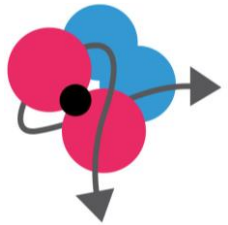


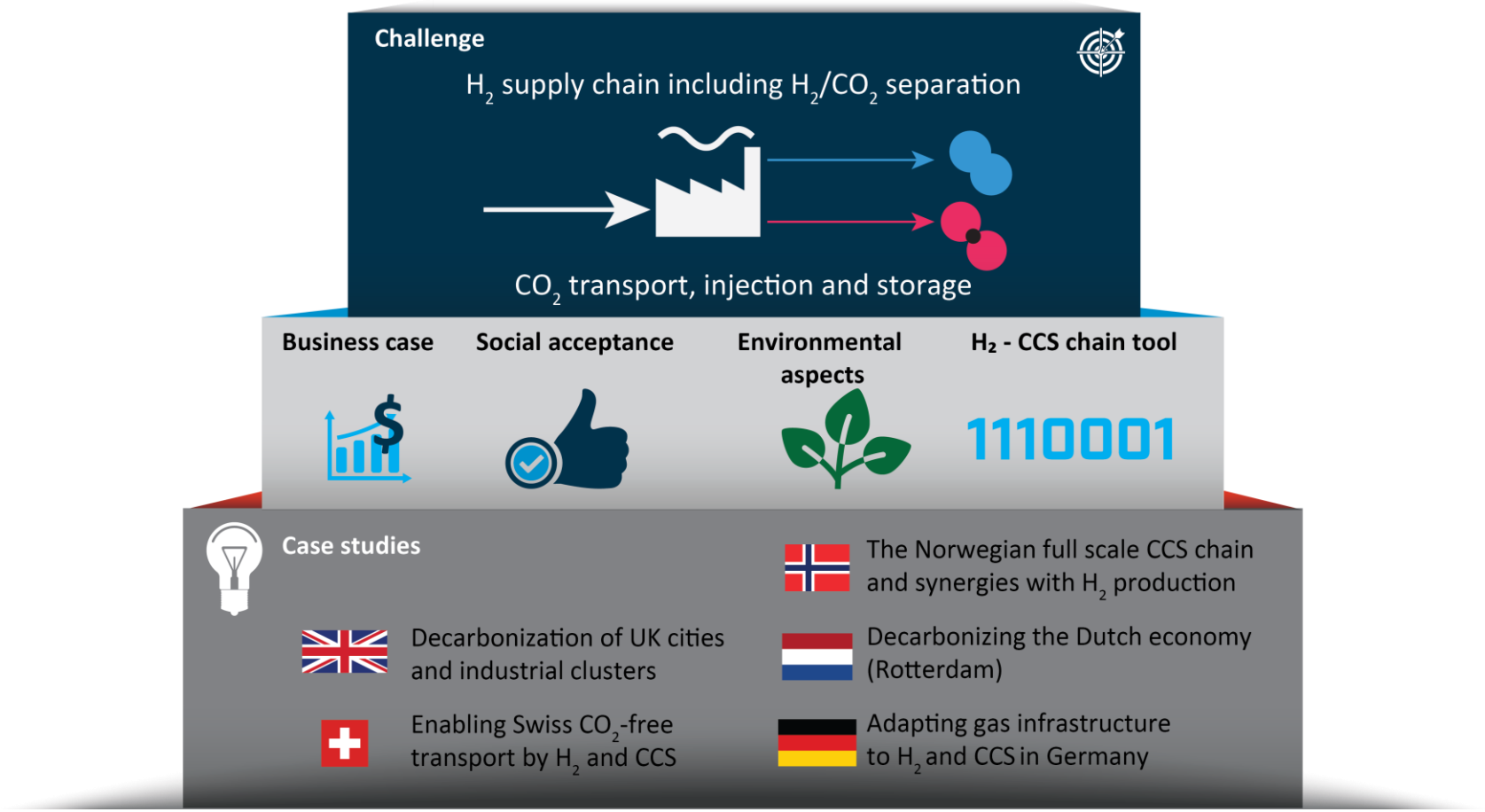
The role of hydrogen and CCS to achieve Europe's climate goals

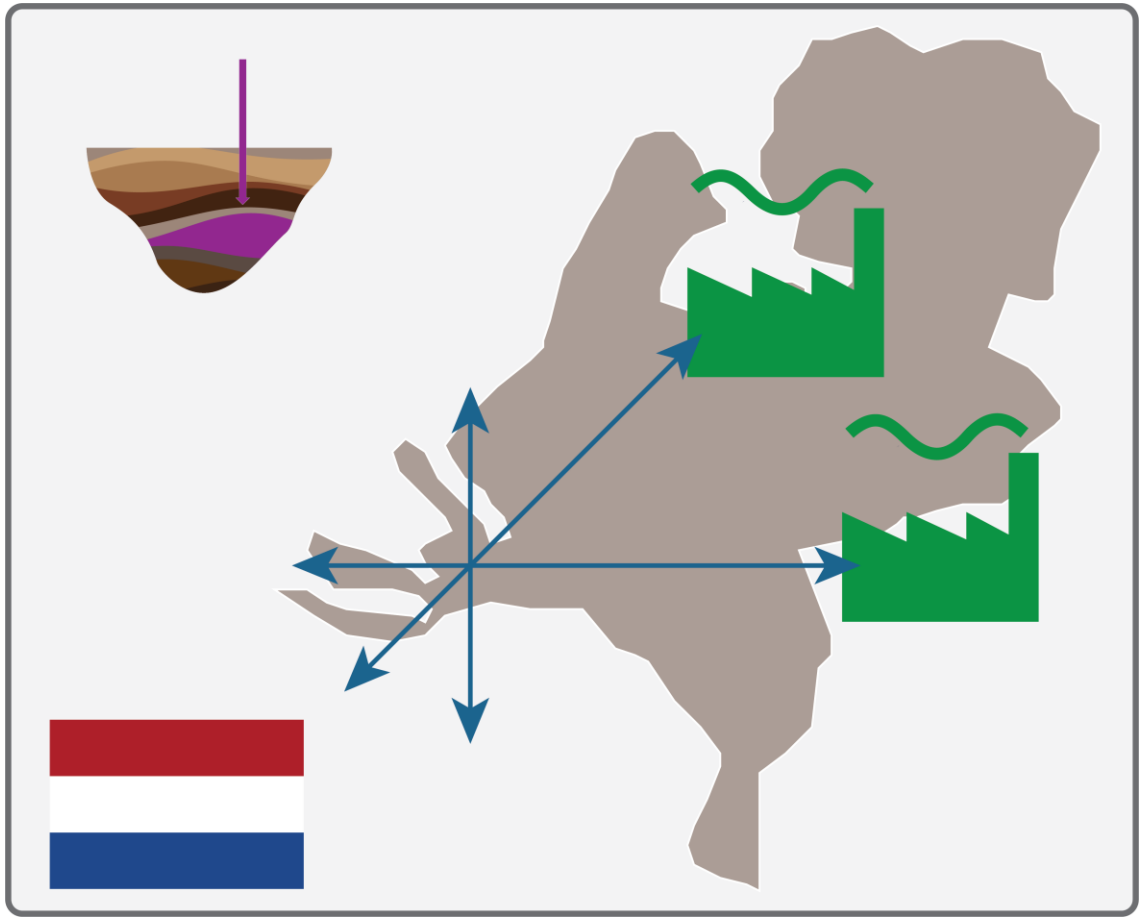
– case studies in Germany, Switzerland, United Kingdom, Netherlands and Norway

Reigstad, Akhurst, Flamme, de Kler, Roussanaly, Mazzotti

ELEGANCY Webinar Series - 18 June 2020

National case studies to accelerate decarbonization of Europe's energy system





Decarbonizing the Dutch economy

Decarbonizing the Rotterdam industry

Figure 9.2: Components of the economic model. This diagram gives the costs (orange) and revenues (green) for the complete project, how these are distributed to the participants is to be decided.

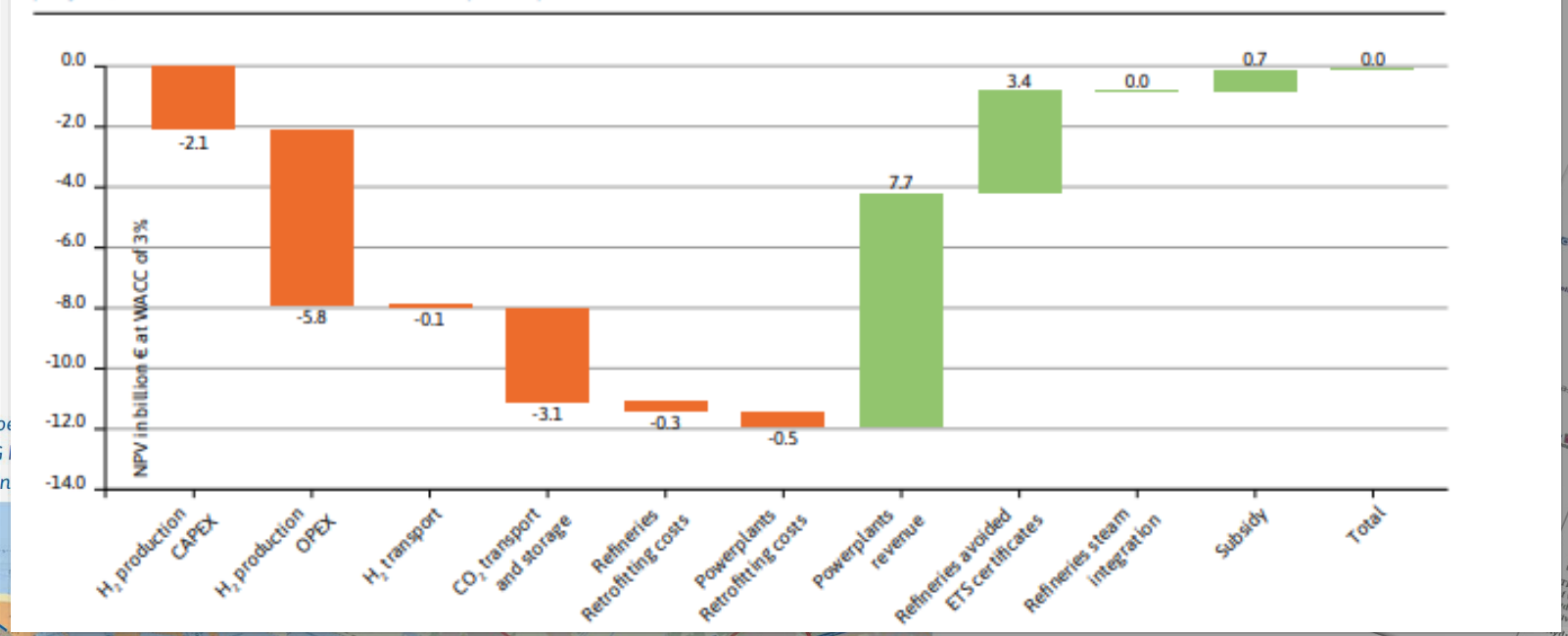
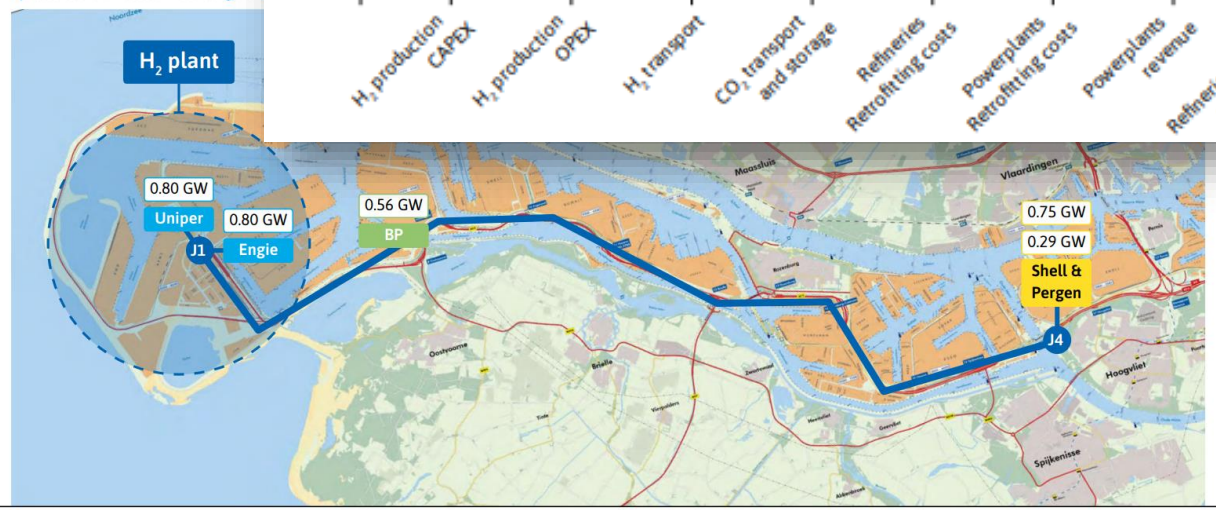


Figure 6.10: Reference scope including both RFG and NG splits into smaller lines goin




Press release | 2 July 2019
H-vision kicks off the hydrogen economy in Rotterdam
The large-scale production and utilisation of blue hydrogen will allow local industry in Rotterdam to substantially reduce its CO_2 emissions well before 2030. This is one of the main conclusions of the feasibility study carried out by 16 companies and organisations, under the guidance of Deltalinqs, within the H-vision project.
Paving the way

Source: H-vision, Feasibility study report

Decarbonizing the Rotterdam industry

Hydrogen demand for High-temperature heating

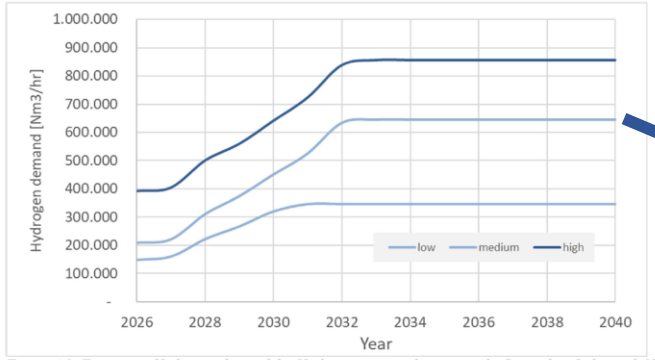


Figure 4.2 Estimation Hydrogen demand for High-temperature heating in the Rotterdam Industrial Cluster.

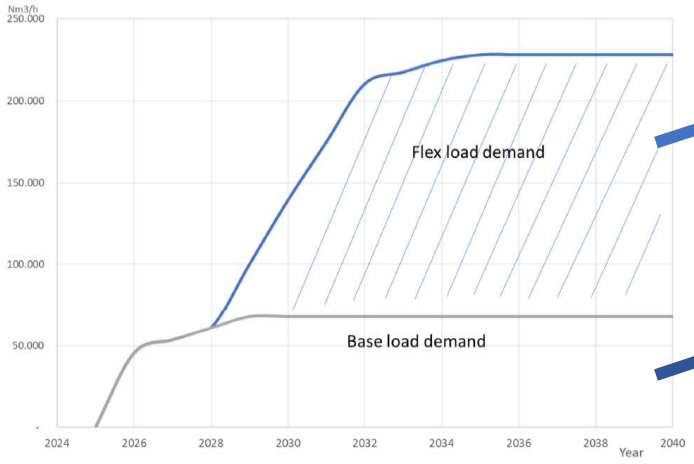


Figure 4.6 Estimation of Hydrogen demand for power generation in the Rotterdam Industrial Cluster.

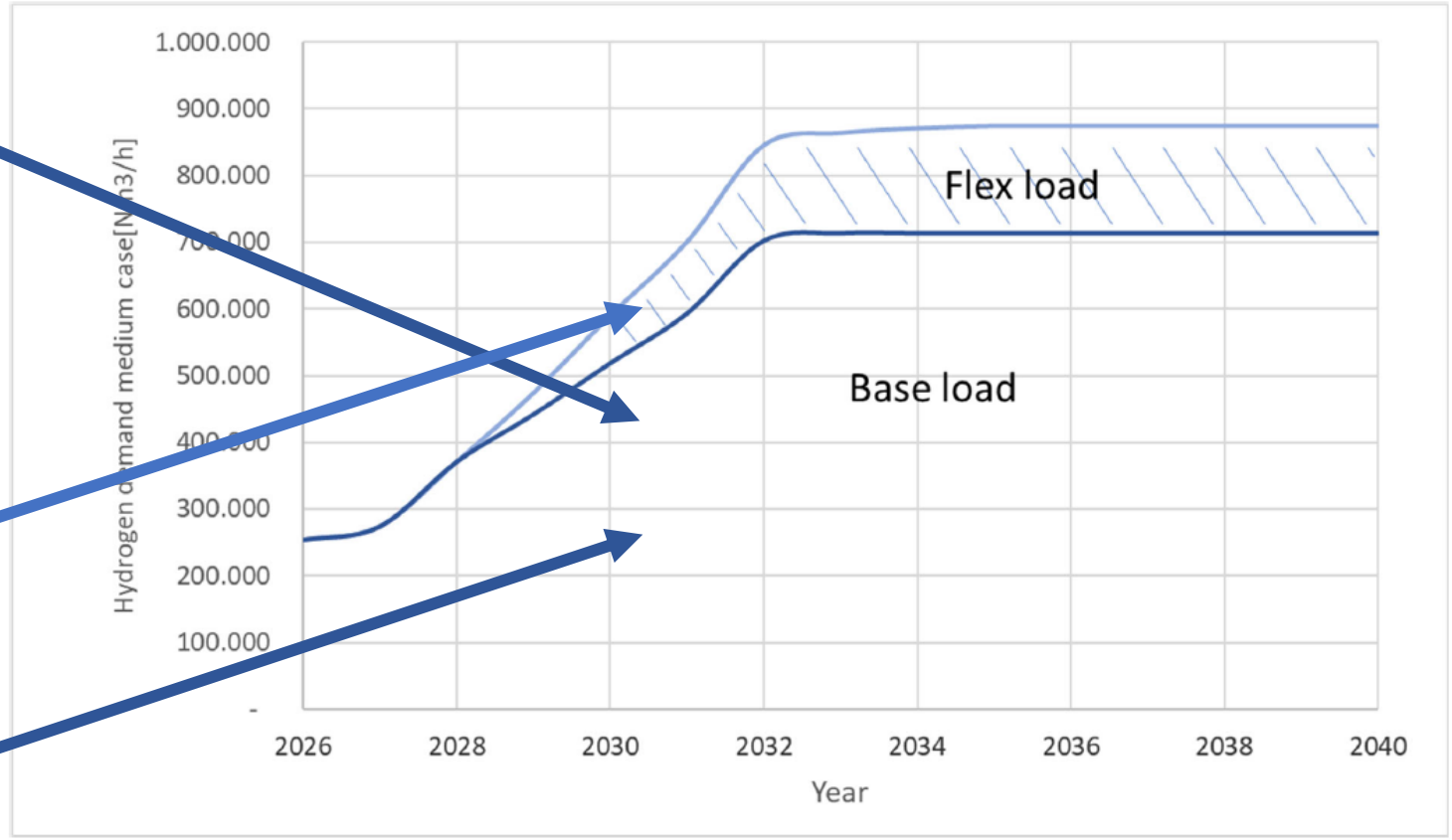
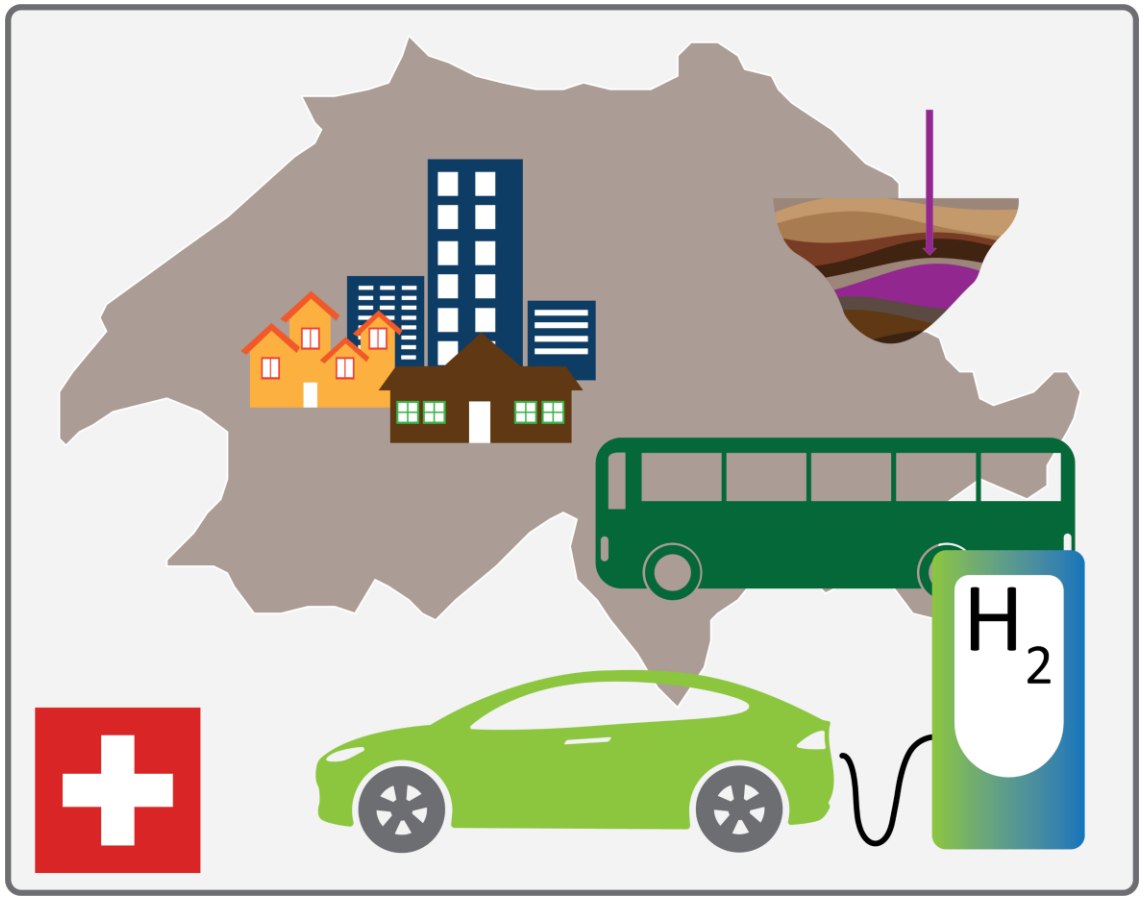


Figure 4.7 Estimation of the Hydrogen utilization for the Rotterdam Industrial Cluster.

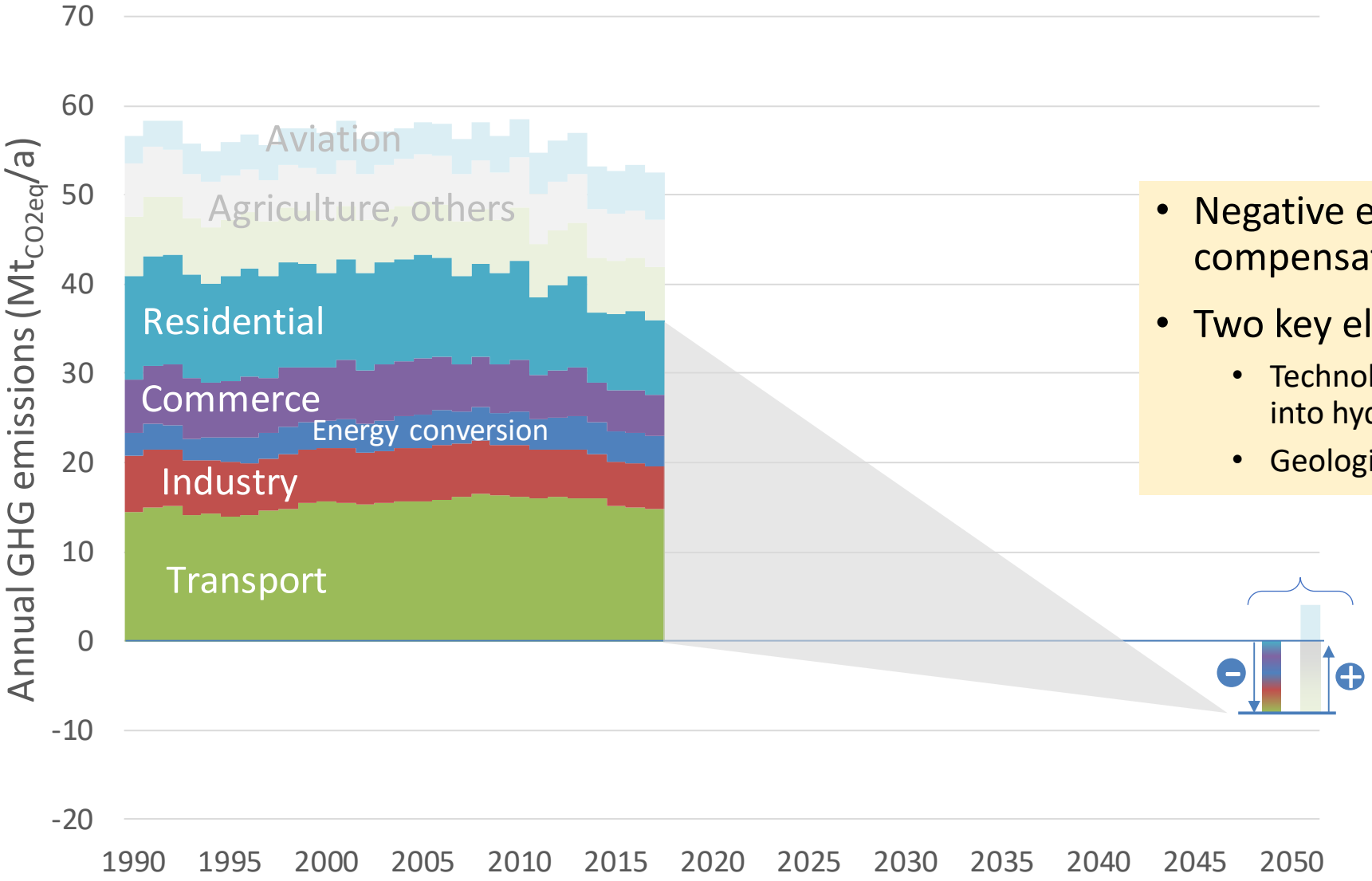
Hydrogen demand for power generation



Enabling Swiss CO_2 –free transport by H_2 and CCS

Swiss climate goal

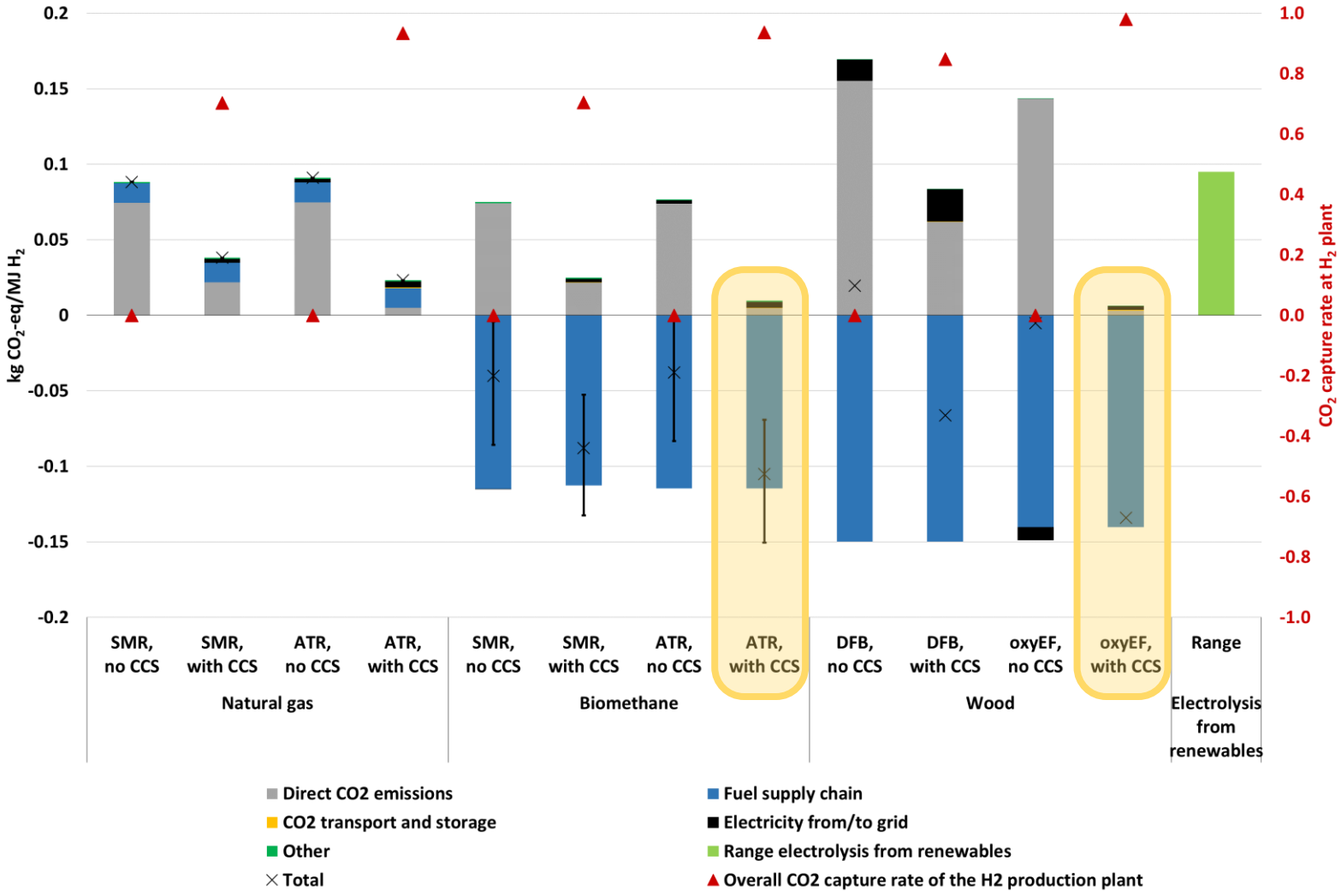
Net zero GHG emissions by 2050



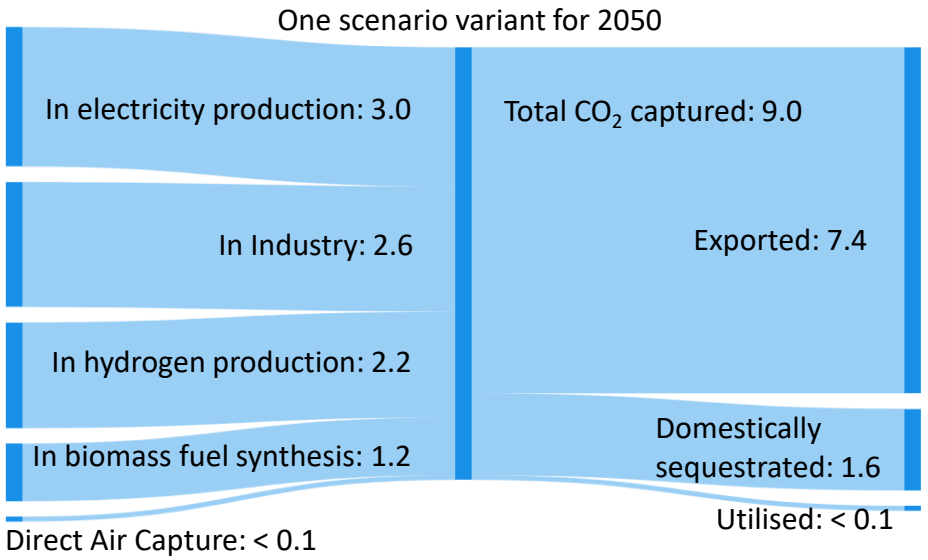
- Negative emissions required to compensate agriculture, etc
- Two key elements needed:
  - Technologies that convert biomass into hydrogen and CO2
  - Geological storage of CO2

Produce hydrogen and capture CO2

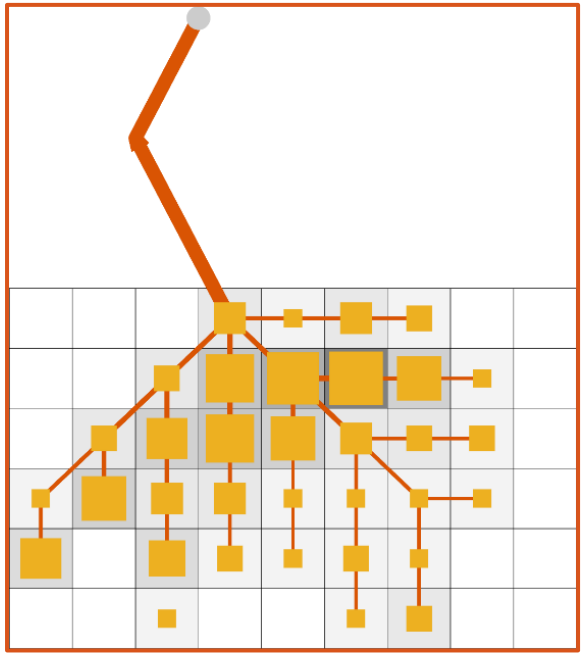
Coupled process modelling and life cycle analysis



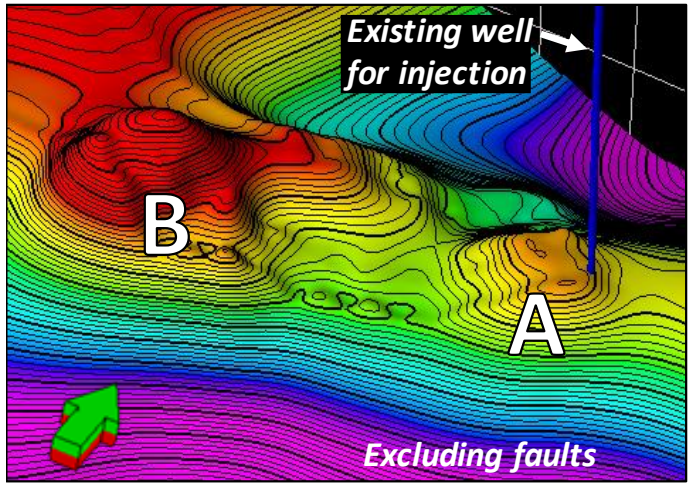
Store CO_2 abroad or in Switzerland



Scenario analysis shows that approx. **10-15 Mt/a** need to be stored



Today: Export CO_2 to the North Sea (see Northern Lights)

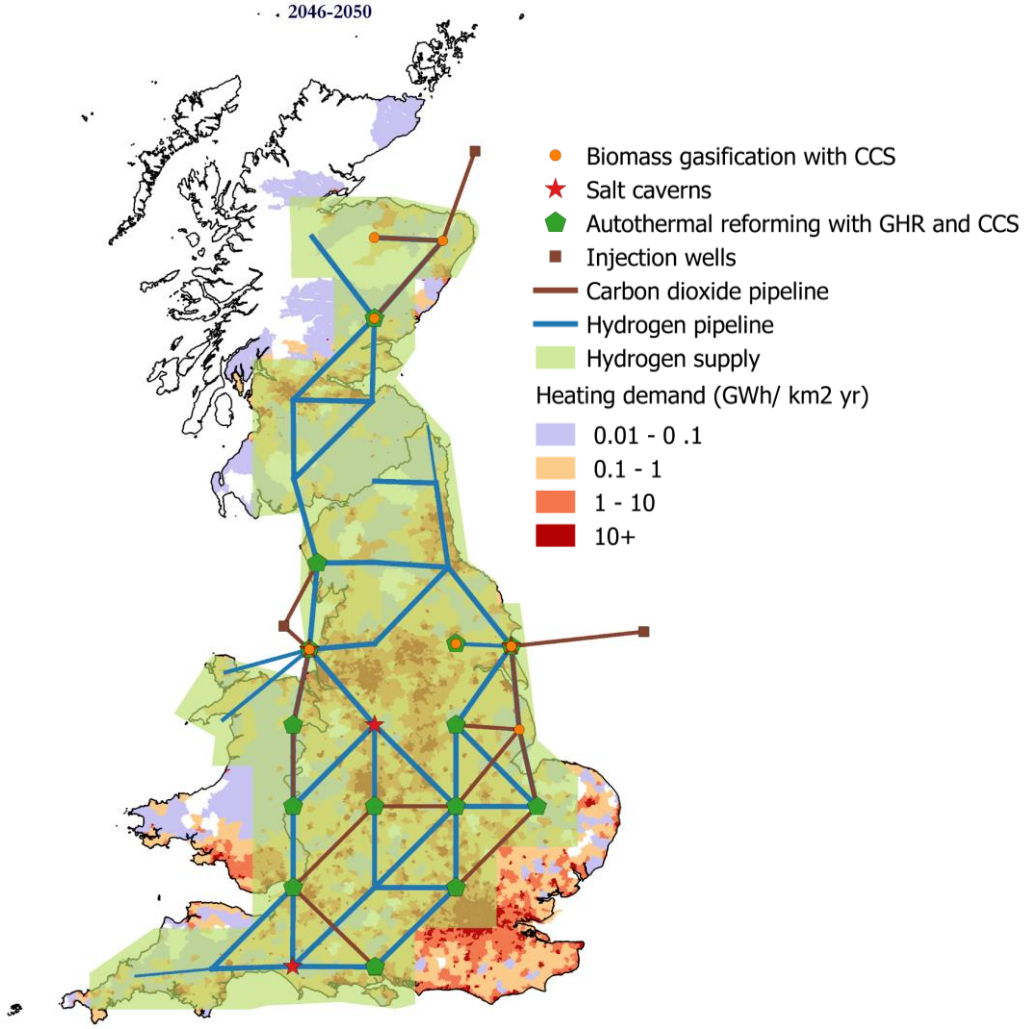


Future: Identification of storage sites in Switzerland

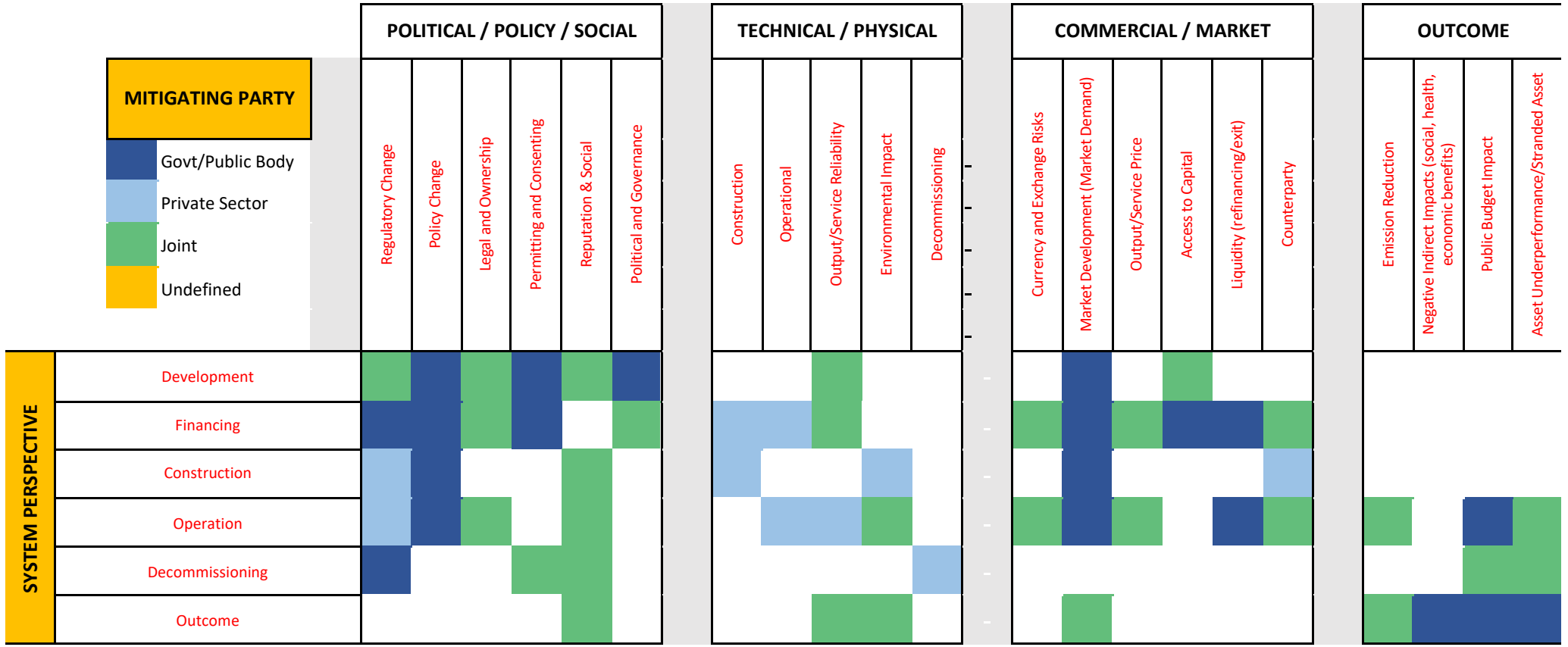
Decarbonization of UK cities and industrial clusters

UK H_2-CCS network development

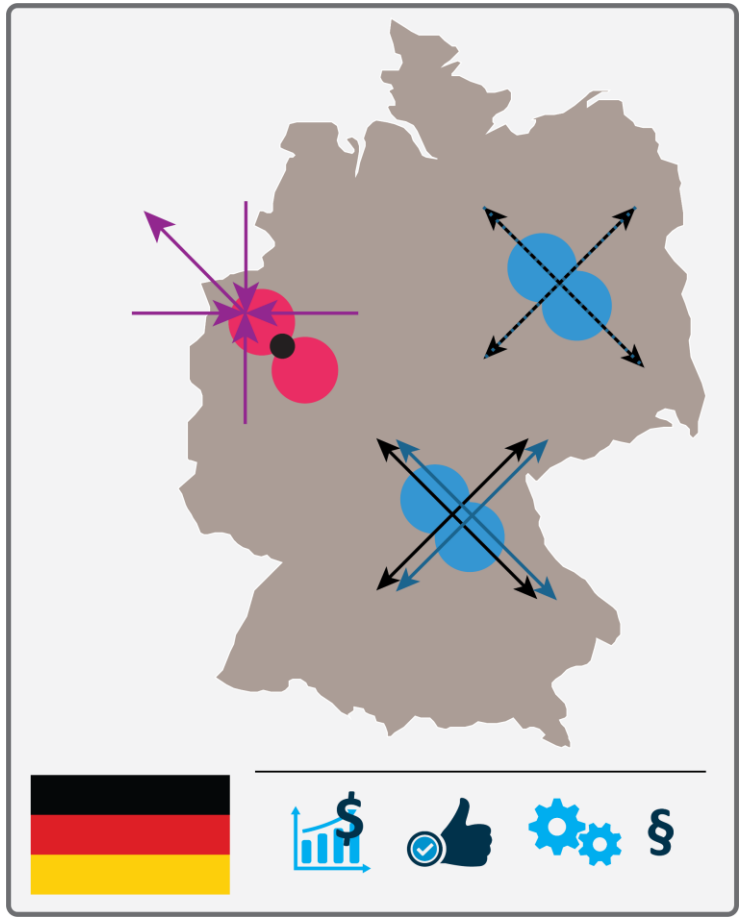
- Cost-effective UK regional development of H_2-CO_2 infrastructure relies on:
  - Sufficient H_2 demand for methane reformation to be cost-effective
  - Availability of H_2 and CO_2 storage capacity
- Sufficient H_2 cavern storage capacity is critical to provide optimal supply of H_2 at peak demand
- A first national-scale theoretical hydrogen storage capacity was estimated
- Theoretical salt cavern storage capacity exceeds requirements for the H21 projects.



UK H21 Delivery: System Business Case Concept

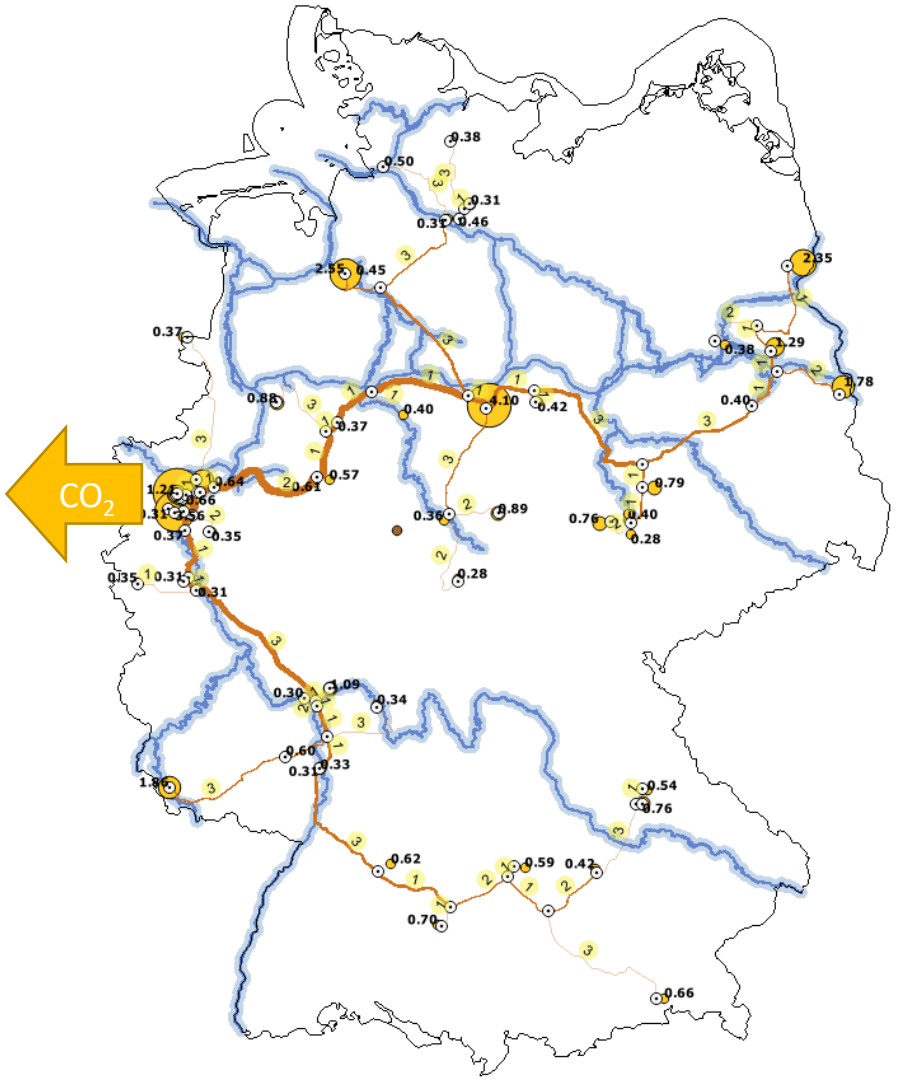


The business case for H21 North of England (NoE) should be defined and evaluated in a system context of Net Zero



Adapting gas infrastructure to H_2 and CCS in Germany

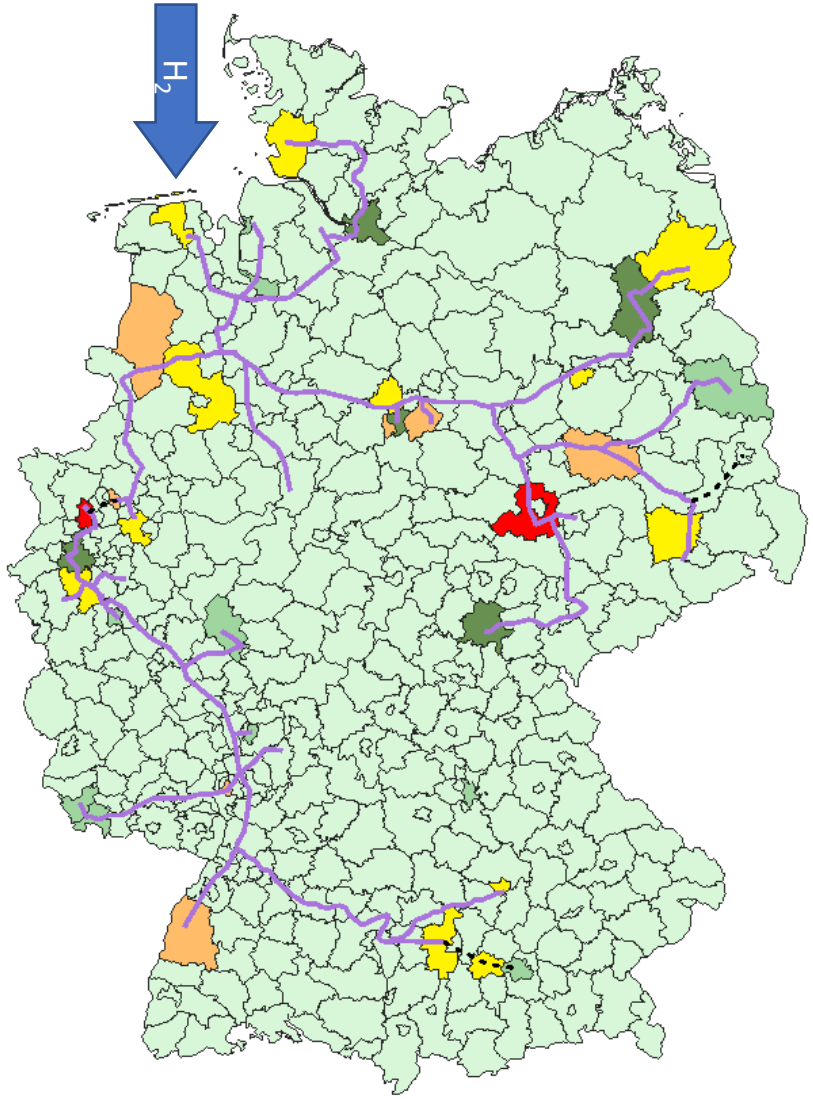
Decarbonization of the gas infrastructure



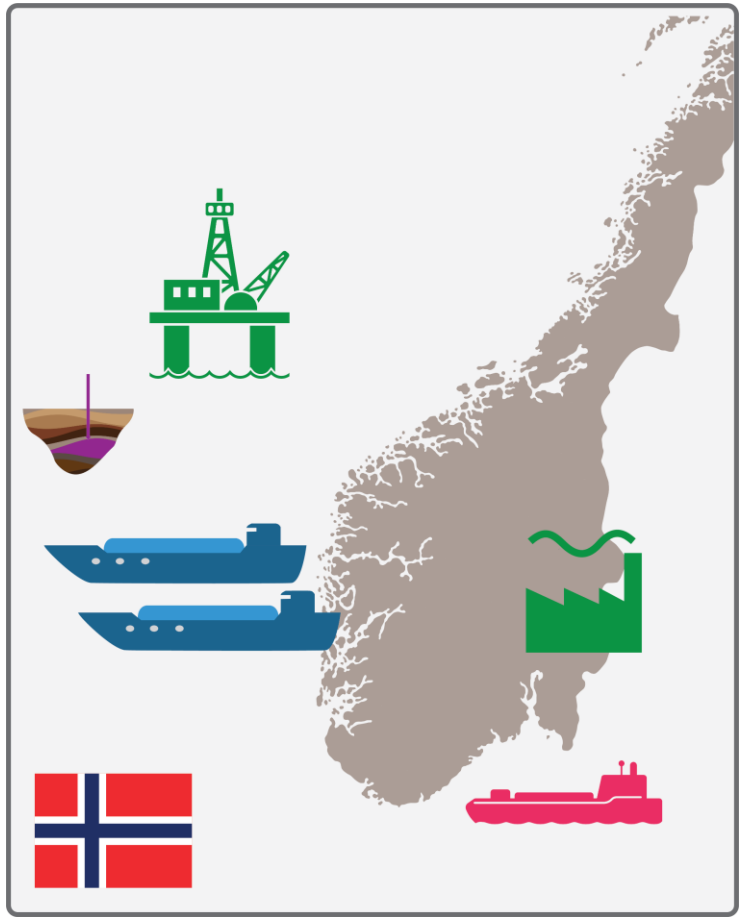
CO_2 sources, pipelines and waterways

Best Case Option

- CCS only at future longtime emitters (waste incineration, cement & paper production)
- Shipping most likely being preferred for CO_2 Transport due to acceptance and legal issues as well as flexibility
- Hydrogen pipelines primarily connected to hot spot areas with industrial consumers
- Hydrogen admixture into natural gas transport grid up to 30%



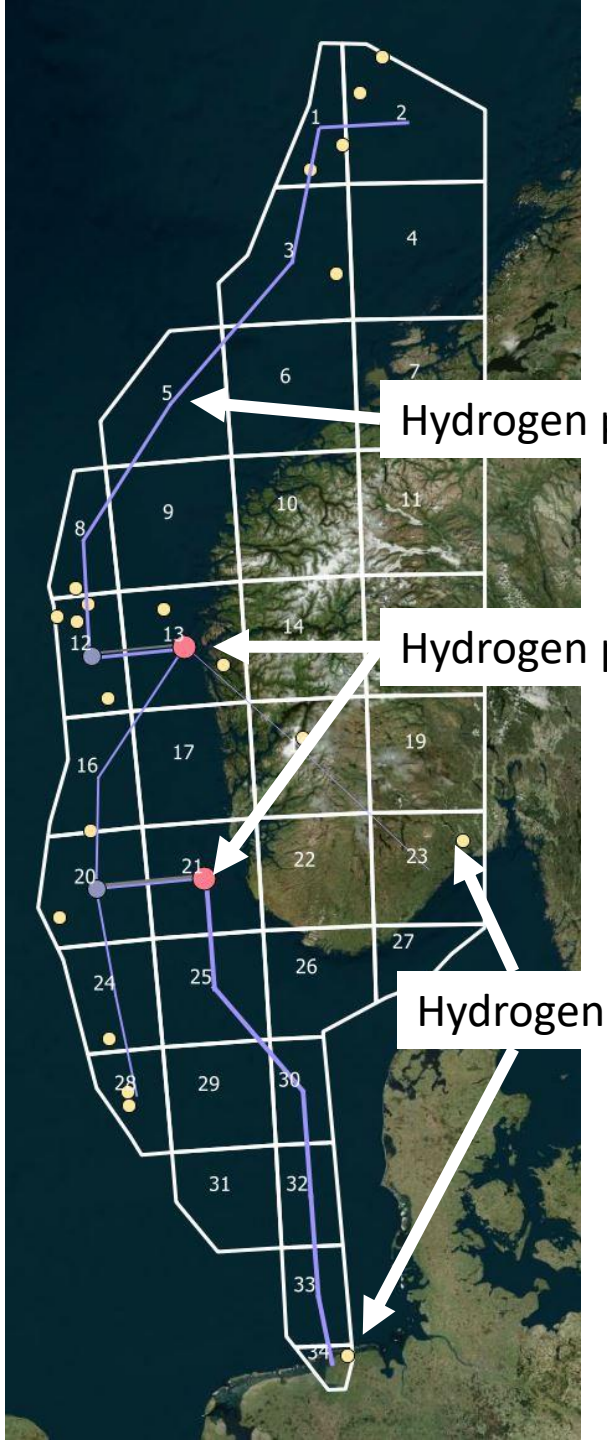
Hydrogen demands and pipelines



The Norwegian full scale CCS chain and synergies with H_2 production

Scenarios for a Norwegian hydrogen value chain

- Optimized infrastructure development
- Hydrogen export to Germany: 5.6 Mtonne/a
- Domestic use of hydrogenand Norway: 0.89 Mtonne/a



Acknowledgement

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