Industrial electrification

Task XIX

Jonathan Moncada & Kira West, TNO, The Netherlands

10 May 2023
Why electrification in industry?

- The need to decarbonize and defossilize the industrial sector

**Ideal World**

- Available green electricity
- Cheap Electricity
- Industry hardly affected by changes

**Piece of Cake**
Why electrification in industry?

- In an ideal world we wish that the ideal gas equation actually works....

  - Green electricity is intermittent
  - There is not enough installed capacity of green electricity
  - Technologies are still in development, what if they cannot make it to commercial?
  - Would society accept it?
  - Do we focus on direct electrification first? But, what about electrification for feedstock?
  - Many industrial operations are not flexible, do we need to rethink how industry is designed?
  - What are the (negative) impacts of electrifying? Would we deplete scarce resources (water, metals)?
  - How do we develop the necessary infrastructure to move electricity (or intermediates) around?
The Task started in 2019
Subtask 1. Mapping of activities
Subtask 2. Enabling a shared view on system aspects of industrial electrification (direct and indirect)

Objective: is to build and strengthen the international ecosystem of industrial electrification with a focus on system impacts.

Currently, participation of groups from 8 countries:

- Government organization
- Research organizations
- Industry
Task XIX: Electrification in Industry

A: Management of the subtask

B: Enabling a shared view on the current status of industrial electrification

C: Enabling a shared view on the current insight & knowledge gaps of system impacts

D: Establishing collaboration with other Tasks and TCPs

E: Next Steps and continuation of the Task
Task XIX: Electrification in Industry
Subtask 2. Enabling a shared view on system aspects of industrial electrification
Task XIX: Electrification in Industry

- Repository of project contributed to the Task (30 + projects)
- Classification of projects
- Workshop on technology development
- Joint collaboration with HPT TCP, and HTCP
- Workshop on systems evaluations, impacts of flexibility
- Workshop on defining the role of flexibility and process integration
- Workshop on infrastructure and sector coupling
- Workshop, Heat pumping technology
- Ideas for continuation
- Synthesis
Agenda

• Heat pumping for direct electrification of process heating in industry
  • Brian Elmegaard, DTU

• Decarbonization of industrial processes through electrification – impact on thermal energy flows
  • Simon Harvey, Chalmers

• From H₂ and CO₂ to platform chemicals
  • Marija Saric, TNO

• Hydrogen in Austrian industry – technical and economic analysis
  • Darja Markova, JKU Linz

• Hydrogen infrastructure in Northern Scandinavia to enable industrial symbiosis and sector coupling
  • Johan Sandstedt, RISE

• Discussion
Brian Elmegaard, DTU Civil and Mechanical Engineering

Energy Future in Industry 9-11 May 2023

Heat pumping for direct electrification of process heating in industry
Heat pumping for direct electrification of process heating in industry

- Electricity production has shown a steep decline in CO2 intensity in Denmark
- At a global level, NZE (IEA) suggest that “around 500 MW of heat pumps need to be installed every month over the next 30 years.”
- Major efficiency benefits for heat pumps
Heat pumping for direct electrification of process heating in industry

- Full electrification of dairy industry is technically possible.
- The Danish Industry could potentially be electrified by 90% implying a heat demand decrease by 50% (compared to BAU)
- The role of process integration is of high relevance for the smart implementation of heat pumps
- Some Heat pumping technologies almost at commercial stage
- Alternative technology for direct electrification (e.g. Microwave, induction) is also required in the transition
- Explore on hybrid solutions
- The need for demonstration, initiatives and incentives
Opportunities for decarbonisation of industrial processes through increased electrification (PROCEL)

Prof. Simon Harvey

Division of Energy Technology
Opportunities for decarbonisation of industrial processes through increased electrification (PROCEL)

- Focus on assessing the impact of electrification
- Electrification is not just replacing one box with another – need to understand impacts in the entire process
- Successful development of a Bottom-up framework for assessing the techno-economic and climate impact of electrification of key unit operations in industrial processes

The impact of electrification
Opportunities for decarbonisation of industrial processes through increased electrification (PROCEL)

- One case study looking at the electrification of the calcination unit in a pull mill plant (Swedish context. 36 point sources of CO2 emissions of which 19 are in the pulping industry!)
- Electrification of the calcination unit in combination with heat recovery from the calcination unit reduces thermal utility demand
- Reduced thermal utility demand releases biomass that can be used for other purposes
FROM H₂ AND CO₂ TO PLATFORM CHEMICALS
ENERGY FUTURE IN INDUSTRY 9TH-11TH MAY 2023 | M. SARIĆ
From H₂ and CO₂ to platform chemicals

- Focus on technology development for the electrochemical (indirect) production of chemicals
- Big role of process intensification by coupling reaction and separation, to overcome the thermodynamic limitations of processes
- Converge process focusing on enhancing the production of methanol from agricultural wastes coupled with hydrogen from electrolysis, resulted in increased conversion
- Development of membranes and reactor design crucial to achieve better conversion rates

MEMBRANE ASSISTED METHANOL SYNTHESIS
CONVERGE PROJECT

- Developing process to produce methanol from agricultural waste at costs competitive to the fossil alternative, opening the way to truly bio-sourced biodiesel.
- Demonstration of integrated process at TRL 5
- Enhanced-membrane methanol (EMM) synthesis: CO₂ conversion 33%

Enhanced-Membrane Methanol (EMM)
CO₂ + 3H₂ → CH₃OH (+ H₂O)

Need of H₂ stream
(supply from electrolysis)

https://www.converge-h2020.eu/
From H₂ and CO₂ to platform chemicals

- Separation enhancement by adsorption process. Case for DME production
- Pilot demonstrator designed and available
- Optimising and scaling-up process
- Opportunities for SEDMES with various gas stream without prior capture.
- Challenges remain on fully scaling up, flexibility operation and H₂ costs
Hydrogen in Austrian industry. Technical and economic analysis.

Dr. Darja Markova


10 May 2023
Hydrogen in Austrian industry – technical and economic analysis

- Complex set of influencing parameters on future demand for power-to-gas products
- Austrian H2 strategy: feedstock and steel are priority areas
- Very wide range of estimations of future demand for H2
- Challenges: availability of H2 (ex: 20 TWh ren elec to produce H2 for steel), limited space, grid reinforcements needed, possibility of H2 imports and cost

Hydrogen in Austrian industry – technical and economic analysis

• A macroeconomic analysis showed potential benefits of developing hydrogen in the Austrian economy
• Additional investment impulses through expansion of H₂ production
• Increase in value added through H₂ production
• Impacts on trade balance (net exports)
• Multi-round effects (e.g. consumption effects due to increased employment)
• Effects still very sensitive to import quota and H₂ import price
Hydrogen, energysystem and infrastructure in Northern Scandinavia and Finland

A prestudy

Johan.Sandstedt@ri.se
Hydrogen infrastructure in Northern Scandinavia to enable industrial symbiosis and sector coupling

- Project for building 1000 km of hydrogen pipeline in Northern Sweden and Finland. 3 billion EUR
- Project consortium with 27 partners – different actors & roles along the value chain
- Power production in Sweden seems to be insufficient for the Swedish demand.
- There will be enough power in the region, i.e. power and hydrogen production in Finland could be a solution.
- There will be need for major investment in transmission capacity.

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<tr>
<td>Power demand(^1)</td>
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<td>Current production in SE1</td>
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<td>Planned additional power production(^2)</td>
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<td>21-36</td>
<td>32-57</td>
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<td>Deficit</td>
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<td>28-43</td>
<td>28-53</td>
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It seems to be a deficit in Sweden...
Hydrogen infrastructure in Northern Scandinavia to enable industrial symbiosis and sector coupling

- There are many industrial investments in northern Sweden that requires huge amount of energy.
- Hydrogen pipelines can be an overall effective complement to electric transmission lines in the region.
- The active support from government and authorities is needed to support the development.
- The regulatory framework must be adopted for hydrogen.
- There is a need for a national strategy.
- Co-planning of electric transmission system and hydrogen system is needed.
- Further research is still required in the area (e.g., hydrogen storage, systems analysis and scenarios).
Discussion

- What is needed to make industrial electrification a reality in two or three words?
- Policy taking the most emphasis and recognize as the most prominent barrier to move forward in electrification
- Aspects such as technology development appear to be a less prominent barrier to develop further industrial electrification
Discussion

• Bold investments in first-of-a-kind systems are needed to kick start deployment of industrial electrification – most people agree.

• Industry needs to be completely restructured in order to be electrified – most people disagree but….. It depends.

• Subsidies are the best way forward for development and deployment of key technologies for industrial electrification – most people disagree…. However… Subsidies very much needed to promote a faster transition. There is also the need to explore other instruments of government support.

• Indirect electrification via hydrogen will be the primary way of electrifying industry in the future – most people disagree…. But there is a lot of attention to hydrogen as a way of decarbonizing industry.
Conclusions

• Electrification of Industry is a very broad topic, a challenge remains on scoping the task
• Electrification is a potential decarbonization pathway for industry if the right choices are made. Systems analysis playing a crucial role on supporting decision making
• Electrification of industry requires the engagement of different actors of the renewable energy value chain
• Restructuring industry for flexible operation together with process integration strategies are key aspects for successful implementation of electrification of industry
• Risk takers are needed to move forward the development and deployment of industrial electrification
• Cooperation between sectors is key to understand synergies and needs
Interested in task 19?

Jonathan Moncada
Task Manager
Researcher in Energy Transition Studies
jonathan.moncadabotero@tno.nl
+31 621 98 19 58

Kira West
Researcher in Energy Transition Studies
kira.west@tno.nl