Steel, Ammonia, Green H_2 and CO_2 – a pack of cards to create industrial symbiosis options in Upper Austria

CORALIS Industrial Symbiosis in Energy Intensive Industries

Valerie Rodin[1,2], Johannes Lindorfer[1], Andreas Zauner[1], Oliver Maier[3]

Thematic area: (5) Decarbonization: Industry

Motivation

Circular economy is a building brick to sustainably transform Europe's industry:
- Utilization of **alternative resources**
- Development of **new value chains**
- **Drastic changes** for some sectors

Thus, Austrian industrial players face big challenges, among these are the **steel and fertilizer industries**.

In Linz, they operate fence-to-fence.

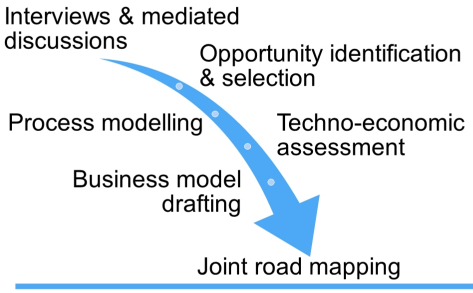
Crude steel production is a great **CO_2** emitter due to coke input
- **Renewable H_2** is an alternative reducing agent

For **ammonia**, H_2 from natural gas is a key resource
- **Renewable H_2** is the alternative

Urea production **consumes CO_2**
- Traditionally, CO_2 is sourced from natural gas steam reforming
- Tapping **alternative CO_2 sources**

Thus, joint questions rise:
- H_2 amounts that can be produced locally from green electricity?
- Feasible alternatives to on-site H_2 production in the long-term?
- Symbiotic CO_2 interlinkages?

Methods



Results (selection)

Green H_2 exchange and import

- Theor. H_2 demand for steel & ammonia production is ~4200 Mio Nm²/a
- Theor. electricity demand ~23 TWh/a
- (Additional) H_2 import needed

H_2 for ammonia production

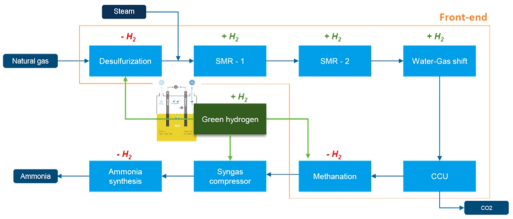


Fig.1.Green H_2 as natural gas replacement for ammonia

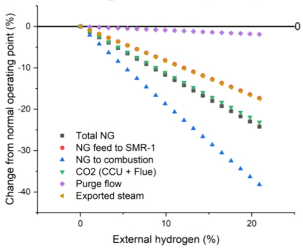


Fig.2. Reduction of natural gas input and CO_2 emissions by increased green H_2 input

- Green H_2 will decrease th NG consumption and reduce CO_2 emissions

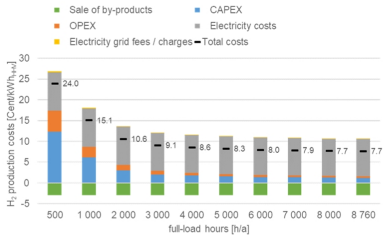


Fig.3. On-site H_2 production cost estimates for a 60 MW electrolyzer

Ammonia as H_2 storage

- After reconversion residuals of NH_3 and N_2 must be removed in H_2 stream to achieve the required purity for metallurgical processes

Methanation options

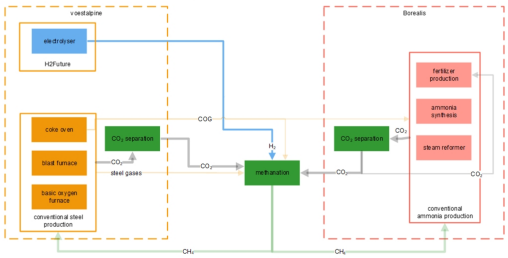


Fig.4. Theor. SNG production from green H_2 & CO_2 off-gases

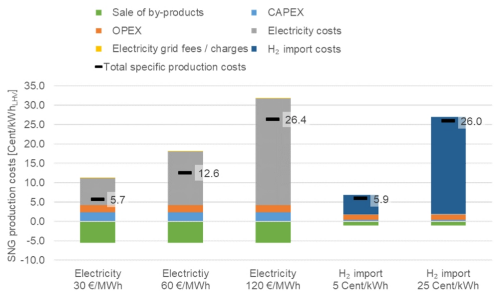


Fig.5. On-site SNG production costs

- Costs for SNG range from around 0.06 to 0.26 €/kWh, for both on-site H_2 production and H_2 import depending on the electricity price.

CO_2 for urea production

Even for decarbonized steel production, certain amounts of carbon are needed for metallurgical processes
- Unavoidable CO_2 emissions theoretically provide sufficient amounts to cover demand of urea production

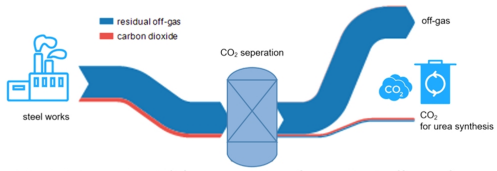


Fig.6. Theoretical CO_2 separation from steel off-gas for utilization at urea plant

Conclusion

Objectives
- Create win-win situation for the industrial players
- Drive their transition to sustainable production.
- Options were assessed in different levels of detail

Initially, CO_2 was in the focus for a local "carbon cycle"

Long-term perspective: cooperation on local H_2 production and import options

Outlook:
- Joint road-mapping process
- Refinement of business models
- Detailing of process adaptions with focus on green hydrogen.

[1] Abteilung Energietechnik, Energieinstitut an der JKU Linz
[2] Institute for Chemical Technology of Organic Materials, JKU Linz
[3] K1MET GmbH

Contact: rodin@energieinstitut-linz.at +43 (0) 732 / 2468 5671 | lindorfer@energieinstitut-linz.at +43 (0) 732 / 2468 5653 | Altenbergerstraße 69 / 4040 Linz www.energieinstitut-linz.at

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