CCS costs for industry:

considerations and collaboration

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Mission
sustainable energy for everyone

Vision
Based on our deep expertise on energy we develop smart policies and solutions and bring them to life.

We know that, if we act now, by 2050 our global energy system can be sustainable, secure, affordable and fully based on renewable sources.

We aim to create a sustainable energy system for everyone.

Values
Dedication Originality Impact Trust

Facts & Figures
• Founded in 1984
• Over 250 professionals, 7 offices in 6 countries
• Over 500 clients served across 50 countries
• Leading experts: the Nobel Peace Prize 2007, awarded to Al Gore and the IPCC, was supported by 10 Ecofys experts
• Eneco Shareholder since 2009
A selection of organisations that we serve
Typical differences power and industry sector

> Industry
- Smaller installations; larger number emission points
- Many different types of plants, plant lay-outs and level of complexities
- Multiple product outputs

> Future developments
- Increased integration of power, heat and products
- Multi-fuel input – multi-output
  - Hydrogen, syngas, transport fuels, chemicals, ...
- Power production will more and more shift into industrial process
CCS in industry compared to power

> CCS may impact industrial product quality
> Availability of heat or power
  - Industry: waste heat or combined heat and power
  - Power: integration of steam cycle
> Mostly retrofit
  - Integration into running plant
  - Sufficient area available?
  - Site specific conditions
> Combining multiple point sources
Economic and market conditions industry

- High risk, short payback periods and high margins
  - Higher discount rates than power sector
- Often exposed to global competition
  - Cement: 100% cost price increase
  - High-value products (refineries): 10% cost price increase
  - Iron and steel: 10-15% cost price increase
    - 575$/t -> 650 – 675 $/t Hot Rolled Coil (IEAGHG)
  - Shift industrial activity; carbon leakage

- Quote from latest IEAGHG report on CCS in steel industry:
  - “[...] this study has demonstrated that this option could have significant costs implications on steel production which could affect the commercial viability of the steel plants fitted with CCS.”
Reference and system boundary

> Reference situation (more) clear
> System boundary considerations
  - Import/export of steam, heat and power
  - Separate CHP (equipped with CCS?)
  - Reserve (boiler) capacity
  - Process related emissions (vs energy related)
> Base load, intermediate load and peak load
  - Changing conditions on the power market in Europe
Collaboration
Emission concentrations
Rotterdam study industrial CCS

- Comparison between centralised and decentralised CCS
  - Post-combustion and oxyfuel processes
  - Flue gas conditioning, absorbers, desorbers, compressors, energy plants, ASU

Study results published:

*Techno-economic assessment of CO2 capture network configurations in the industry*

*Berghout et al, forthcoming (GHGT-11)*
Post-Reccsor configuration

Source: Berghout et al., UU
Results (preliminary)

> Post-combustion
  - Centralised: 70 euro/t
  - Decentralised: 86 euro/t

> Oxyfuel
  - Centralised: 63 euro/t
  - Decentralised: 80 euro/t

> Economy of scale effects
> Large-scale CHP plants
> Revenues from power to the grid

> Centralised: particular interesting for small point sources
Complications in coordinated capture

- Timing of the CCS application
- Dependency on other ones operations
- Allocation of costs and risks and/or defining tariff structure
Combining (industrial) CO₂ transport

- Large sources with relative high capture costs and low transport costs (typical: coal-fired power plant)
- Small sources with low capture costs and relative high transport costs (typical: ethanol plants, hydrogen/ammonia plants)

> What could collaboration offer to reduce transport costs?
Conclusions

> Industrial application of CCS considerably different from power sector; main differences:
  - No black and white differences
  - Large variety in industrial sources
  - Different commercial and market conditions
  - Rapid changing power market
  - System boundary definition, especially for industrial processes

> Collaboration between emitters can significantly reduce costs, both for capture and transport & storage
  - Collaboration is not straightforward
    ● Capture: independent production operation
    ● T&S: uncertainty in future flows (who invest in early network?)
    ● Risks and costs sharing
Thank you!

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