HySteel
Deutscher Wasserstoff- und Brennstoffzellen-Verband

DWV
Deutscher Wasserstoff- und Brennstoffzellen-Verband

Green Steel Production:
HySteel meta-study 03/2022

KEY QUESTIONS

- What are the advantages and disadvantages of hydrogen imports compared to the production of green hydrogen in Germany?
- Which technical, technological and economic parameters for the conversion of the German steel industry to low-emission steel production based on green hydrogen are mentioned in the literature and how are they described or quantified?
- What are the advantages and disadvantages of importing H2-reduced sponge iron (H2-DRI) compared to H2-reduced iron ore (DRI-production) in Germany?

HYSTEEL META-STUDY

- *"Emission-free steel production - meta-study on the technical, technological and economic parameters for the conversion of the German steel industry to low-emission steel production based on green hydrogen"*
- Authors: Uwe Albrecht, Michael Ball, Ulrich Bünger, Christopher Kutz, Jan Michalski
  (Ludwig-Bölkow-Systemtechnik GmbH)
- Published: March 2022

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SUMMARY OF RESULTS

GREEN STEEL

- Profound changes in primary steel production expected by 2050, despite forecast of constant future production (approx. 39-44 Mt/a):
  - Phasing out BF/BOF due to tighter climate policy
  - H_2-DR/EF as most robust zero-emission technology with high operational and site flexibility, contribution CH_4-DR/EF open
  - Secondary steel (scrap Electric Furnace): up to 50 % of total crude steel production
  - DR continues to enable production of high steel qualities
- Need for reinvestment in primary steel production (approx. 53 % or 18 Mt/a by 2030) creates "window of opportunity".
- Transformation costs: Investments of approx. 10 bn € (until 2030) and 30 bn € (until 2050) - of which approx. 50 % for DR in Germany
- 80 % of additional costs compared to blast furnace route caused by H2 (at 4 €/kg) but negligible in high price segment, but favorable CO2 avoidance costs <50 €/t_{CO2} under optimistic framework conditions
- Significant reduction of GHG emissions already in the short and medium term require ambitious expansion of DRI capacities in Germany

LOW-EMISSION HYDROGEN

- Production pathways: Green H_2 in focus, blue H_2/CH_4-DR as a bridge
- Demand for green H_2 (DE): 0.5-3.3 Mt/a (18-110 TWh) by 2030 and 7.8-20.7 Mt/a (260-690 TWh) by 2050, taking into account ambitious climate protection targets
- In the short term: demand of the steel industry as a "no regret"-option, in the long term up to 2.1 Mt/a (material use) and 1 Mt/a (energy use) by 2050
- High import dependency for H_2 of around 60 % between 2030 and 2050
- Wide range of supply costs for green H_2: 6-12 €/kg (2020), 2-10 €/kg (2030) and 1.5-7.5 €/kg (2050)
- High transport costs[1] compensate for low H_2-production costs abroad: pipeline (48-inch)[2] <1.5 €/kg or 1-3 €/kg ship (e.g. LH_2, NH_3)
- Domestic distribution: development of transport network infrastructure starting from steel and chemical centres mandatory

1 Transport costs are highly dependent on case and distance.
2 Pipeline transport: Applies up to about 3.000 - 4.000 km, retrofitting of existing pipelines cheaper, costs for small pipelines higher.

KEY RECOMMENDATIONS FOR ACTION

HYDROGEN SUPPLY

- Rapid expansion of renewable power generation.
- Intersectoral cooperation.
- Possible geographical relocation of steel plants.
- Avoidance of regulatory hurdles (e.g. additionality criterion) and additional cost compensation (e.g. CCfD, H2Global).
- International certification system for low-emission hydrogen.
- Possible instruments: quota systems for various sectors.
- Use the leverage effect of the steel industry in the development of H_2 markets and infrastructures.
- Global cooperation to create transparent and liquid global H_2 markets.

GREEN STEEL PRODUCTION

- Start-up financing and investment security through stable and long-term framework conditions. Targeted funding (CAPEX & OPEX) and access to European funding pots resp. IPCEI. "Level playing field" for international competition: EU-ETS, effective compensation mechanisms (e.g. CBAM), export regulations.
- Promoting demand for green steel: regulatory requirements, purchase rules for other sectors, priority in public procurement contracts. Early, high-profile communication of the need for action and the start of transformation.
- Develop further education and training opportunities. International cooperation for the transformation of global steel production. Further development of adapted process technology.
- Regular review and adaptation of technology strategy and business models.

CONCLUSION HYSTEEL META-STUDY

- Steel production:
  - Direct reduction based on green hydrogen essential long-term option for decarbonising the steel sector.
  - Bridge to climate neutrality via direct reduction based on natural gas thanks to rapid climate effects and technical availability.
  - Great industrial policy significance of the steel industry and domestic DRI-production (technical/economic classification of H_2-DRI-imports depends on location and business model).
- Hydrogen:
  - "Game changer" hydrogen: competitive advantage through clean H_2 and electricity at favourable prices in sufficient quantities.
  - High leverage of the steel industry on the development of H_2-infrastructures - "no regret"-option.
  - Long-term focus on green H_2 in an optimal mix of domestic production and H_2-imports.
- Need for action:
  - High investment requirements for the conversion of the steel sector - Start-up financing through funding and investment security.
  - Risk of "carbon leakage" and loss of value creation and jobs - "level playing field" through robust regulatory framework.
  - Availability of hydrogen - targeted and accelerated development of the market and supply chains for clean hydrogen.

GREEN HYDROGEN IS ESSENTIAL FOR ZERO-EMISSION STEEL PRODUCTION AND REQUIRES A RAPID POLICY FRAMEWORK AND THE IMPLEMENTATION OF INITIAL PROJECTS BY INDUSTRY.

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