Hydrogen in Austrian industry.
Technical and economic analysis.

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Future demand – influencing parameters

Influencing parameters on the future demand for PtG-products in the industry

• A lot of different parameters are influencing the future demand
• Most of the parameters are influenced by others

Figure: Influencing parameters on the future demand for PtG-products in the industry (Source: Energieinstitut an der JKU Linz)

- **Industry**
  - Feedstock (chemical industry)
  - Steel industry
  - High-Temperature Heat
  - Low-Temperature Heat

- **Transport**
  - Aviation
  - Shipping
  - Long-haul trucks and buses
  - Light duty vehicles

- **Energy system**
  - Peak load balance
  - Storage and flexibility options

- **Buildings**
  - Individual heating

Source: based on Agrara Energiewende 2021, own representation BMK 2022
Future demand – different scenarios for the industry

- In general, scenarios have a wide range - from 20 to 60 TWh
- Different time horizons until climate neutrality (2040 / 2050) - Austria has set itself the goal of being climate neutral by 2040
- The Austrian Hydrogen Strategy has the most ambitious scenario with the highest use of hydrogen in the industry
- In (AGGM, 2021) hydrogen is mainly used in the steel industry – the other sectors are decarbonized by electrification or by the use of biomethane

Figure: Different scenarios for the future development of the hydrogen demand in the Austrian industry sector – a literature analysis
Future demand - Austrian Hydrogen Strategy

Total demand for renewable gases in Austria in 2040
(Source: Austrian hydrogen strategy (data based on the study Baumann et al., 2021 “Erneuerbares Gas in Österreich 2040: Quantitative Abschätzung von Nachfrage und Angebot.” with EI-JKU as project partner)

- Hydrogen demand about 60 TWh
  - Chemical industry (about 47 %)
  - Steel industry (about 38 %)

- There is a need for 4,5 TWh SNG
  - Steel industry (about 73 %)
  - Chemical industry (about 27 %)
Future demand - Austrian Hydrogen Strategy

Total demand for renewable gases in Austria in 2040
(Source: Austrian hydrogen strategy (data based on the study Baumann et al., 2021 “Erneuerbares Gas in Österreich 2040: Quantitative Abschätzung von Nachfrage und Angebot.” with EI-JKU as project partner)

- The demand for gaseous energy carriers in the industry sector remains the same
- There is a shift from the use of natural gas to renewable hydrogen

Figure: Current and future demand in industry 2040 (acc. to Austrian Hydrogen Strategy)
Future demand - Steel industry

Hydrogen demand steel industry in Austria – climate neutrality by 2040/2050

- Studies conducted in Austria estimate the demand to be significantly higher than studies conducted in Europe for Austria.

Figure: Future hydrogen demand in the Austrian steel industry according to different literature sources.
Future demand - Steel industry

What does a hydrogen demand in the steel industry of about 20 TWh mean?

• … would require a nominal electrolysis power of about 4.4 GW
• … there is an annual need for app. 35 TWh of renewable electricity to operate the electrolysis plant.

Challenges …

• Size of the electrolyzer: For comparison, electrolysis plants currently planned for the year 2030 have a nominal electric power in the range of about 100 MW
• Required space at the site in Linz is limited
• Renewable electricity demand: For comparison, in 2020, in total, about 56 TWh of renewable electricity was generated in Austria. Even the expansion targets of an additional 27 TWh by 2030, will not be sufficient.
• Electricity grid developments?

→ build up an infrastructure for **hydrogen imports** to supplement domestic production and provide a cost-effective mix of renewable hydrogen for the local players.
Hydrogen import

- **Import quota:** EU in the range of 50%, Austria in the range of 60 – 70% (In general, the predictions currently vary widely)

- Total cost of imported hydrogen:
  - The forecasts for the costs of imported green hydrogen still show a **wide range of 50 to 250 €/MWh** (1.7 – 8.3 €/kg). (Depends on a variety of parameters: production costs in the exporting country, the transport costs, the conversion costs, … most of them are still subject to uncertainty - first and foremost, how **fast can the necessary production and transport infrastructure be built**.)
  
- Following parameters must be observed and taken into account in the export countries when **setting up future hydrogen import supply chains**: Social conditions, politics, geopolitics, environmental standards and sustainability criteria

- E.g. possible import counties for Austria (EU):
  - Europe: Norway, Spain, Iceland, Denmark, Ukraine
  - The Middle East and North Africa: UAE, Saudi Arabia, Oman, Morocco
  - South America: Chile, Argentina
  - North America: Canada
  - Australia
Scenarios for macro-economic analysis

Hydrogen demand in industry and share of supply options:

- Total demand for hydrogen in the Austrian industry in 2040: 59.5 TWh
- Intermediate target: domestic hydrogen production 2030: 7,5 TWh
- Hydrogen import: about 60 %
- Share of H2 production not with electrolysis: 10 %

Figure: Hydrogen demand in industry and share of supply options (Source: Energieinstitut an der JKU Linz)
Scenarios for macro-economic analysis

Hydrogen production in Austria - shares of the different electricity sources:

- 10 % PV – 1000 full-load hours
- 20 % Wind – 3000 full-load hours
- 30 % combined PV+Wind – 4000 full load hours
- 40 % grid – 6000 full-load hours

Figure: Electrical energy demand for hydrogen production (Source: Energieinstitut an der JKU Linz)

Figure: Electrical power for hydrogen production (Source: Energieinstitut an der JKU Linz)
Scenarios for macro-economic analysis

Size (nominal power) and CAPEX of PtG plants and amount of PtG plants needed for hydrogen production:

Figure: Amount of PtG-plants needed for hydrogen production (Source: Energieinstitut an der JKU Linz)

Figure: Share of different PtG-plants for hydrogen production – size (nominal) power (Source: Energieinstitut an der JKU Linz)

Figure: CAPEX of PtG-plants (Source: Energieinstitut an der JKU Linz)
Scenarios for macro-economic analysis

Total investment cost for the production facilities (PtG-plants) in Austria to cover the hydrogen demand in the industry.

Figure: Total investment cost for the production facilities (PtG-plants) in Austria to cover the hydrogen demand in the industry (Source: Energieinstitut an der JKU Linz)
Macroeconometric ex-ante simulations – simulation design

- **Geographical scope:** Austria
- **Timeframe:** 2025-2040
- **BAU scenario:** No integration of renewable H\(_2\) in the Austrian industry takes place.
- **Simulation scenarios:** Integration of renewable H\(_2\) (59.5 TWh by 2040) into Austrian industrial processes

![Expansion paths of H\(_2\) production plants for industrial processes](chart1)

**Investments in expanding the domestic H\(_2\) production for industrial processes**

![Investments chart](chart2)
Based on the results of the ex-ante macroeconometric simulation analyses, positive effects on the Austrian economy through the integration of renewable H₂ into Austrian industrial processes can be identified.

### Average GDP and employment effects

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Δ GDP</th>
<th>Δ employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø 2025-2030</td>
<td>+0.5 bn €p.a.</td>
<td>+ 20,000 employees</td>
</tr>
<tr>
<td>Ø 2031-2040</td>
<td>+1.3 bn €p.a.</td>
<td>+ 34,000 employees</td>
</tr>
<tr>
<td>Ø 2025-2040</td>
<td>+1.0 bn €p.a.</td>
<td>+ 29,000 employees</td>
</tr>
</tbody>
</table>

Notes: Nominal and net values. Results include direct, indirect and induced effects compared to the BAU scenario where no integration of renewable H₂ and SNG in the Austrian industry takes place.

Source: Own calculation based on MOVEZ, February–March 2023, Energieinstitut at the JKU Linz.
Macroeconometric ex-ante simulations – Results (II)

Main drivers:

- **Additional investment impulses** through expansion of H₂ production
- **Increase in value added** through H₂ production
- **Impacts on trade balance** (net exports)
  - substitution gas imports (positive)
  - imports of necessary components of electrolysis & production infrastructure (negative)
  - imports of electricity for electrolysis (negative)
  - imports of H₂ (negative)
- **Multi-round effects** (e.g. consumption effects due to increased employment)

Effects on key macroeconomic variables and their interaction - Integrating renewable H₂ into Austrian industrial processes, 2025-2040

Notes: Nominal and net values. Results include direct, indirect and induced effects compared to the BAU scenario where no integration of renewable H₂ in the Austrian industry takes place.
Source: Own calculation based on MOVE2, February-March 2023, Energieinstitut at the JKU Linz.
Macroeconometric ex-ante simulations – Results (III)

Effects of H$_2$ import quota intensity on GDP through integrating renewable H$_2$ into Austrian industrial processes

- The higher the share of domestically produced H$_2$, the lower the value-added flows from H$_2$ imports and the higher the positive effects on GDP.

- More intensive domestic H$_2$ production leads to higher levels of investment, so that there are also positive effects on the GDP.

Notes: Nominal and net values. Results include direct, indirect and induced effects compared to the BAU scenario where no integration of renewable H$_2$ in the Austrian industry takes place.
Source: Own calculation based on MOVE2, February-March 2023, Energieinstitut at the JKU Linz.
Macroeconometric ex-ante simulations – Results (III)

Effects of H\textsubscript{2} import price on GDP effects through integrating renewable H\textsubscript{2} into Austrian industrial processes

- In the case of a higher import price, the import costs will reduce the positive effects on GDP.

- Conversely, a low import price results in a lower burden on the trade balance and thus a more positive effect on GDP.

Notes: Nominal and net values. Results include direct, indirect and induced effects compared to the BAU scenario where no integration of renewable H\textsubscript{2} in the Austrian industry takes place.
Source: Own calculation based on MOVE2, February-March 2023, Energieinstitut at the JKU Linz.
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Overview of few national projects on hydrogen for industry
UpHy I+II project overview

- UpHy I: 5/2018 – 5/2022
- UpHy II: 1/2021-12/2024
- Installation of 10 MW electrolysis plant in Schwechat (refinery)
- CAPEX EUR 24,6 Mio.
- Production of about 1,500 t a of green hydrogen starting from August 2023
- 500 t a for mobility
- 2 Bus/heavy-duty HRS

Partners:
- OMV
- Verbund
- HyCentA
- Energieinstitut an der JKU Linz
- V&F Analyse- und Messtechnik GmbH
- WIVA P&G
- Montan University Leoben
H2PIONEER Project overview

- Project duration: 10/2018 – 9/2023
- On-site production of renewable hydrogen at the semi-conductor production facility (Infineon) in Villach
- Production of about 800 kg/day of green hydrogen starting in 2023
- Development of hydrogen reuse concepts

Partners:
- Verbund
- Infineon
- HyCentA
- WIVA P&G
- Energieinstitut an der JKU Linz
ReHyB Project overview

- Project duration: 06/2021 – 5/2024
- Reuse of used hydrogen from the semi-conductor industry for mobility application
- Build hydrogen refueling station

**Partners:**
- HyCentA
- Infineon
- OMV
- Postbus
- Energieinstitut an der JKU Linz
Thank you for your attention

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