Future Work

Jochen Ströhle

1st Public Workshop of the SCARLET project
20 April 2016; Darmstadt, Germany
WP3: Scale-up and Engineering for a 20 MW$_{th}$ CCL Pilot Plant

- **WP leader:** GECC

- **Objectives:**
  - Definition of CCL process configuration for 20 MW$_{th}$ pilot plant, based on the host facility 600 MW$_e$ coal fired power plant Emile Huchet operated by UNIPER
  - Design and engineering of components of 20 MW$_{th}$ pilot plant
  - Detailed plan for operation and logistics
  - HSE and technical risk assessment for the CCL pilot
WP4: Integration of CCL into a Full-Scale Hard Coal Power Plant

- WP leader: UNIPER

- Objectives:
  - Evaluation of the process regarding full-scale implementation to a hard coal power plant
  - Techno-economic analysis, identification of cost of electricity (CoE) and cost of CO$_2$ avoided to evaluate CCL technology compared to other CCS solutions
  - Assessment of the environmental impact of CCL systems by conducting a life cycle analysis (LCA)
WP5: Integration of CCL into a Full-Scale Lignite Power Plant

- **WP leader:** RWE

- **Objectives:**
  - Evaluation of the process regarding full-scale implementation to a lignite power plant
  - Techno-economic analysis, identification of cost of electricity (CoE) and cost of CO₂ avoided to evaluate CCL technology compared to other CCS solutions
  - Assessment of the environmental impact of CCL system by conducting a life cycle analysis (LCA)

Source: RWE Power
WP6: Integration of CCL into Full-Scale Industrial Plants

- **WP leader:** ULSTER

- **Objectives:**
  - Evaluation of the process regarding full-scale implementation to cement and steel production plants
  - Techno-economic analysis, identification of production cost and cost of CO₂ avoided to evaluate CCL technology compared to other CCS solutions
  - Assess the environmental impact of CCL system by conducting a life cycle analysis (LCA)
2nd Public Workshop

- 1st quarter 2017
- Location and place to be decided
Open Discussion

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Indirectly Heated CaL Process

- No oxygen for calciner → **high efficiency** (1.5 – 2 % points efficiency drop)
- No coal in calciner → **few impurities** (sulfur, ash), **low deactivation**
- Almost **pure CO₂** stream at calciner exit
- Very low efficiency drop (~4 % points, incl. CO₂ compression)
- Technology validated in pilot scale (0.3 MWₜₘ)
300 kW\textsubscript{th} Pilot Plant

- **Carbonator**
  - 650 °C
  - 3 cooling lances
  - Make-up
  - L-valve
  - L-valve
  - CaCO\textsubscript{3}
  - CaO
  - Cooling air intake

- **Calciner**
  - 900 °C
  - 72 Heat pipes
  - Gas analysis CO\textsubscript{2}, O\textsubscript{2}

- **Combustor**
  - 1000 °C
  - Gas analysis CO\textsubscript{2}, O\textsubscript{2}, CO, SO\textsubscript{2}

- **Purge**
  - Cone valve

- **Air intake**
  - CO\textsubscript{2}, H\textsubscript{2}O, SO\textsubscript{2}

- **Gas analysis**
  - CO\textsubscript{2}, O\textsubscript{2}, CO, SO\textsubscript{2}

- **Cooling**
  - Air intake
  - Flue gas header
  - 250 °C

- **Electrical preheating**
  - 550 °C

- **Start-up burner**
  - (Propane)

- **Lances**
  - (Propane)

- **ID fan**

- **Bag filter**

- **Stack**
300 kW\textsubscript{th} Pilot Plant
## Comparative Assessment

<table>
<thead>
<tr>
<th>Material toxicity</th>
<th>Maturity</th>
<th>Efficiency drop (incl. compression) [% points]</th>
<th>CO₂ avoidance costs [€/t CO₂]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amine scrubbing</td>
<td>high</td>
<td>very high</td>
<td>8.9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>IGCC with CCS</td>
<td>high</td>
<td>high</td>
<td>8.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Oxy-fuel combustion</td>
<td>-</td>
<td>high</td>
<td>8.4&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Oxy-fired CaL</td>
<td>low</td>
<td>medium</td>
<td>6</td>
</tr>
<tr>
<td>Indirectly heated CaL</td>
<td>low</td>
<td>low</td>
<td>4.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chemical looping</td>
<td>low/medium</td>
<td>low</td>
<td>3&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> CO₂ Capture at Coal Based Power and Hydrogen Plants, IEAGHG report, 2014

<sup>b</sup> CALMOD project, 2014

<sup>c</sup> Junk et al., Technical and economical assessment of the indirectly heated carbonate looping process, Clearwater Coal Conf, 2015

<sup>d</sup> Lyngfelt and Leckner, A 1000 MW<sub>th</sub> Chemical-Looping Combustor for solid fuels – discussion of design and costs, 3<sup>rd</sup> Int. Conf. Chemical Looping, 2014