Electrification of the chemical industry - An opportunity for the chemical and energy sector

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Electrification of the chemical industry

An opportunity for the chemical and energy sector

Chemical industry under pressure

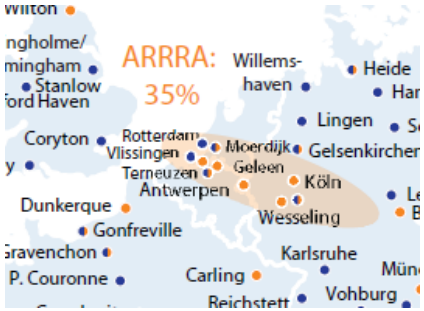
- Increased global competition.
- Weak position on feedstock and energy.
- Operational costs are high.
- Geographical shifts in demand.

Figuur 5: Indicatieve ontwikkeling van concurrentiefactoren; relatieve score van regio's

		Europa			VS			Midden-Oosten			Azië		
		2005	nu	2020	2005	nu	2020	2005	nu	2020	2005	nu	2020
Productiekosten	Feedstockkosten												
	Energiekosten												
	Overige productiekosten ❶												
Structuur chemiesector	Mate van integratie ❷												
	Chemiekennis ❸												
	Downstream activiteiten ❹												
Eindmarkten	Omvang eindvraag ❺												
	Groei eindvraag												

From: "De Chemie in Nederland, Een voorwaardelijke toekomst", Rabobank, 2014

Strategy of the topsector chemistry



- *Strengthen the current clusters*
  - Highly integrated mega-cluster ARRRA
  - Combination of bulk and specialty chemical production.

- *Stimulate innovation towards*
  - Green and sustainable chemistry
    - Renewable feedstock.
    - Sustainable production processes.
  - Smart materials and high added-value solutions.

Opportunities arising through

- Sharp increase in fluctuating electricity from wind & solar:
  - Need of energy sinks, e.g. by flexible use in chemical products.
  - Cheap energy prices at certain peak moments

- Scientific and technical advances in:
  - CO_2 activation.
  - Electrochemistry.
  - Heat upgrading technology.
  - Energy management systems.
  - Modular and scalable chemical process technology.

- Need for supply of local chemical intermediates or products.

Electrification of the chemical industry

Use electric energy instead of thermal and/or chemical energy:

- **Indirect**: Use electricity to upgrade/generate heat.
- **Direct**: Use electricity for direct chemical transformations.

TNO and ECN collaborative RD&I program

- 3 year program with 2 MEur public funding.
- *Collaborative applied R&D* to address the challenges.
- Bring the technologies into industrial practice by *pilot/demo activities*.
- *Open innovation setting* in collaboration with academia and industry.

- Lines that will be addressed:
  - Detailed assessment of electrification opportunities.
  - Electrochemical production of chemical intermediates and products.
  - Manufacturing of low-cost flexible electrolyzers.
  - Modular and scalable process technology.
  - Flexible heat pump technology

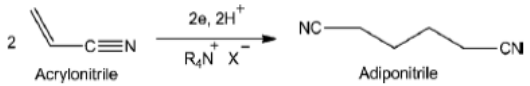
Indirect electricity use

- Upgrading heat and steam for efficient use in chemical processes.
- Electric driven heat pump technology:

- Challenges:
  - Business case development
  - Load-following at flexible electricity supply
  - Retrofit approaches
  - Process integration

Direct electricity use by electrosynthesis

- Direct synthesis into higher value intermediates and products.
- Use of sustainable feedstock, like CO_2.
- Examples: CO, Butanol, EO, phosgene, MCA, sugar-derived



or

$CO_2 + 2\ H^+ + 2\ e^- \rightarrow CO + H_2O$

- Challenges:
  - Choosing the right conversions at the right time.
  - Bringing down capital costs for electrochemical cells.
  - Increase energy efficiency and selectivity.
  - Downstream processing.

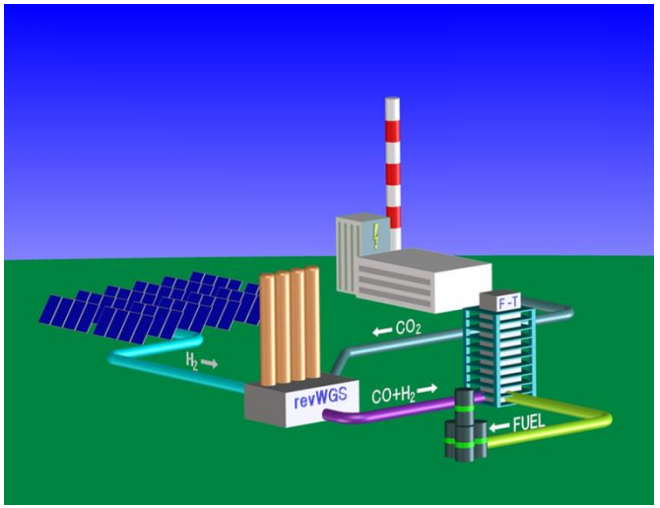
Direct electricity use by electrolysis

- Electrolysis of water to H_2 and O_2
- Use of H_2 and O_2 as feedstock for the chemical process.
- Examples: H_2, SNG, Methanol, FT-fuels, ammonia, formic acid

- Challenges:
  - Bringing down capital costs for electrolyzers.
  - Low-cost manufacturing and engineering of the system.
  - Flexible load-following.

Hydrogen as key component

- Transition from fossil fuel to sustainable sources based energy.
  - Use of Hydrogen:
    - Use in transport
    - Large scale storage
    - Add to NG network
    - ***Convert to fuels and chemicals***



- Availability of Hydrogen
  - There are many options:
    - ***Electrolysis*** (existing but expensive, cheapest when combined with wind energy)
    - Plasmas (R&D stage at Universities)
    - Photo-electrochemistry (R&D stage at Universities)
    - ….

The way forward

- Strong involvement of component manufacturers, system suppliers & end-users (both chemical industry as renewable electricity suppliers)
- Roadmap for development of low cost electrolyzers together with market parties
- Potential manufacturing break-throughs
- Options to buffer intermittent electricity (cases and products)
- Assessment of industrial business cases
- ***Final goal*** ⇨ ***pilot demonstration***

Questions?

Remarks?

Suggestions?

Discussion!

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