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POTENTIALS FOR INTERREGIONAL INTEGRATION IN THE HYDROGEN VALUE CHAIN

Presentation at the
Dutch-German Forum on Comparative and European Energy Law
Cologne, October 26th 2023

Dr. André Wolf
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Agenda

1. The potential of renewable hydrogen
2. Current EU landscape of renewable hydrogen projects
3. A closer look at the Netherlands / North Rhine-Westphalia
4. Barriers to interregional supply chains: economic perspective
5. Policy instruments and recommendations

The Potential of Renewable Hydrogen

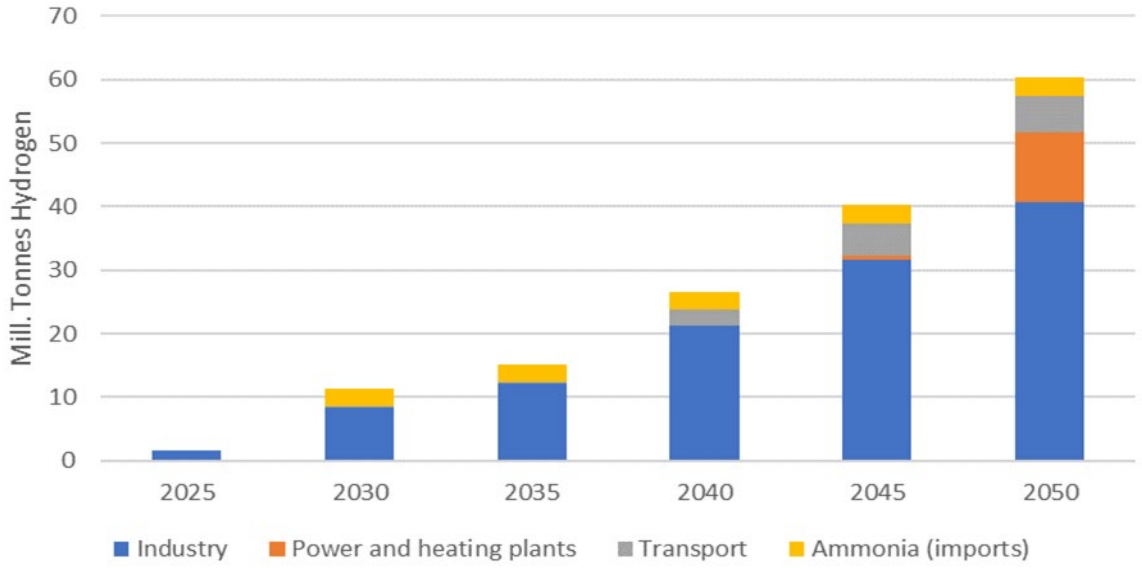
Reasons for renewable hydrogen

- Ambitious climate policy targets (EU: 55% emissions reduction target 2030 (vs. 1990), climate neutrality by 2050) require not only steeper expansion paths for RES-E generation, but also cross-sectoral application
- Direct electrification is not uniformly the most technically and economically viable option for all sectors and applications
- Using RES-E for hydrogen production creates an energy carrier that can be stored well and an input that can be used flexibly (energy source, raw material, reducing agent)
- Renewable hydrogen enables decarbonization of otherwise hard-to-abate industries
- Domestically produced renewable hydrogen simultaneously reduces dependencies on fossil resources and contributes to the EU's resilience goals

The Potential of Renewable Hydrogen

Usage potentials of renewable hydrogen

EU



Source: Fraunhofer CINES (2023)

Germany

Year	2030	2040-2050
Sector	*Mill. T Hydrogen*	*Mill. T Hydrogen*
Steel	0.61-0.85	2.21
Chemical industry	1.09	6.82
Other industry	0.03-0.09	unknown
Transport	0.91-0.95	7.67
Energy	0-0.61	8.73
Heat (incl. industr. processes)	0.15-0.30	3.79-15.15
Total	**2.79-3.91**	**29.21-40.58**

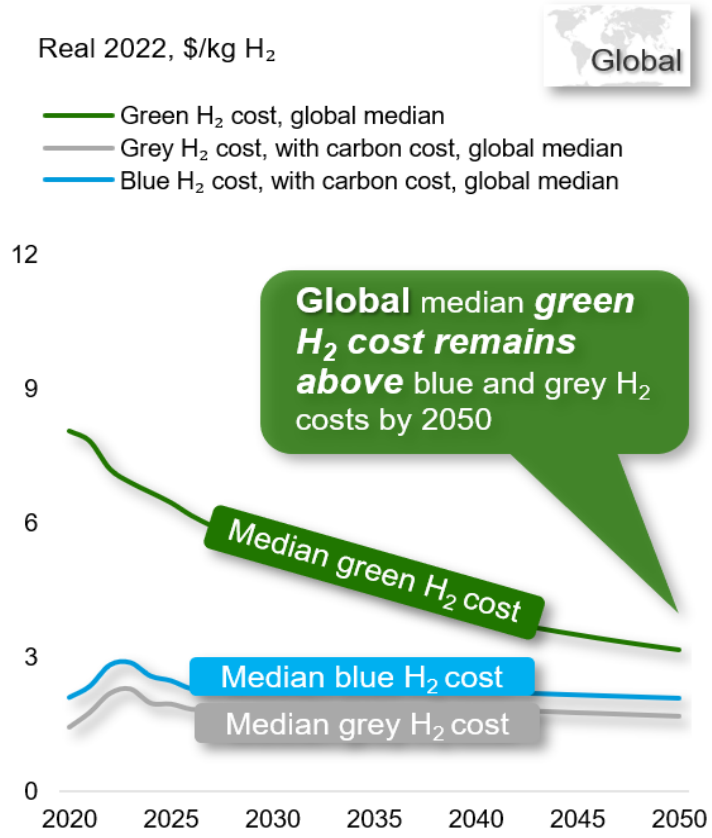
Source: National Hydrogen Council (2023)

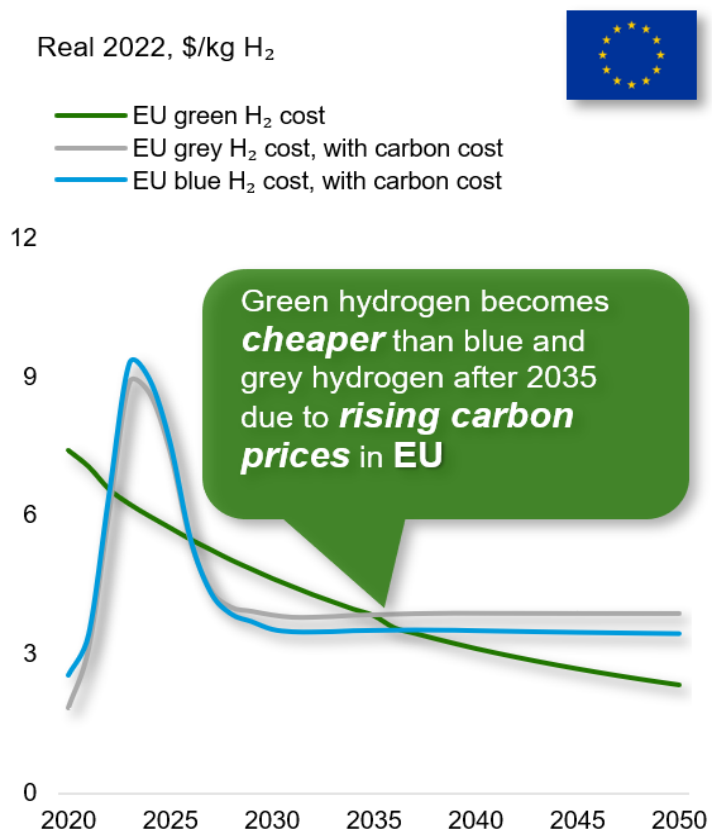
Goals EU (RePowerEU-Plan):

- Year 2030: **20 Mill. T** renewable hydrogen (among which: 10 Mill. T produced domestically)
- Year 2050: **50 Mill. T** renewable hydrogen

The Potential of Renewable Hydrogen

Cost forecasts





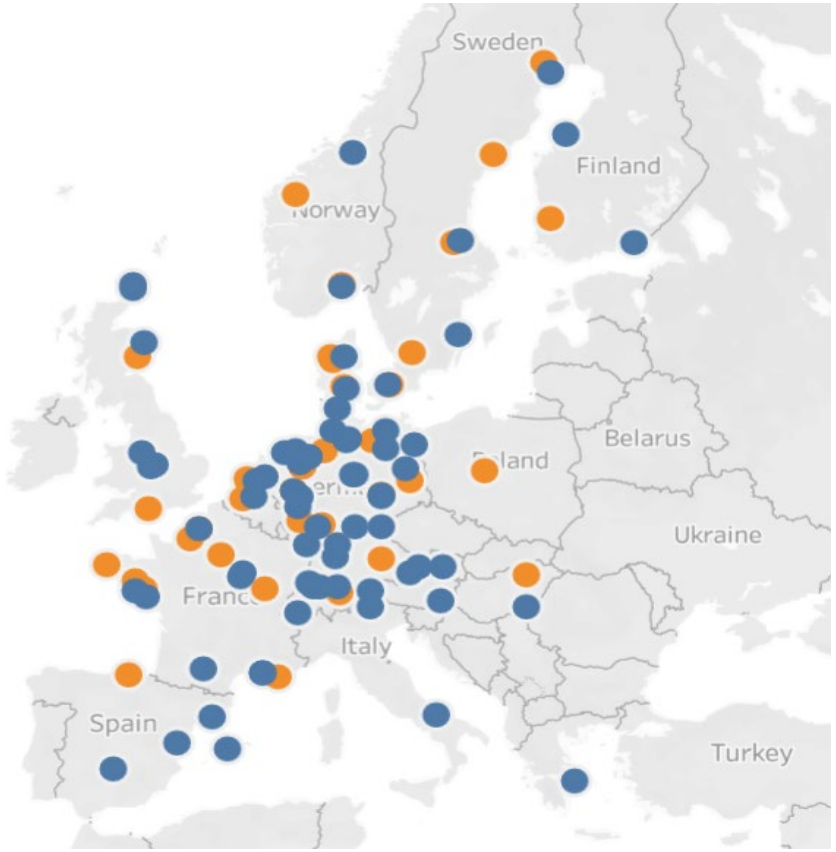
DATA: CRU Hydrogen Cost Model; NOTE: underlying assumptions on fossil fuel and carbon prices from CRU Economics Cost Macro; costs of green power taken from CRU Long-term Renewable Energy Costs Model

Crucial cost parameters for renewable hydrogen:

- Price development electrolysers (-> *CAPEX*)
- Demand growth hydrogen (-> *Potential for fixed cost degression*)
- Electricity costs (-> *OPEX*)
- Volatility electricity supply
- Buildup transport infrastructure, evolution transport technologies (-> *Transport costs*)

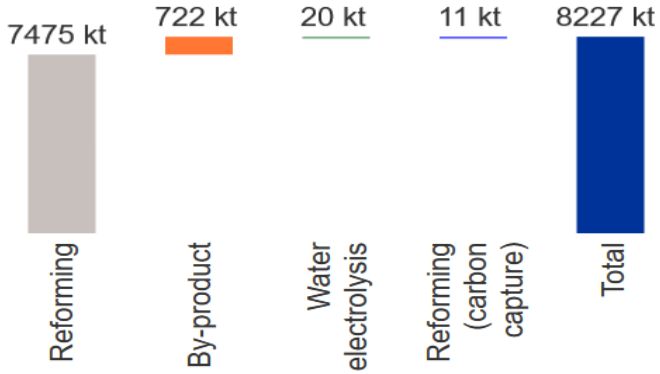
Current EU Project Landscape

Current clean hydrogen production facilities

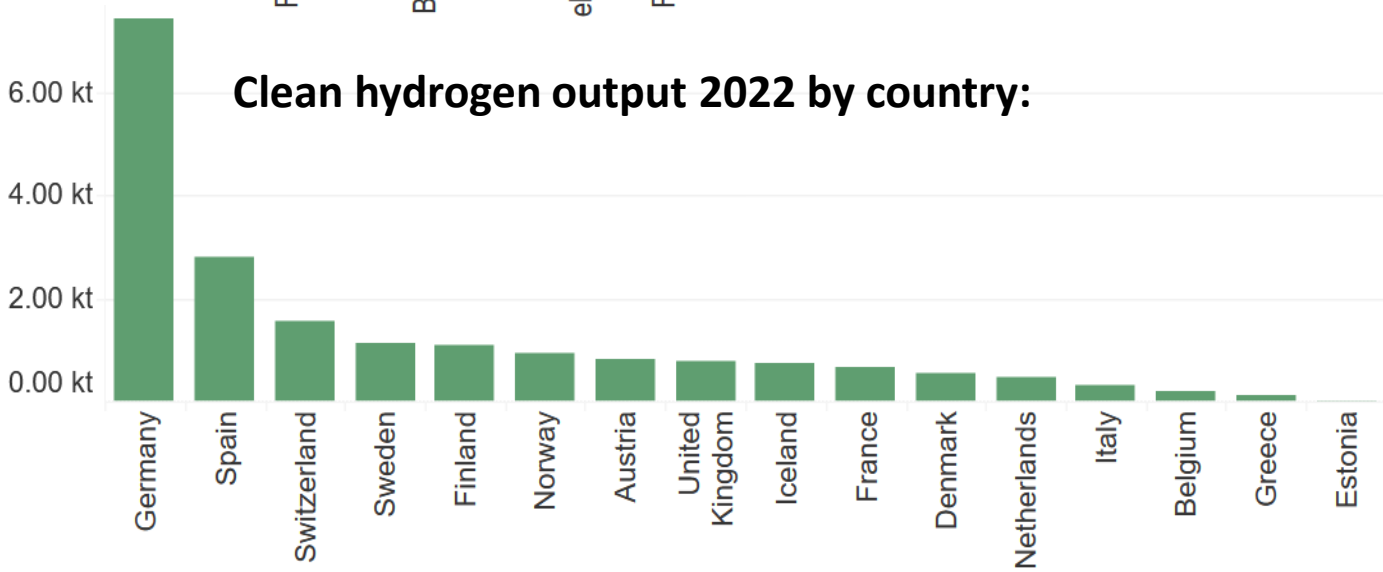


Source: EHO (2023); Blue: in operation; Orange: under construction

Total hydrogen output 2022 (incl. UK/EFTA):

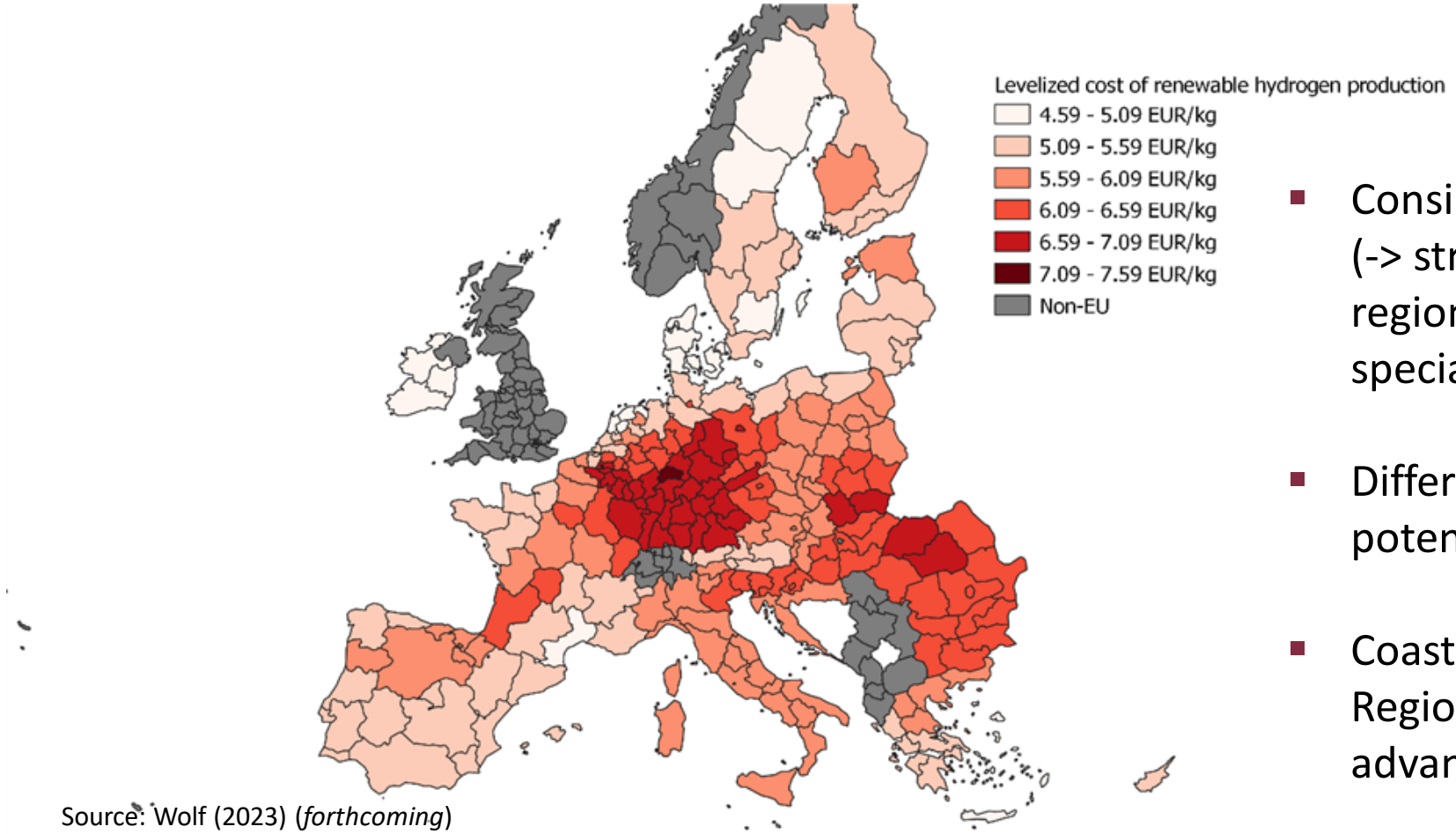


Clean hydrogen output 2022 by country:



Current EU Project Landscape

Estimates of current renewable hydrogen production costs at regional level (regional RES-E)

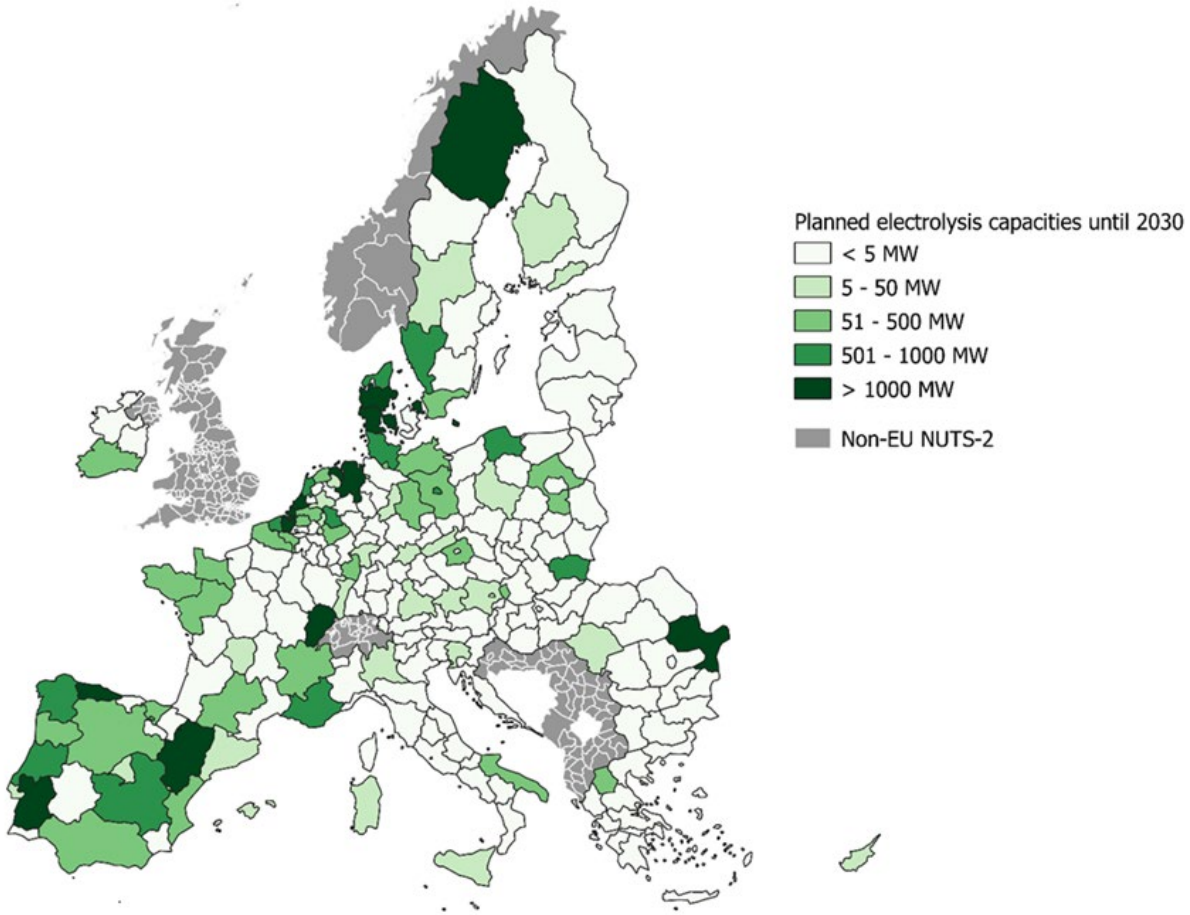


Source: Wolf (2023) (*forthcoming*)

- Considerable cost gap within Europe (-> stressing the importance of cross-regional markets to foster specialization)
- Differences in regional RES-E potential as main driving force
- Coastal regions (especially North Sea Region) with significant cost advantages

Current EU Project Landscape

Emerging future capacity landscape (announced projects until 2030)



Source: Wolf (2023)

- Clear focus on few core regions (especially North Sea and Iberia)
- Proximity to RES-E capacities important location factor
- Correlation with regional hydrogen demand potentials comparatively less strong

→ Fast development of cross-regional hydrogen transport infrastructure essential

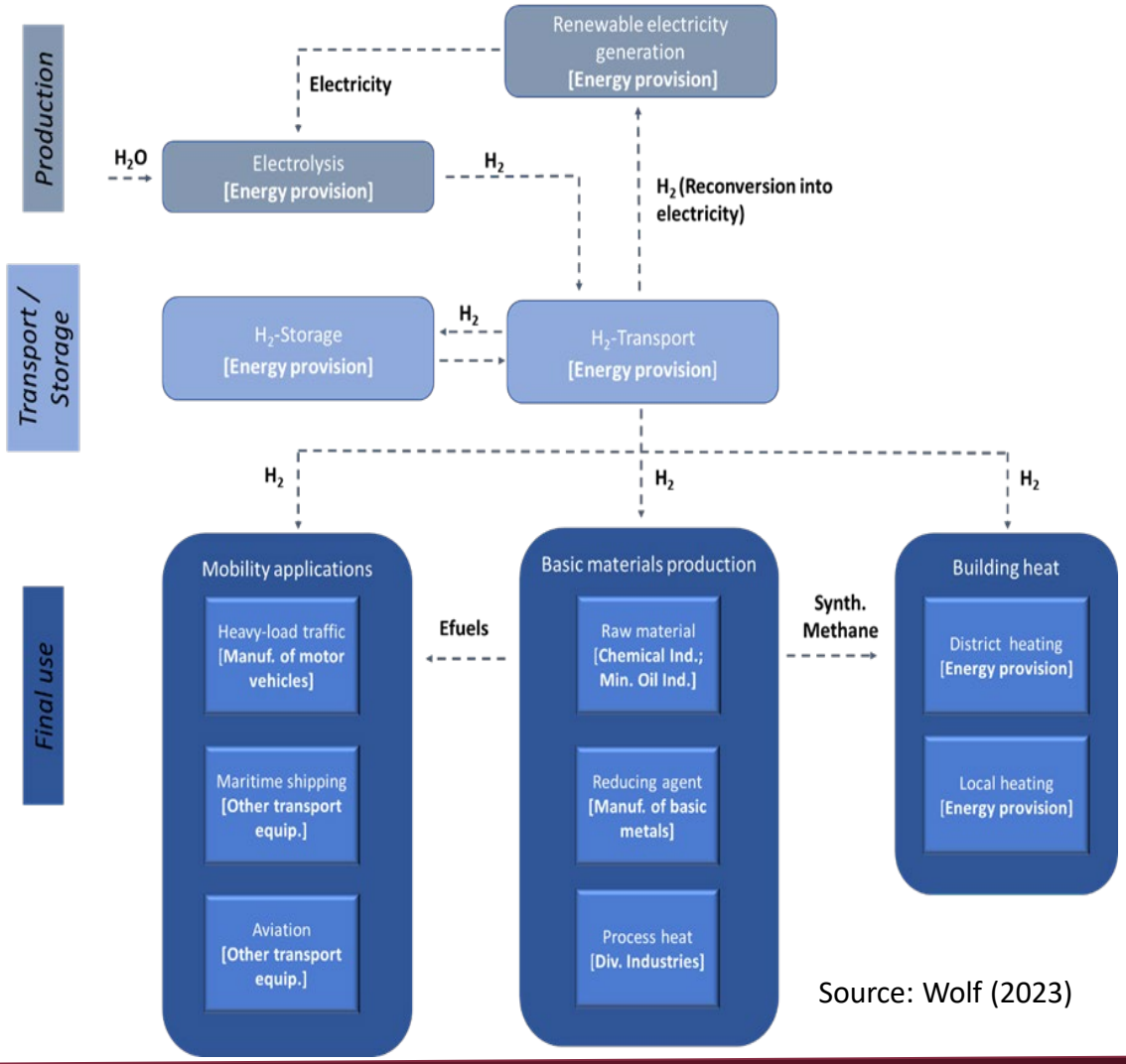
A Closer Look at Netherlands / North Rhine-Westphalia

Specific potentials for joint supply chains

- High potential for wind power (North Sea region)
- Prospects of offshore electrolysis

- Existing local hydrogen pipelines (chemical industry)
- Rotterdam as future European hydrogen import hub
- Duisburg as storage and inland distribution hub
- Variety of hinterland transport routes in planning (Hydrogen Corridor)

- Significant presence of hard-to-abate industrial sectors
  - Major steel industry in Duisburg and Velsen: Significant potential for H2-based direct reduction
  - Chemical clusters In both NRW (Districts Cologne, Düsseldorf) and NL (Zuid-Holland, Noord-Brabant): Renewable hydrogen e.g. for basic chemical Methanol
  - Region as European logistics centre: Hydrogen as solution for freight transport (trucks, inland shipping)

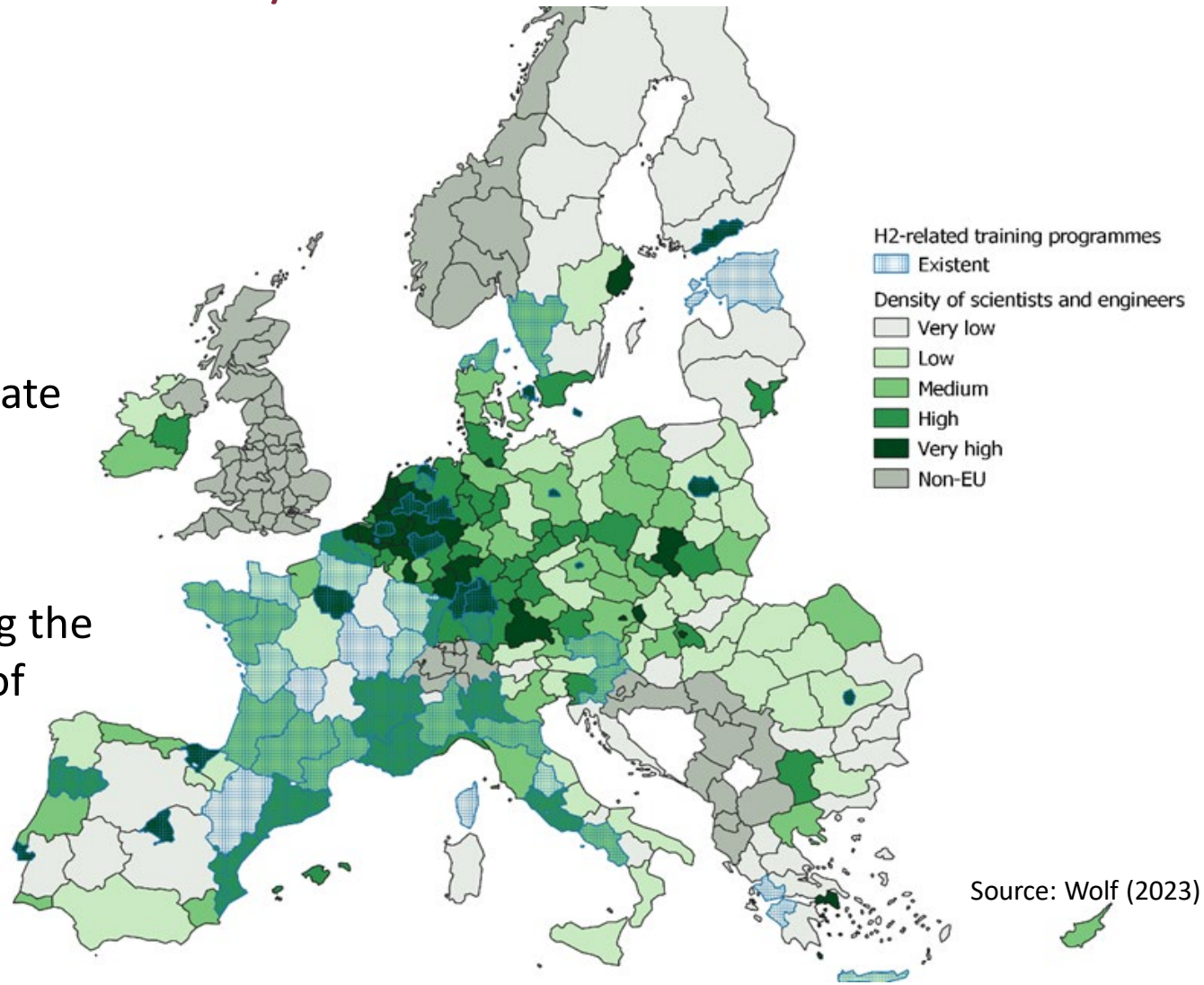


Source: Wolf (2023)

A Closer Look at Netherlands / North Rhine-Westphalia

Framework conditions

- High level of engineering know-how and talent in the region
- Significant regional presence of intermediate suppliers (electrolyser stacks, fuel cells, components)
- Districts of Düsseldorf and Cologne among the NUTS-2-regions with the largest number of hydrogen refuelling stations in the EU

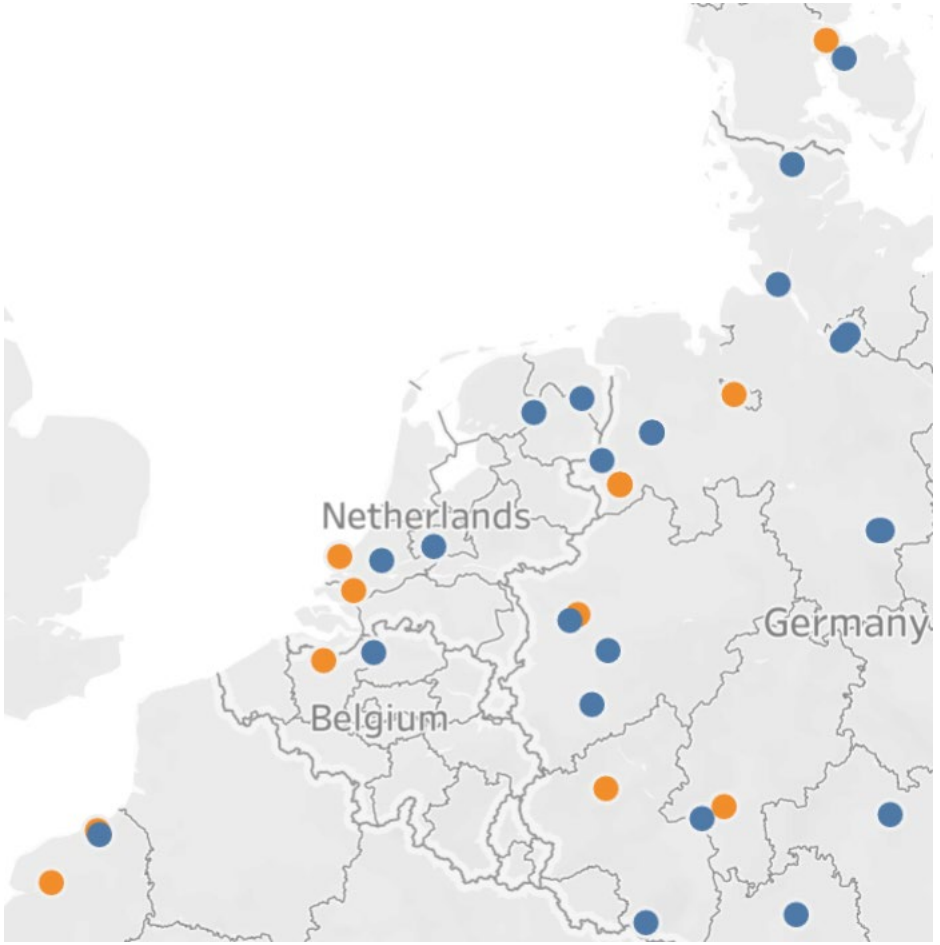


Source: Wolf (2023)

A Closer Look at Netherlands / North Rhine-Westphalia

Currently created large-scale capacities*

- The European Hydrogen Observatory (EHO) reports **nine** current large-scale-projects in NL/NRW in the field of renewable hydrogen production/consumption (total EU number: 113), two of them particulary large in European comparison (*Holland Hydrogen* and *Trailblazer*)
- The aggregate production capacities of projects located in NL/NRW amount to **241 MW** (Installed EU-wide capacity 2022: 143 MW (Clean Hydrogen Monitor))
- Dedicated final use areas are chemicals/refining (4 projects), mobility sector (4 projects) and steel (1 project)



Source: EHO (2023); Blue: in operation; Orange: under construction

* Projects under construction / in operation with at least 0.5 MW electrolysis capacity

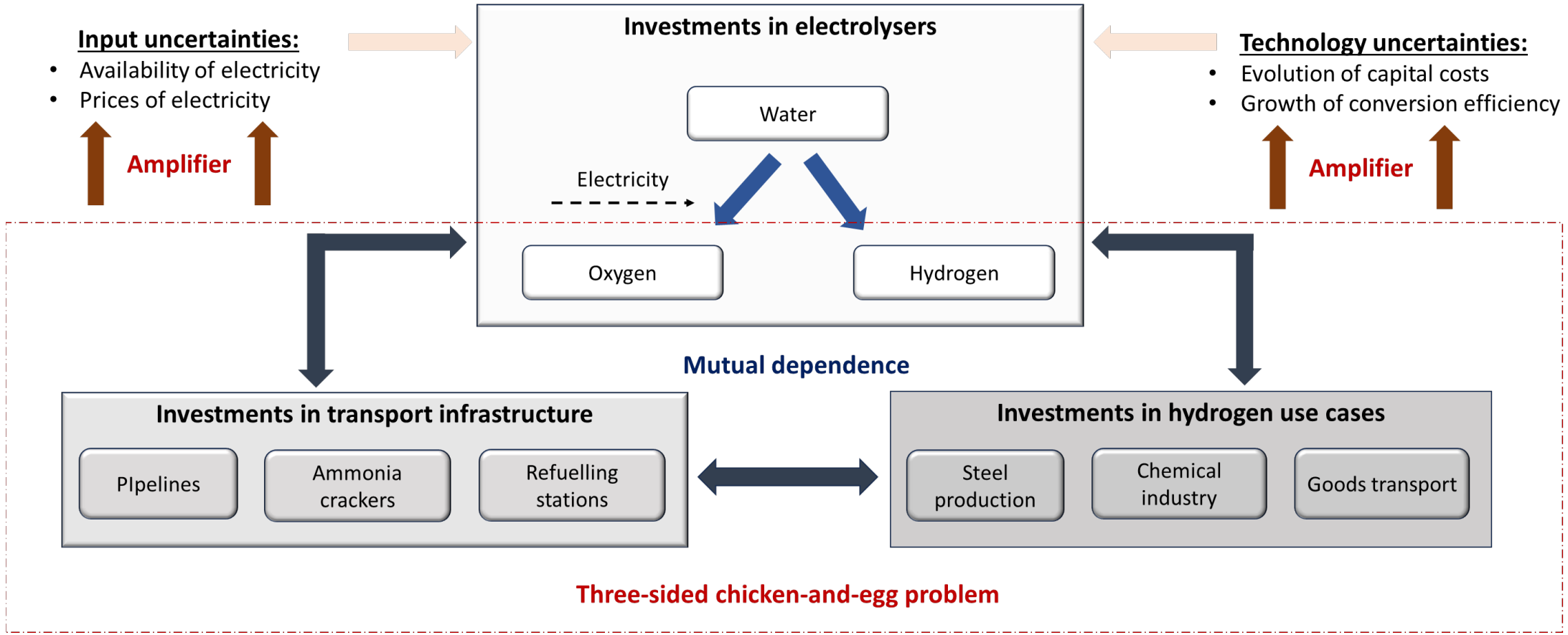
A Closer Look at Netherlands / North Rhine-Westphalia

Existing economic and institutional cooperation

- Long history of intense cross-border trade and investment relations
- Already in 2020: Formal agreement of intensifying cooperation in the development of a hydrogen economy through cross-national projects
- HY3 project with joint feasibility study of a transnational hydrogen market
- Ambitious political goals for production capacities on both sides:
  - Netherlands: Capacity to produce at least 4 GW of green hydrogen in 2030 and double that amount in 2032
  - Germany: Goal updated to 10 GW until 2030 (instead of 5 GW)

Barriers to interregional Supply Chains

Major economic obstacle: The „second-mover-advantage“



Policy Instruments and Recommendations

Support instruments for different stages of hydrogen supply chains

CAPEX-support:
- CAPEX-grants
- Access to cheap credit
- Simplified approval procedures

OPEX-support:
- OPEX-grants
- Reduction levies/network charges electricity
- Promotion PPAs

Revenue support:
- Certification
- Price premiums
- Minimum prices
- State as intermediary

Demand support:
- CO2-pricing
- CCfDs
- Green lead markets

Framework conditions:
- Reduction barriers to pipeline expansion
- Support PV/Wind energy capacities
- Support grid expansion and smart grids

→ H_2-Infrastructure

Policy Instruments and Recommendations

General recommendations

- Leave debates on hydrogen technologies behind, focus on market development
- Rapid scaling and future security of supply as critical policy targets:
  → Stimulate demand so that renewable hydrogen "Made in Europe" can realize its potential for long-term cost advantages
- Parallel development of intra-European (pipelines) and transcontinental infrastructure
- Securing additional raw material requirements (especially iridium, platinum) in the form of strategic resource partnerships and entry into the circular economy

Policy Instruments and Recommendations

Some key areas of action

€	Establishment of competitive production premium auctions (European Hydrogen Bank)
	Establishment of EU-wide certification systems for renewable hydrogen
	Introduction of green procurement quotas for selected industrial products
	Securing investment incentives in pipeline infrastructure
	Establishment of strategic resource partnerships for electrolyser metals
	Acceleration of RES-E expansion and European electricity market integration

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No. 6 | 2022 17 May 2022

How green hydrogen will make Europe more independent

Hydrogen is an important element in the EU's quest for fossil-free energy sources.

André Wolf

Hydrogen produced from renewable electricity will be a versatile building block on the road to energy independence. Prerequisite: a smart support policy. This will have to remove regulatory barriers and take account of technical strengths and weaknesses.

Key propositions:

- **A Europe-wide hydrogen market** could lay the foundations for a new efficiency-enhancing division of labour in Europe.
- **Adequate availability of renewable electricity** represents the critical bottleneck on the way to a hydrogen-based economy.
- **Political efforts to get the market up and running** should focus primarily on promoting domestic capacity for generating electricity and on developing a hydrogen power infrastructure. The way that hydrogen is utilised will then be decided on the market.
- **Contractual fixing of CO_2 prices** and other forms of risk assumption may help to alleviate demand-side planning uncertainty.

THANKS FOR YOUR ATTENTION!

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No. 1 | 2023 17 January 2023

Establishing hydrogen hubs in Europe

An analysis of the European hydrogen landscape

André Wolf

Green hydrogen has outgrown the testing stage: over the next few years, large consortia across Europe will be investing large sums to build the supply chains of tomorrow. This phase will determine our success or failure in the race for this technology. Europe as a whole will only be successful if it aligns the development of supply chains with the potential of its regions and exploits the advantages of a European division of labour. This cepInput, the first analysis of the geographical layout of a European hydrogen economy, provides food for thought.

Key propositions:

- In view of the diverse options for utilisation, the regional economic structure in Europe offers **great potential for a European division of labour** along hydrogen supply chains.
- This potential is not fully reflected in the geographical distribution of the major projects that are currently in the starting blocks.
- **Improving European coordination of funding channels** and ensuring that they are consistently aligned with regional economic criteria is important in the current start-up phase.
- The medium-term goal must be the **emergence of transregional markets** for green hydrogen in Europe. The conditions for this must start being created today with increased promotion of infrastructure development and by harmonising market regulation.