tr>
<tr>
<td>June 2009</td>
<td>8 %</td>
<td>383.90</td>
<td>46</td>
</tr>
<tr>
<td>July 2009</td>
<td>2%</td>
<td>136.86</td>
<td>40</td>
</tr>
<tr>
<td>September 2009</td>
<td>2%</td>
<td>295.48</td>
<td>135</td>
</tr>
<tr>
<td>September 2009</td>
<td>10%</td>
<td>656.68</td>
<td>62</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>3,661.42</strong></td>
<td><strong>1,126.7</strong></td>
</tr>
</tbody>
</table>
Duration/Consumption:

- Duration of test: 46 hours
- Orujillo consumption: 383.9 t
- Total fuel fed: 4,588.6 t

Fuel characterisation

<table>
<thead>
<tr>
<th>Parameter (* dry base)</th>
<th>Orujillo average analysis (ELX)</th>
<th>Average analysis of common fuel (ELX)</th>
<th>Fuel with 8% orujillo (ATISAE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>13.32</td>
<td>0.73</td>
<td>0.7</td>
</tr>
<tr>
<td>Volatiles* (%)</td>
<td>68.73</td>
<td>18.54</td>
<td>21.5</td>
</tr>
<tr>
<td>Ash* (%)</td>
<td>8.42</td>
<td>22.35</td>
<td>22.1</td>
</tr>
<tr>
<td>( C_{\text{fixed}}^* ) (%)</td>
<td>22.85</td>
<td>59.22</td>
<td>56.4</td>
</tr>
<tr>
<td>LHV (kcal/kg)</td>
<td>3,685</td>
<td>6,019.66</td>
<td>6,104.5 (HHV)</td>
</tr>
<tr>
<td>( C^* ) (%)</td>
<td>49.64</td>
<td>69.82</td>
<td>64.6</td>
</tr>
<tr>
<td>( H^* ) (%)</td>
<td>5.99</td>
<td>3.66</td>
<td>3.42</td>
</tr>
<tr>
<td>( N^* ) (%)</td>
<td>1.44</td>
<td>1.45</td>
<td>1.24</td>
</tr>
<tr>
<td>( S^* ) (%)</td>
<td>0.13</td>
<td>3.86</td>
<td>3.29</td>
</tr>
<tr>
<td>( Cl^* ) (mg/kg)</td>
<td>2,770</td>
<td>271.44</td>
<td>800</td>
</tr>
</tbody>
</table>

Grinding system operation
Duration/Consumption:

- Duration of test: 46 hours
- Orujillo consumption: 383.9 t
- Total fuel fed: 4,588.6 tons

Clean gas characterisation

<table>
<thead>
<tr>
<th>Clean gas characterisation</th>
<th>With 8% orujillo (ELX)</th>
<th>Average composition 1999-2008 with common fuel (ELX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ (%)</td>
<td>2.37</td>
<td>2.34</td>
</tr>
<tr>
<td>CO (%)</td>
<td>60.36</td>
<td>60.81</td>
</tr>
<tr>
<td>H₂ (%)</td>
<td>22.55</td>
<td>21.95</td>
</tr>
<tr>
<td>N₂ (%)</td>
<td>13.70</td>
<td>13.82</td>
</tr>
<tr>
<td>Ar (%)</td>
<td>1.00</td>
<td>1.01</td>
</tr>
<tr>
<td>CH₄ (ppm)</td>
<td>136.67</td>
<td>98.92</td>
</tr>
<tr>
<td>H₂S (ppm)</td>
<td>Not analysed</td>
<td>3.35</td>
</tr>
<tr>
<td>COS (ppm)</td>
<td>21.99</td>
<td>6</td>
</tr>
<tr>
<td>LHV (kcal/mol)</td>
<td>54</td>
<td>54</td>
</tr>
</tbody>
</table>

Clean gas evolution

Chloride content in the wash water of the raw gas increased because of the higher chlorides content in orujillo.
23

Particles before/during the test: 0.01 mg/Nm³

4. R&D PLAN: Diversification of raw fuels and products

ORUJILLO CO-GASIFICATION TESTS – CENIT PROJECT (5)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value w/ 8% orujillo</th>
<th>Values w/ common fuel (2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAP (mg/Nm³)</td>
<td>&lt; quantification limit (&lt; 0.00001)</td>
<td>&lt; quantification limit (&lt; 0.000571)</td>
</tr>
<tr>
<td>VOCs (mgC/Nm³)</td>
<td>9.46</td>
<td>37.91</td>
</tr>
<tr>
<td>Dioxines &amp; Furanes (ng I-TEQ/Nm³)</td>
<td>0.00209</td>
<td>&lt; quantification limit (&lt; 0.0009)</td>
</tr>
<tr>
<td>HCl (mg/Nm³)</td>
<td>&lt; quantification limit (&lt; 0.56)</td>
<td>&lt; quantification limit (&lt; 1.45)</td>
</tr>
</tbody>
</table>

Emissions from HRSG chimney (CC)

EMISSIONS DURING 8% ORUJILLO CO-GASIFICATION TEST

NOx (mg/Nm³)

SO₂ (mg/Nm³)

Orujillo (%)
ORUJILLO CO-GASIFICATION TESTS – CENIT PROJECT (6)

Main conclusions extracted from co-gasification tests in ELCOGAS:

- The technical viability of co-gasification up to 10% has been demonstrated.

- **Operation on design ranges**

- **Biomass handling:**
  - Orujillo should not be stored for a long time, since the biomass absorbs humidity.
  - Orujillo goes easily stodgy if a large quantity is stored in the feed hopper before its consumption.

- **Grinding system:** during the 8% and 10% tests, the increase of the mills consumption and the DP were detected.

- **Gasifier load:** no influence on the gasifier load arises from the orujillo co-gasification when 1%, 2%, 4% & 6% tests were carried out. The 8%-10% tests affected the mills performance.

- **Clean gas:** Orujillo co-gasification has no impact on the clean gas quality; its characterisation is similar to those relating to ELCOGAS common operation.

- **Emissions:** the 8% and 10% addition of orujillo seems to have an influence on the SO$_2$ emissions (although orujillo has no content in sulphur), but always within limits (under study COS catalyst and scrubber performance).
4. R&D PLAN: CO₂ emission reduction

- IGCC Efficiency Optimisation
  - Analysis of viability to improve efficiency based on Critical Assessment of Puertollano IGCC design
  - Auxiliary consumption optimisation (New revision)
  - Development of tools to improve efficiency. Supervision on line of main (120) equipment efficiency (Installed and in tests)
  - Integration optimisation. Improvement of controls to adjust heat & mass balances in real operation

- CO₂ capture for CCS with IGCC
To demonstrate the feasibility of capture of CO$_2$ and production of H$_2$ in an IGCC that uses solid fossil fuels and wastes as main feedstock.

To obtain economic data enough to scale it to the full Puertollano IGCC capacity in synthetic gas production.

**PARTICIPANTS & BUDGET**

ELCOGAS – UCLM – Ciemat – INCAR-CSIC 14 M€ (initially 18.5 M€)

**COORDINATED**

Project of pilot plant in existing IGCC of Puertollano is part of a Spanish national initiative, “Advanced technologies of CO$_2$ conversion, capture and storage” and it is coordinated with other related projects:

- **Project # 2** is to explore CO$_2$ capture with oxyfuel technology in a 20MW pilot plant. To be built in El Bierzo, NW of Spain. CIUDEN
- **Project # 3** is to study and regulate geological storage in Spain. IGME
- **Project #4** is to study public awareness of CCS technologies. CIEMAT
4. R&D PLAN: CO₂ emission reduction
“Singular and strategic project PSE-CO₂”

**COAL + PETCOKE**

**GASIFICATION**

Raw gas → **FILTRATION SYSTEM**

Clean gas: 2% of total flow (3600 Nm³/h)
- 22.6 bar
- 130 °C
- 60.5% CO
- 22.1% H₂

MP steam → **SHIFT REACTOR** (Sour /Sweet)

CO + H₂O → CO₂ + H₂

**PURIFICATION & DESULPHURISATION**

H₂ rich gas:
- 37.5% CO₂
- 50.0% H₂
- 3.0% CO

183,000 Nm³/h → **CO₂ AND SULPHUR REMOVAL** (Chemical, aMDEA)

100 t/d → **CO₂**

¿SH₂?

CO₂ and H₂ → **PURIFICATION (PSA UNIT)**

1.5% CO₂

40% → 2 t/d

H₂: 99.99%

Recycle gas compressor

Pilot plant size: 1:50 ~ 14 MWₜₜ
4. R&D PLAN: CO\textsubscript{2} emission reduction

“Singular and strategic project PSE-CO\textsubscript{2}”

**Executed (May 2010)**
- 100% engineering work
- 100% equipment supply
- 99% construction

**Start-up: Jun 2010**
- End of the tests to obtain data for different operating conditions and purity grades **March 2011**

**MAIN SUPPLIERS**

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4. R&D PLAN: CO$_2$ emission reduction
“Singular and strategic project PSE-CO$_2$”
4. R&D PLAN: CO$_2$ emission reduction
“Singular and strategic project PSE-CO$_2$”

Aerial view (February 2010)

Operation display of the pilot plant
4. R&D PLAN: CO$_2$ emission reduction

**Pilot plant** for CO$_2$ capture & H$_2$ production and electricity with IGCC technology

Other activities: To be done **after PSE as R&D platform**:  
- Water shift reaction **catalyst** optimisation. Tests of different catalyst
- **New processes** to separate CO$_2$-H$_2$
- CO$_2$ different **treatment** processes
- Improvement of **integration** efficiency between CO$_2$ separation processes and IGCC plant

Other proposals from Industry or Research community to use the IGCC plant and its pilot plant to develop of process, equipments, components or even pre-engineering of new plants with CCS and Zero emissions
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5. CONCLUSIONS

IPA CC → Unless greenhouse gas emissions are cut by 50-80% by 2050 (especially CO₂), the impact of global warming will be disastrous.

World energy demand → Expect to be doubled by 2050.

We must act fast using a portfolio of solutions (energy efficiency improvement, renewables & CCS) to reduce CO₂ emissions in the required massive scale.

IGCC technology can contribute to this aim because:

✓ Existing IGCC plants are an opportunity to develop cleaner electricity with fossil fuels

✓ Diversification of fossil fuels use according to the reserves and total life cycle is absolutely necessary

✓ Clean co-production of H₂ and electricity is possible and can be adapted to market demand

✓ Massive H₂ production is currently possible and technology is available
ELCOGAS IGCC: Towards zero emissions power plants

Thank you for your attention

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