CCS for Industrial Sources of CO₂ in Europe

• Industry direct CO₂ emissions are one quarter of total EU emissions
• 60% of this is from four sectors:
  – Iron and steel
  – Chemical industry
  – Petroleum refining
  – Cement and lime
• 25% of industrial emissions are inherent to process chemistry of some key materials
  – Steel – blast furnace, reduction of iron ore
  – Cement – calcination, lime from limestone
  – Hydrogen – steam reforming, for fuel upgrading, methanol and ammonia/fertiliser production
• IPPC targets for industry emission reductions in EU
  – 34-40% by 2030
  – 83-87% by 2050
• CCS necessary to make deep cuts in industry emissions
• CCS for high-emission processes could achieve 200-300 Mt/yr CO₂ reduction
  – Processes listed above plus:
  – Fluid catalytic cracking – catalyst regeneration
  – Steam cracking for olefin production

• Energy intensive industries in Europe contribute significantly to GDP, employment and innovation
  – Iron and steel, cement, refineries, chemicals combined have turnover of € 900 billion, c.7% of EU GDP, 25% of EU industry
  – These sectors employ directly 1.75 million, 0.7% of EU labour force, 2.9% of EU industry employment
  – Materials and innovations skills from these industries needed to grow green economy

• Identified options for CCS from large industrial sources could contribute most of reductions required by 2030
• Needs concerted action now to achieve this
• But CCS from these large sources alone not sufficient for 2050 target, even at high-end estimates

<table>
<thead>
<tr>
<th>Sector</th>
<th>Assumption for estimate (SCCS, 2013)</th>
<th>CO₂ emission reduction, Mt/yr</th>
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</thead>
<tbody>
<tr>
<td>Iron and Steel</td>
<td>50% of emissions from blast furnaces captured</td>
<td>89</td>
</tr>
<tr>
<td>Cement</td>
<td>50% of emissions from cement plant captured</td>
<td>50</td>
</tr>
<tr>
<td>Refineries</td>
<td>Most emissions from hydrogen production captured, some emissions from combustion plant captured, totalling 25%</td>
<td>33</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Available (W Europe) ammonia plant emissions captured, 80% cracker emissions captured, 10% combustion emissions captured</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>208</td>
</tr>
</tbody>
</table>
• CCS is a key technology to achieve deep cuts in emissions from industry
• Fundamental industrial processes have inherent CO₂ formation where capture is only option for avoiding emissions

• Industry with high emissions clustered in several areas in Europe
• Storage sites identified in feasibility studies
• NW Europe clusters match well with storage availability in North Sea

**Distribution in Europe of refineries, integrated steel plants, cement plants emitting >0.5 Mt/yr CO₂**

**CO₂ storage sites and volumes around Europe**

**CO₂ from ammonia production**
• 6-7 Mt/yr CO₂ already separated at ammonia plants and available for use
  – Figures adjusted for estimated bulk CO₂ sales and consumption in urea
• Most close to North Sea coasts
  ➢ Could be used to prove CO₂ transport and storage infrastructure

**Availability of CO₂ from ammonia production in Europe**

**CCS from large industrial sources can play major role in achieving 2030 emission reduction targets**
• Appropriate policies and support mechanisms needed to achieve rate of deployment required
• Need wider measures to achieve 2050 targets
  – Efficiency improvements, fuel switching, CCS in wider and smaller applications