Industrial Value Chain: A Bridge Towards a Carbon Neutral Europe

Energy Intensive Industries’ contribution to Europe’s long-term climate strategy
Content

- General approach of contribution
- Profiling EIIls
- Solutions space
- Framework conditions
- Towards an Industrial strategy
Profiling ELIs

**Solutions space**
- Technology options
- Circularity
- Symbiosis
- Energy transition
- Business models

**Framework conditions**
- R&D missions
- CAPEX/OPEX
- Low-CO2 electricity
- Infrastructure
- Regulatory

**Urgency/Int’l environment**

**Integrated industrial strategy enabling carbon neutral Europe**
Profiling Ells
EIIs reduced greenhouse gas emissions by 36% between 1990 and 2015 and contributed significantly to the EU’s overall emission reductions in same period (-24% in 2015 ref. 1990).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals(^3)</td>
<td>325.1</td>
<td>212</td>
<td>128.4</td>
<td>-61%</td>
<td>-196.7</td>
</tr>
<tr>
<td>Fertilizers(^4) [ammonia+nitric acid] (included in chemicals)</td>
<td>76</td>
<td>66</td>
<td>28</td>
<td>-63%</td>
<td>-48</td>
</tr>
<tr>
<td>Steel(^5)</td>
<td>258</td>
<td>232</td>
<td>190</td>
<td>-26%</td>
<td>-68</td>
</tr>
<tr>
<td>Cement(^6)</td>
<td>163</td>
<td>157</td>
<td>105</td>
<td>-36%</td>
<td>-58</td>
</tr>
<tr>
<td>Refining(^7)</td>
<td>122</td>
<td>143</td>
<td>137</td>
<td>+12%</td>
<td>+15</td>
</tr>
<tr>
<td>Pulp and paper(^8)</td>
<td>39.9</td>
<td>43.2</td>
<td>32.7</td>
<td>-18%</td>
<td>-7.2</td>
</tr>
<tr>
<td>Ceramics(^9)</td>
<td>26</td>
<td>26</td>
<td>17</td>
<td>-35%</td>
<td>-9</td>
</tr>
<tr>
<td>Non-ferrous metals and ferro-alloys(^10)</td>
<td>52.3</td>
<td>31</td>
<td>17.8</td>
<td>-66%</td>
<td>-34.5</td>
</tr>
<tr>
<td>Lime(^11)</td>
<td>25.9</td>
<td>23</td>
<td>19.4</td>
<td>-25%</td>
<td>-6.5</td>
</tr>
<tr>
<td>Glass(^12)</td>
<td>28</td>
<td>20</td>
<td>18.1</td>
<td>-35%</td>
<td>-9.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,040</td>
<td>887</td>
<td>665</td>
<td>-36%</td>
<td>-375</td>
</tr>
<tr>
<td><strong>EU28 (excl. LULUCF)</strong>(^13)</td>
<td>5,650</td>
<td>5,220</td>
<td>4,319</td>
<td>-24%</td>
<td>-1,331</td>
</tr>
</tbody>
</table>
• Final energy use by EIs was reduced by 20% between 1990 and 2016.
• Most sectors showed significant efficiency improvements over this period.

A major fuel shift occurred away from solid fuels towards biomass, waste and electricity in same period.
EIIs production was seriously affected through the economic crisis. Only chemicals production was above pre-crisis levels in 2017.

Most EIIs have a high trade intensity and are exposed to a high-level of international competition.
EIIs are the lifeblood of key value chains in EU but also their supply chains are linked to other EIIs.

EIIs products are and will be needed more to enable the energy transition and will be at the forefront of low-carbon solutions.

Most EIIs already see recycled materials, waste and by-products of other industries as important raw material inputs.
Solutions Space
• Important progress has been made in the development of **low-CO2 breakthrough technologies** for EII processes.

• Continued European R&D support under different programmes together with private R&D initiatives played an enabling role in this progress.

• The **gestation time of these breakthroughs is long** and many of them have not reached industrial scale demonstration level.

• Much **higher levels of final electricity demand are expected** if industrial low-CO₂ technologies are deployed across the EU.

• Transition to higher levels of electrification can create a **virtuous cycle between the EU’s renewable energy and industrial transition**, under the right conditions.

• EIIIs play an important role in the circular economy and this role will increase in the future in a conducive regulatory environment.

• **Industrial symbiosis, clustering and synergies** with non-industrial sectors show potential for significant energy savings and materials efficiency.

• In the areas of energy transition and circular economy **new business models are being explored**.
<table>
<thead>
<tr>
<th>Low-carbon technology database with over 80 technological options as addendum to EII contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thermochemical processes</strong></td>
</tr>
<tr>
<td><strong>Photochemical processes</strong></td>
</tr>
<tr>
<td><strong>Low Carbon Ammonia (H2 based)</strong></td>
</tr>
<tr>
<td><strong>Hybrid Ammonia (H2 and CH4)</strong></td>
</tr>
<tr>
<td><strong>Low-carbon methanol production (CO2 + H2)</strong></td>
</tr>
<tr>
<td><strong>Low-carbon syngas (e.g., via MTO (Methanol to Olefins) and methanol to olefins) using H2 and CO2</strong></td>
</tr>
<tr>
<td><strong>Direct out of H2 and CO2 in single system</strong></td>
</tr>
<tr>
<td><strong>Catalytic, aqueous and syngas (BTX) via H2 based methanol</strong></td>
</tr>
<tr>
<td><strong>Polypropylene/ polyethylene and polyamides using CO2</strong></td>
</tr>
<tr>
<td><strong>Formic acid (using electrochemical CO2 reduction)</strong></td>
</tr>
<tr>
<td><strong>Mineral carbonation</strong></td>
</tr>
<tr>
<td><strong>Directly and DAB (direct synthesis from CO2)</strong></td>
</tr>
<tr>
<td><strong>Sodium acrylate from syngas and CO2</strong></td>
</tr>
<tr>
<td><strong>Electrocatalytic processes to convert CO2 to ethylene</strong></td>
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<tr>
<td><strong>Biofuels</strong></td>
</tr>
</tbody>
</table>
For each sector multiple technology options are being developed towards significant GHG reductions.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Electrification (heat and mechanical)</th>
<th>Electrification (processes: electrolysis/ Electrochemistry excl. H2)</th>
<th>Hydrogen (heat and/or process)</th>
<th>CCU</th>
<th>Biomass (heat and feedstock)/ biofuels</th>
<th>CCS</th>
<th>Other (including process integration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>xxx</td>
<td>xx</td>
<td>xxx</td>
<td>xxx</td>
<td>x</td>
<td>xxx</td>
<td>Avoidance of intermediate process steps and recycling of process gases: xxx Recyling high quality steel: xxx</td>
</tr>
<tr>
<td>Chemicals fertilizers</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx(∗)</td>
<td></td>
<td>Use of waste streams (chemical recycling): xxx</td>
</tr>
<tr>
<td>Cement/Lime</td>
<td>xx (cement) x (lime)</td>
<td>o (cement) o (lime)</td>
<td>x (cement) x (lime)</td>
<td>xxx</td>
<td>x</td>
<td></td>
<td>Alternative binders (cement): xxx Efficient use of cement in concrete by improving concrete mix design: xxx Use of waste streams (cement): xxx</td>
</tr>
<tr>
<td>Refining</td>
<td>xx</td>
<td>o</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>xxx</td>
<td>Efficiency: xxx</td>
</tr>
<tr>
<td>Ceramics</td>
<td>xxx</td>
<td>o</td>
<td>xx</td>
<td>x</td>
<td>x</td>
<td>xxx</td>
<td>Efficiency: xxx</td>
</tr>
<tr>
<td>Paper</td>
<td>xx</td>
<td>o</td>
<td>o</td>
<td>xxx</td>
<td>o</td>
<td></td>
<td>Efficiency: xxx</td>
</tr>
<tr>
<td>Glass</td>
<td>xxx</td>
<td>o</td>
<td>x</td>
<td>o</td>
<td>xxx</td>
<td>o</td>
<td>Higher glass recycling: xx</td>
</tr>
<tr>
<td>Non-ferrous metals/alloys</td>
<td>xxx</td>
<td>xxx</td>
<td>x</td>
<td>xxx</td>
<td>x</td>
<td></td>
<td>Efficiency: xxx Recycling high quality non-ferrous: xxx Inert anodes: xxx</td>
</tr>
</tbody>
</table>

o: Limited or no significant application foreseen
x: Possible application but not main route or wide scale application
xx: medium potential
xxx: high potential

∗: Sector already applies technology on large scale (can be expanded in some cases)

(∗) in particular for ammonia and ethylene oxide

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Synergies between the EU’s energy transition and the EII’s low-CO₂ transition

- Reducing indirect emissions
- Industrial Low-CO₂ Power Purchase Agreements (PPAs)
- Industrial Demand Response
- Storage options
- New value chains in Europe: can become very important (size)

→ The virtuous cycle: Energy Transition powers Industrial Transition powers Energy Transition

Nine Emerging Business Models related to the green economy

- Industrial symbiosis
- Product Management Service
- Cradle to Cradle (C2C)
- Green Supply Chain Management (GSCM)
- Circular Supplies business model
- Product Life Extension
- Lean manufacturing
- Closed loop production
- Take Back Management (TBM)

→ Digital Economy/Digitisation as facilitator/enabler
Framework conditions
Two Horizontal Challenges

**SPACE**

*The industrial transition will have to happen in highly competitive and dynamic international environment.*

**TIME**

*For most energy intensive companies, 2050 is just one (large) investment cycle away from today.*
Three main R&D challenges

1. The need to scale up breakthrough technologies towards demonstration and commercialisation.
2. Optimal combination and integration of technologies (incl. breakthrough technologies)
3. An increased focus on cost reduction (OPEX).

Examples
• Reducing the cost of low-CO2 H2 production and development of alternative production of low-carbon H2 such as methane pyrolysis and water photolysis;
• Reducing the cost of biomass (waste) transformation to fuels or basic chemicals
• Optimisation of technologies needed for the electrification of high temperature furnaces (comparable to commercial sizes of current glass, cement and ceramic furnaces) and other electricity based processes (including electrochemistry, intensified processes with alternative energy forms such as plasma and microwave technologies, and pyrolysis technologies) at industrial scale.
• Reducing cost of capturing and purifying CO2.
Low-CO2 electricity challenges: access + cost

Estimates on future electricity demand by industry (left: Eurelectric, right: aggregation of EII sectoral inputs/roadmaps)
(Left) Average electricity prices for selection of energy/electro intensive producers (Source: CEPS) and (right) price ranges where types of electrified industrial heat and processes could be able to compete with existing processes.
Infrastructure challenges

Urgent need for (future) infrastructure mapping: start bottom up (clusters), identify EU industrial projects of common interest
Financing/investment challenges

- CAPEX for industrial low-\(\text{CO}_2\) transition will be high & significantly above current investment levels
- Investment decisions in low-\(\text{CO}_2\) processes will not happen if OPEX is not competitive.
- Addressing the CAPEX-OPEX challenge will require a mix of instruments
- New low-\(\text{CO}_2\) process plants will likely be constructed at same industrial sites leading to additional costs (CAPEX+OPEX) for producers. Allowing accelerated depreciation of new installations and other tax incentives can help address this.
- European environmental state aid guidance will have to be reviewed
Regulatory challenges

1) Protection against unfair international competition towards a level playing field

2) Full carbon leakage protection from both direct and indirect costs of the EU ETS

3) A large and ambitious mission oriented RD&I program for industrial low-CO₂ technologies, including funding for industrial demonstration and scale up

4) Consistency within the energy and climate policy framework to ensure that energy consumption and low-carbon policies are compatible

5) Reconsideration and a better alignment of the environmental state aid guidance

6) Industrial symbiosis and a circular economy through the effective combination of energy recovery and recycling

7) Streamlining of the permitting procedures allowing a timely and predictable set of infrastructures and interconnections

8) Transparent accounting framework for CCU across sectors and value-chains to allow business cases to emerge
THE WAY FORWARD – A NEW INDUSTRIAL STRATEGY
• Design and implementation of a **EU flagship mission oriented R&D programme** addressing main challenges towards competitive low-CO2 processes in EIIIs. Adequate support for demonstration of advanced low-CO2 technologies towards market readiness.

• **Strategic alignment of the EU’s energy and industry transitions** in particular (ample and competitive supply of low-CO2 electricity to EIIIs).

• Development of **adequate financing mechanisms for high CAPEX (low-CO2) investments** including support for replacement of existing and productive assets. A state aid regime that acknowledges the size and scope of the industrial low-CO2 transition.

• **Strategic industrial low-CO2 infrastructure planning** with a focus on regional and transnational industry clusters and industrial symbiosis & development of EU industrial projects of common interests.

• **Smart regulatory instruments** that can assist with lead market creation for low-CO2 products and processes (e.g. public procurement & development of low-CO2 standards for products).

• During the transition **continued protection** for energy intensive industries to safeguard competitiveness and investments in Europe.
AN EU STRATEGY FOR LONG-TERM EU GREENHOUSE GAS EMISSION REDUCTIONS WILL ONLY BE SUCCESSFUL IF IT FULLY EMBEDS SUCH INDUSTRIAL STRATEGY.