Innovative process technologies and their contribution to decarbonise the EU industry sector

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AGENDA

1. Introduction: Challenges in industry decarbonisation
2. Innovations for deep decarbonisation
3. Scenarios for decarbonisation towards 2050
4. Conclusions
Industry GHG emissions about 19% of EU total in 2015

Industry sector:
- Industry in 2015 about 19% of total GHG emissions
- 37% reduction from 1990 to 2015 in industry sector
- EU Low-Carbon Roadmap from 2011 requires emission reduction of 83-87% by 2050 for all sectors

Source: EEA
Today’s available technologies are not sufficient for decarbonisation

- Deep decarbonisation not possible via BAT energy efficiency and traditional fuel switch
- Innovative low-carbon technologies are needed

Decarbonisation challenges

Strong reliance on natural gas, mostly high temperature

Process emissions chemically linked to production

Emission sources 2015, EU

- Coke technically required in blast furnace
- Strong reliance on refinery gas
- Strong reliance on natural gas (also as feedstock)
- High temperature limits use of renewables

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Many process innovations are under development

Grass paper (Creapaper)
Grass based fibres replacing wood fibres

Deep Eutectic Solvents (Provides)
Dissolving ligno-cellulose raw material as used for paper production

Source: http://www.graspapier.de/

Source: Towards the EU ETS Innovation fund workshops (online available)
Use technology readiness levels (TLR) to measure distance to market entry

Example from NASA by Mankins (2009)
TRLs reveal diversity of innovations with regard distance to market

Technology readiness level (TRL) ->

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<tr>
<th>Clusters of mitigation options</th>
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<tbody>
<tr>
<td>Energy and process efficiency</td>
<td>Deep eutectic solvents</td>
<td>Waterfree paper production</td>
<td>Electrolysis steel</td>
<td>H2-DRI+EAF</td>
<td>H2 plasma smelting</td>
<td>Top-gas recycling</td>
<td>Black liquor gasification</td>
<td>Near net shape casting</td>
<td>Electricity for process heat</td>
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<td>Fuel switch</td>
<td>Carbon capture and storage (CCS) and CCU</td>
<td>Cement from recycled concrete</td>
<td>High quality EAF</td>
<td>Oxyfuel CCS</td>
<td>Post-combustion CCS</td>
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<td>Material efficiency and substitution</td>
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3 scenarios are simulated with bottom-up model FORECAST

<table>
<thead>
<tr>
<th>Scenario definition</th>
<th>REF</th>
<th>TRANS-CCS</th>
<th>TRANS-IPT</th>
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<tr>
<td><strong>Mitigation options</strong></td>
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<td><strong>Energy efficiency</strong></td>
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<tr>
<td>According to current policy framework and historical trends.</td>
<td>Faster diffusion of incremental process improvements (BAT &amp; INNOV ≥TRL 5).</td>
<td>= TRANS-CCS + selected radical process innovations (INNOV ≥TRL 5)</td>
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<td><strong>Fuel switch</strong></td>
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<td>Fuel switching driven by energy and CO₂-prices</td>
<td>Financial support for Fuel switching to biomass and PtH</td>
<td>= TRANS-CCS + Higher financial support for biomass and PtH</td>
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<td><strong>CCS</strong></td>
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<td>CCS for major processes</td>
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<td><strong>Recycling and re-use</strong></td>
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<td>Slow increase in recycling rates based on historical trends.</td>
<td>Faster increase in recycling (e.g. steel, aluminium, paper).</td>
<td>= TRANS-CCS</td>
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<td><strong>Material efficiency and substitution</strong></td>
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<td>Based on historic trends.</td>
<td>Increase in material efficiency &amp; substitution.</td>
<td>= TRANS-CCS</td>
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Simulation

- Bottom-up simulation
- High technology detail
- Country level
- Policy instruments
Results: CO2 reduction of >80% possible – without CCS

EU 28 industrial GHG emissions by scenario

Reference scenario (REF):
- Slow decrease in GHG, driven by energy efficiency, some recycling and fuel switch away from fuel oil

Scenarios TRANS-CCS and TRANS-IPT:
- Reduction in industrial GHG emissions:
  ~70% by 2050 compared to 2015
  ~83% by 2050 compared to 1990
- Remaining challenges:
  - Process-related emissions
  - Remaining natural gas

Source: FORECAST
Decarbonisation (without CCS) increases electricity demand drastically

Final energy demand for process heating (>500°C) scenario TRANS-IPT, EU28

Fuel switch in TRANS-IPT scenario:

- **Definition**: Hydrogen accounted as electricity with 70% efficiency
- Increase in **electricity** driven by radical process switch (e.g. H2-Direct Reduction replacing Basic oxygen furnace steel)
- **Biomass** often co-firing in existing processes (e.g. clinker kiln)
- **Timing**: Biomass before 2030 and electricity/hydrogen after 2030
- High **financial support** for biomass, PtH and H2 needed (CO2 price was not sufficient)
- Across all sectors and scenario still a substantial amount of **natural gas** is used

Source: FORECAST
Scenario TRANS-IPT requires fundamental change in process technologies

Assumptions
- Market entry in 2030
- Reaching saturation in 2050
- Requires replacement of entire capital stock within only 20 years
- Technologies need to be ready for fast market introduction by 2030
Comparison: Relevance of technologies varies across studies for Germany

Comparison of selected industry decarbonisation studies for Germany

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<tr>
<th>Scenario</th>
<th>GHG reduction</th>
<th>Energy efficiency</th>
<th>Biomass</th>
<th>PtH</th>
<th>PtG</th>
<th>CCS</th>
<th>New processes</th>
<th>Circular economy</th>
<th>Material efficiency &amp; substitution</th>
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Summary: Innovations facilitate decarbonisation of EU industry

1. Introduction
   - Available technologies not sufficient for decarbonisation of EU industry

2. Innovations
   - Many low-carbon process innovations are under development
   - They differ strongly in maturity and distance to market

3. Scenarios
   - >80% decarbonisation is possible – even without CCS, but requires:
     - Process innovations,
     - CO2-free secondary energy carriers,
     - Innovations in material efficiency and circular economy

4. Comparison
   - Other studies and scenarios show a broad range of possible decarbonisation futures for industry -> Still very uncertain

5. Conclusion
   - While major changes occur after 2030, technologies will need to be developed, tested and made available before
Is the EU ETS sufficient to achieve deep decarbonisation of industry?

- Phase 4 needs to make the process innovations ready for large-scale market entry in 2030 latest.
- The EU ETS needs to make new solutions cost-effective, e.g. technologies with high operational costs due to hydrogen or electricity use.
- The ETS needs to generate sufficient trust to allows for billion euros investments to take place.
- Innovations in material efficiency and circular economy require effective price signals along the entire value chain.
Thank you for your attention!

Further material:
- Set-Nav Issue Paper on industry
- Set-Nav Report on industry

Available at:
http://www.set-nav.eu/content/pages/results
-> „Energy Systems: Demand perspective“