Carbon Capture, Utilisation and Storage (CCUS) and Energy Intensive Industries (EIIIs)

From Energy/Emission Intensive Industries to Net Zero Emission Industries

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Outline of the presentation

• Content of the report.

• Main topics of the executive summary.

• Recommendations: views on the required commitment from various players in order to develop CCUS.

• Specific information on each sector.

• Interactions between EILs.

• Next steps
Content of the report

- Energy Intensive Industries ~ Emission Intensive Industries

- Steel (2.3 GtCO₂/year)
- Cement (2.3 GtCO₂/year),
- Chemicals (1 GtCO₂/year),
- Refining (1 GtCO₂/year),
- Hydrogen (0.5 GtCO₂/year),
- Natural gas and
- Heavy oil production,
- Fertilizers (0.4 GtCO₂/year),
- Waste to Energy (0.2 GtCO₂/year)
- Other energy intensive industries have not been studied. For example, paper/pulp, aluminum.

- Note: Numbers for steel, cement and chemicals are for 2014 (IEA ETP 2017). Consistent numbers across all EIIIs difficult to find
Executive Summary

• EIIls are key building blocks of all economies,
  • Ex: steel and cement to build cities in emerging countries

• They are needed for climate change mitigation and adaptation,
  • Ex: hydrogen for energy and industrial process

• Their cumulative share of CO₂ emissions is significant,
  • Their cumulated emissions are close to power generation emissions

• They are actively working on decreasing CO₂ emissions,
  • Energy efficiency, process improvements, new sources of energy...

• CCUS will play an essential role in decreasing CO₂ emissions,
  • CCUS will be needed to achieve net zero emissions

• CCUS: EIIls are pursuing efforts and facing challenges.
  • All sectors are active in CCUS at different stages.
  • Beyond technology, costs and competitiveness (carbon leakage) are major issues
The development of CCUS in EII's will require commitment from various players.

• EII's,
  • Developing cooperation between the different sectors (R&D, projects),
  • Developing hubs,
  • Coordinating with the oil and gas sector (transport, storage),
  • Development of CO2 utilisation.

• Governments,
  • Providing predictability on CCUS support,
  • Encourage procurement of low-carbon products and development of infrastructure, avoid carbon leakage.

• The oil and gas sector,
  • Bringing its expertise in transport and storage
  • Potentially, an important facilitator of interactions between EII's

• End use consumers,
  • Taking into account that the cost of CCUS can be relatively modest when compared with the total cost of the final product

• CCUS organizations.
  • Advocate the paramount importance of CCUS to meet the challenge of climate change mitigation
Specific information for each sector

• Each sector’s contribution to today’s economies and their growth,
• A geographical analysis of its production,
• The trends in emissions,
• **The main CO₂ emission patterns for typical facilities of this sector,**
• Other ways than CCUS to decrease CO₂ emissions,
• How CCUS is needed to achieve net zero emissions,
• The development status of CCUS in this sector,
• The main challenges to CCUS development.
The main CO2 emission patterns for typical facilities of the steel sector

![Diagram showing CO2 emission patterns in the steel sector](image)

*Number from IEAGHG, 2000, assumed to be average of additional fuel to off-gases from BF and BOF

Table A.1.1. Characteristics of exit gases from the different facilities in an integrated steel mill, with use of off-gases as fuel taken into consideration (ISO, 2010)

<table>
<thead>
<tr>
<th>Facility</th>
<th>CO2 emissions, tCO2/t</th>
<th>CO2 concentration, %</th>
<th>Pressure of gas stream, Mbar</th>
<th>Other parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke plant</td>
<td>0.15</td>
<td>2</td>
<td>30</td>
<td>N2, CH4, H2, CO2, water, dust, tar, H2S</td>
</tr>
<tr>
<td>Sinter plant</td>
<td>0.40</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blast furnace</td>
<td>0.80</td>
<td>25</td>
<td>50</td>
<td>H2, CO, N2, water dust, H,S, NOx, SOx</td>
</tr>
<tr>
<td>Basic oxygen furnace</td>
<td>0.10</td>
<td>20</td>
<td>20</td>
<td>H2, CO, N2, water, dust, H2S</td>
</tr>
<tr>
<td>Other</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total crude steel</td>
<td>1.16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casting, rolling, finishing</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total hot rolled coil</td>
<td>1.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power station</td>
<td>0.1</td>
<td>0.15(?)</td>
<td>27</td>
<td>N2, O2, NO, NOx, SOx, water, dust</td>
</tr>
</tbody>
</table>

Figure A.1.1. The integrated steel mill blast furnace route to steel production. (Based on Figure 2 in Birat and Maizières-les-Metz, 2010, and on IEAGHG, 2013).
Interactions between EIs

• Most capture technologies can be applied to several if not all the EIs,
• All capture technologies are CAPEX and energy demanding: the latter opens the door to monetize waste heat for capture purpose,
• Some EIs will play a significant role in decarbonising other industries
  • Hydrogen for steel industry,
  • Mineralisation (involving the cement industry) for CO₂ storage in all industries,
  • Chemical industries by providing chemical utilisation of CO₂,
  • Oil and Gas industries by providing transport and geological storage solutions.
• Examples of today’s collaboration between industries are shown in the report.
• The report will be published by the next fall CSLF Technical Group Meeting.

• Thanks for your attention!
Back-up
Still to be improved/implemented

• Interactions between EIIIs (we have been working for a relatively short time on this).

• English to be improved (we might drop reviewing the annex).

• Make sure that we took on board the last comments (we know there are a few comments which were not taken on board yet).

• There might be some room for new ideas too.
Main contributors to this report

• France
• Norway
• Canada
• Saudi Arabia
• IEAGHG
• Sectorial business organisation and companies covering the full perimeter.