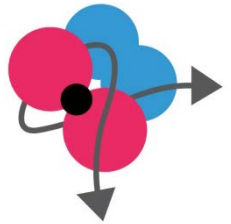


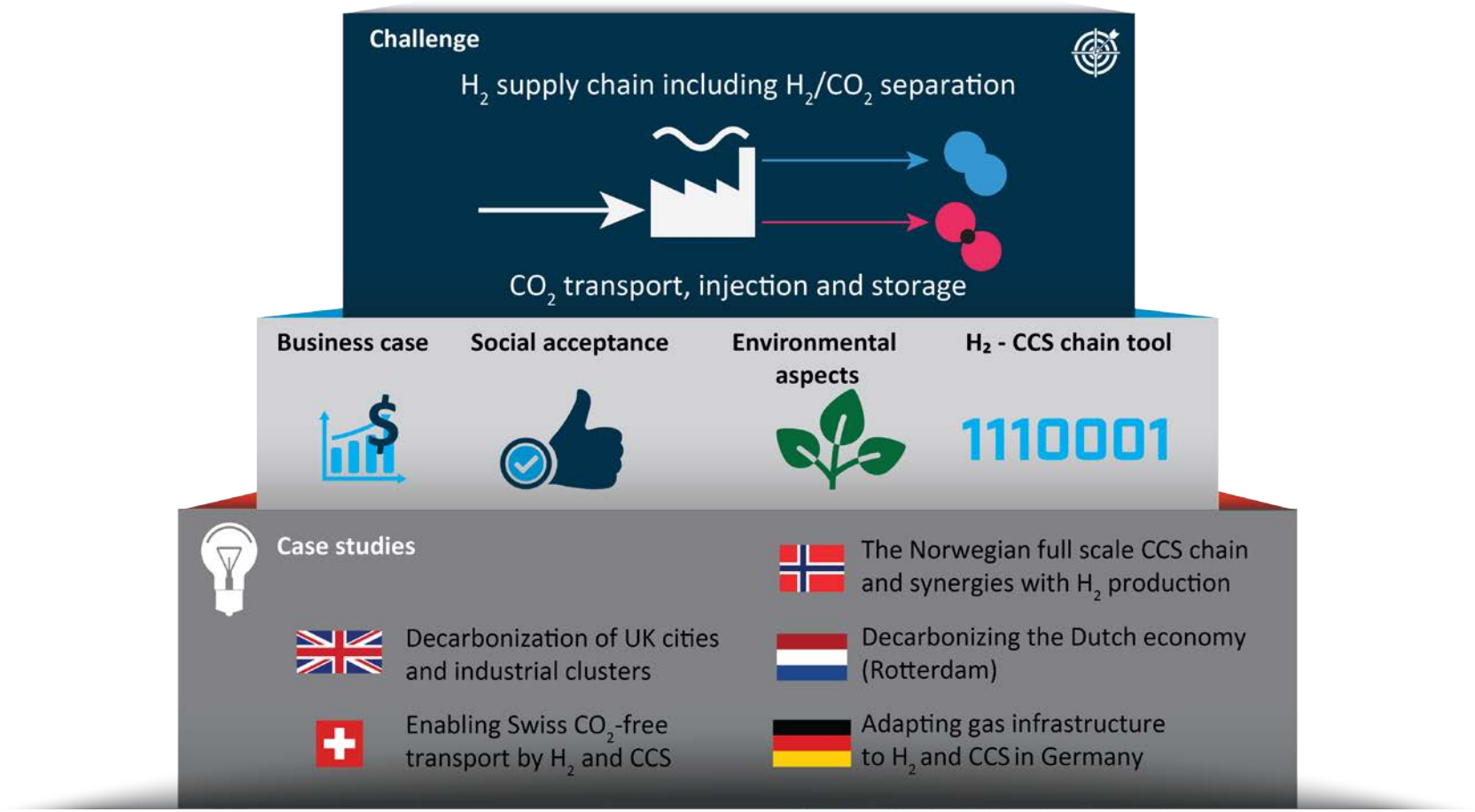
Unlocking opportunities and addressing challenges for large-scale hydrogen provision in Germany, Switzerland, United Kingdom, the Netherlands and Norway

ELEGANCY Webinar Series - 19 June 2020

Agenda

10:30 – 10:45	Welcome and introduction	Reigstad (SINTEF) and Shah (Imperial College London)
10:45 – 11:15	A Roadmap for the introduction of a low carbon industry in the Rotterdam Regioin and the Dutch H_2 backbone	van de Beek (TNO) and Weimann (Univ. of Utrecht)
11:15 – 11:40	Business case and opportunities for a Norwegian hydrogen value chain synergies with the Norwegian large-scale CCS deployment	Roussanaly (SINTEF)
11:40 – 12:10	Hydrogen and CCS to reduce emissions from domestic heating and industrial clusters, H21 North of England and Grangemouth case studies, UK	Akhurst (BGS), Goldthorpe (Sustainable Decisions Ltd.)
13:30 – 14:00	A multi-disciplinary approach of assessing strategic infrastructure development for natural gas, CO_2 and hydrogen in Germany	Flamme (Ruhr-University Bochum)
14:00 – 14:30	Identifying the role of hydrogen and CCS for reaching the Swiss climate targets	Mazzotti (ETH)
14:30 – 14:45	Summary of impacts for the Netherlands, Norway, UK, Germany and Switzerland	Reigstad (SINTEF) and Shah (Imperial College London)

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

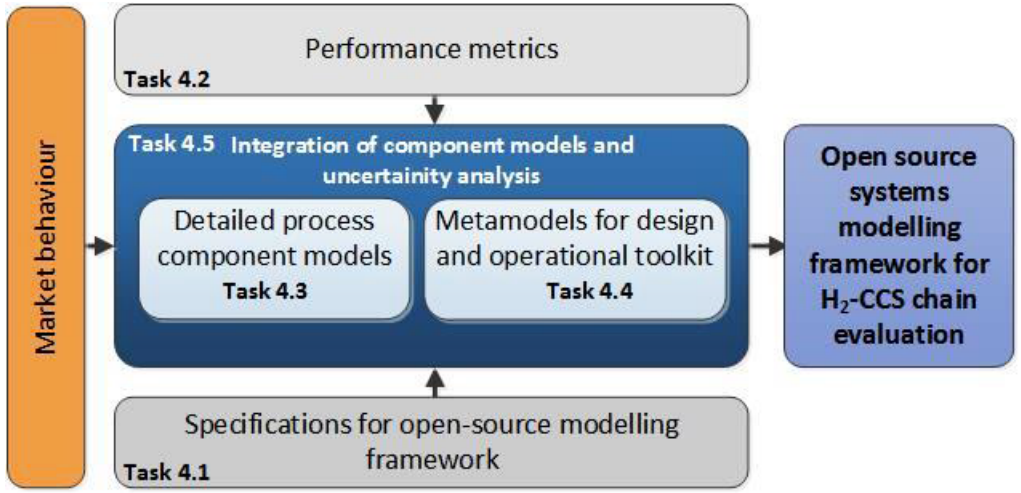


Aims of WP4

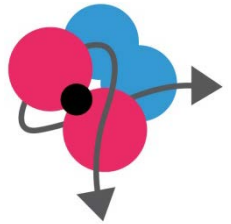
- Develop an open-source systems modelling framework with a steady-state design mode and a dynamic operational mode.
- Develop multiscale models and an integrated modelling approach for the chain components incorporating results from WP1 and WP2.
- Apply the methodology in conjunction with the case studies in WP5 with respect to

  (i) the potential time evolution of the system and (ii) integrated assessments of the proposed designs.

WP4 forms a link between the research done in WPs 1,2 and 3 and the case studies performed in WP5.



WP4 Key Researchers



Imperial

Nixon Sunny (PhD), Diana Iruretagoyena (Postdoc), Edward Graham (Postdoc), [Nilay Shah and Niall Mac Dowell as supervisors]

SINTEF

Rahul Anantharaman, Brage Rugstad Knudsen, Julian Straus (all Research Scientists)

TNO

Robert de Kler (Research Expert)

PSI

Christian Bauer, Karin Treyer, Evangelos Panos (all Research Scientists)

RUB

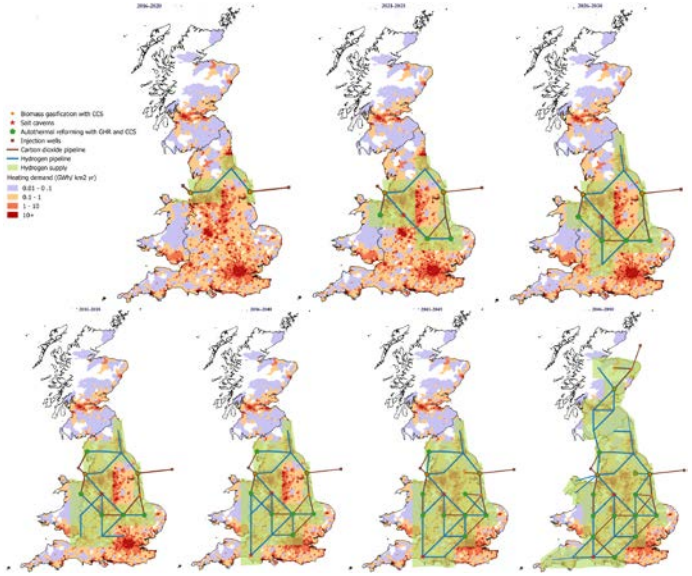
Benedikt Semrau, Roland Span

ETHZ

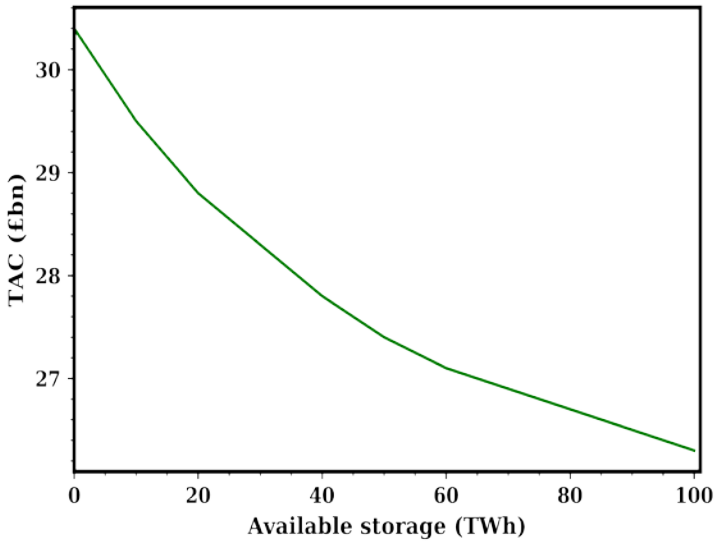
Cristina Antonini (PhD), Mijndert van der Spek (Postdoc), Marco Mazzotti [as supervisor]

WP4 design tool

- Toolkit combines geographical data analysis, powerful mathematical optimisation and visualisation of results to enable integrated design of H_2-CCS systems in regional and national context.
- Design tool integrated with LCA to combine cost and GHG emissions reduction
- Example key finding: large scale H2 storage is valuable!



H2/CO2 system evolution

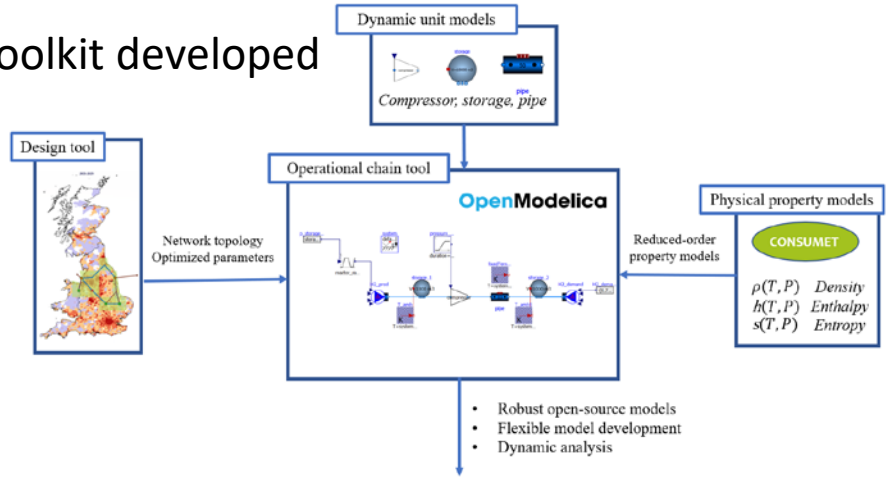


system cost versus H2 storage

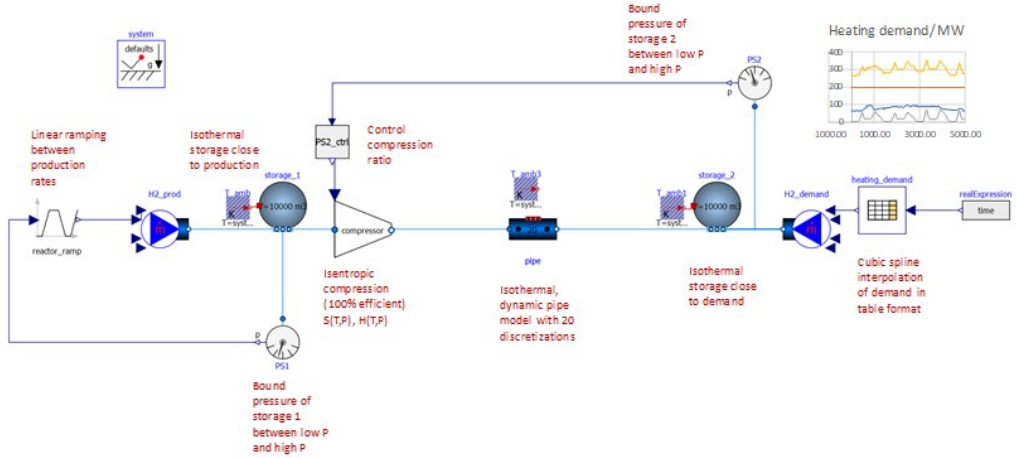
Rotterdam and Grangemouth Cluster design

WP4 operational tool – study system dynamics

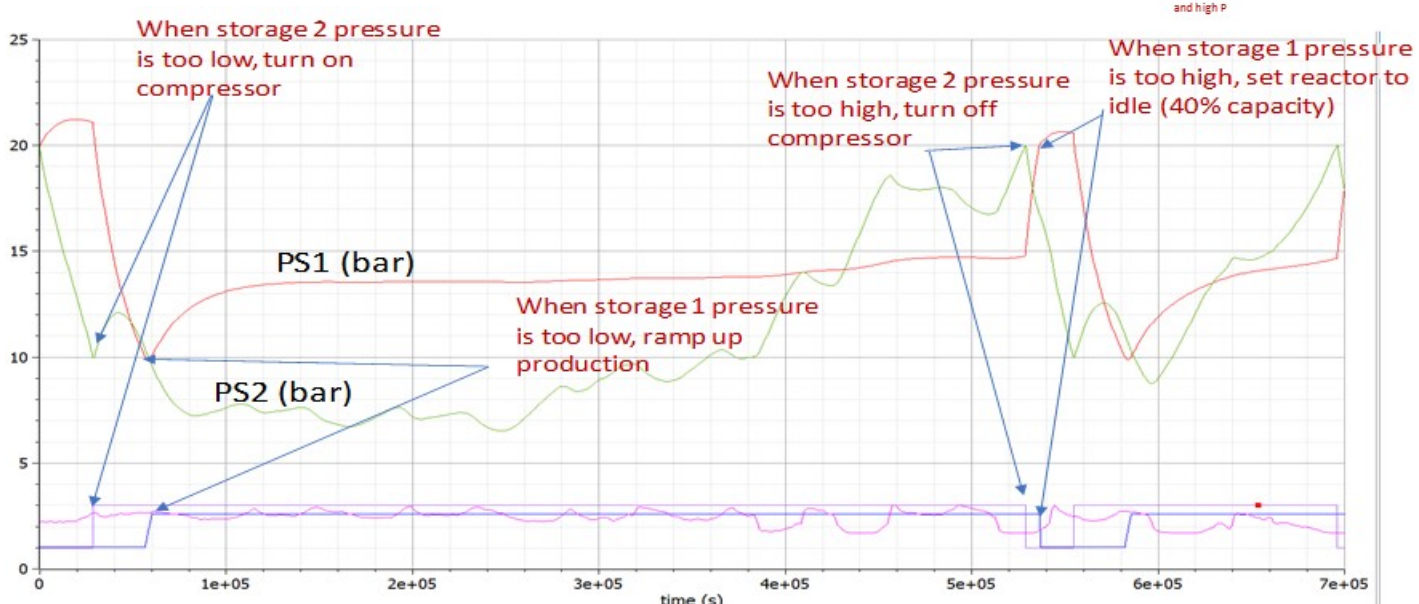
Toolkit developed



Case study



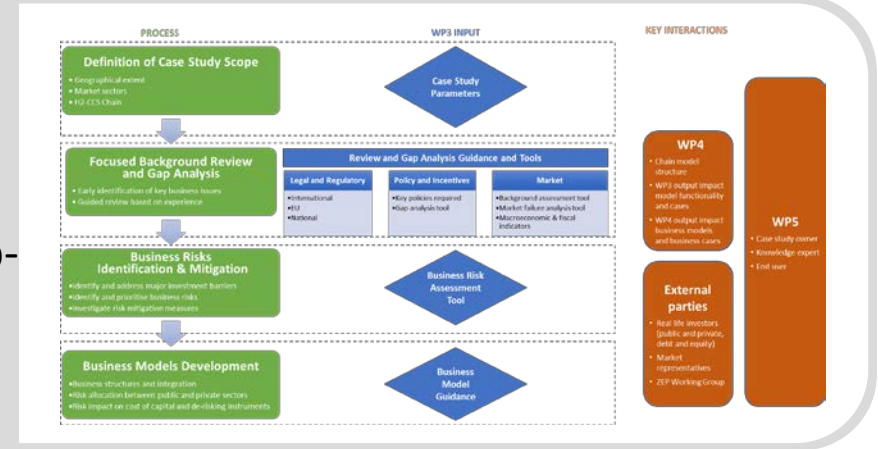
System dynamics



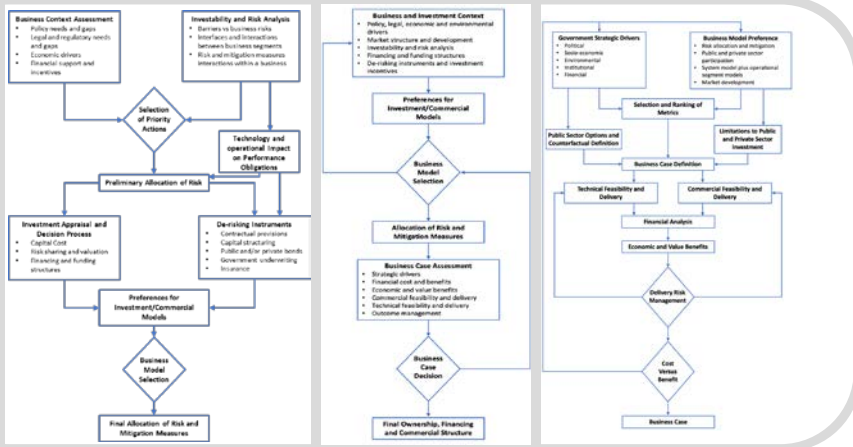
- Pipe diameter = 0.2 m
- Pipe length = 30 km
- Compression ratio (Pr) = 1 or 3
- Storage 1 and 2 50000 m3 (large)
- Storage pressures limited between 1 and 2 MPa
- 1 hr ramp up, 10 mins ramp down (maximum possible ramp rate of ATR-GHRs)

Business model toolkit

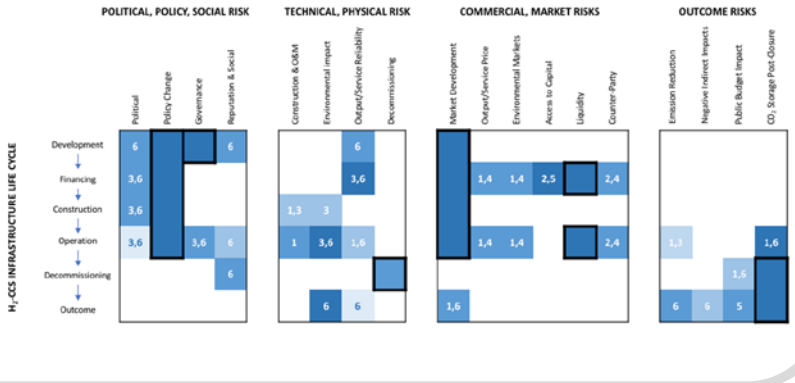
Methodology for business model development



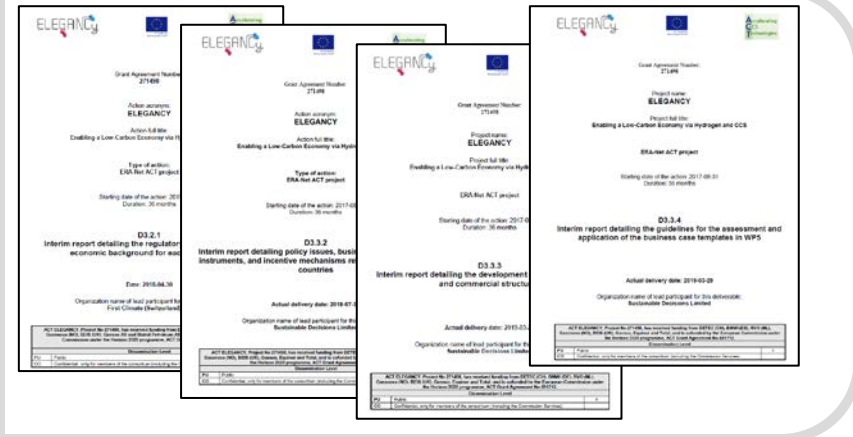
Workflows for business model development and business case assessment



Analytical and visualisation tools for application within and beyond Elegancy



Guidance for each step in the process



WP3 Toolkit for Business Model Selection and Business Case Assessment

- Purpose of the tools
  - **Simplify** the complexity of H2-CCS business environment
  - Enable the user to identify the **key issues** for the project early in the development process
  - **Prioritize** issues and actions to be taken
  - Not about optimization
  - Facilitate **collaboration and engagement** at early stage
  - **Concepts in the tools** are pre-defined and constructed based on literature and reports, existing frameworks, interactions with project partners and external stakeholders, team's own knowledge and experience

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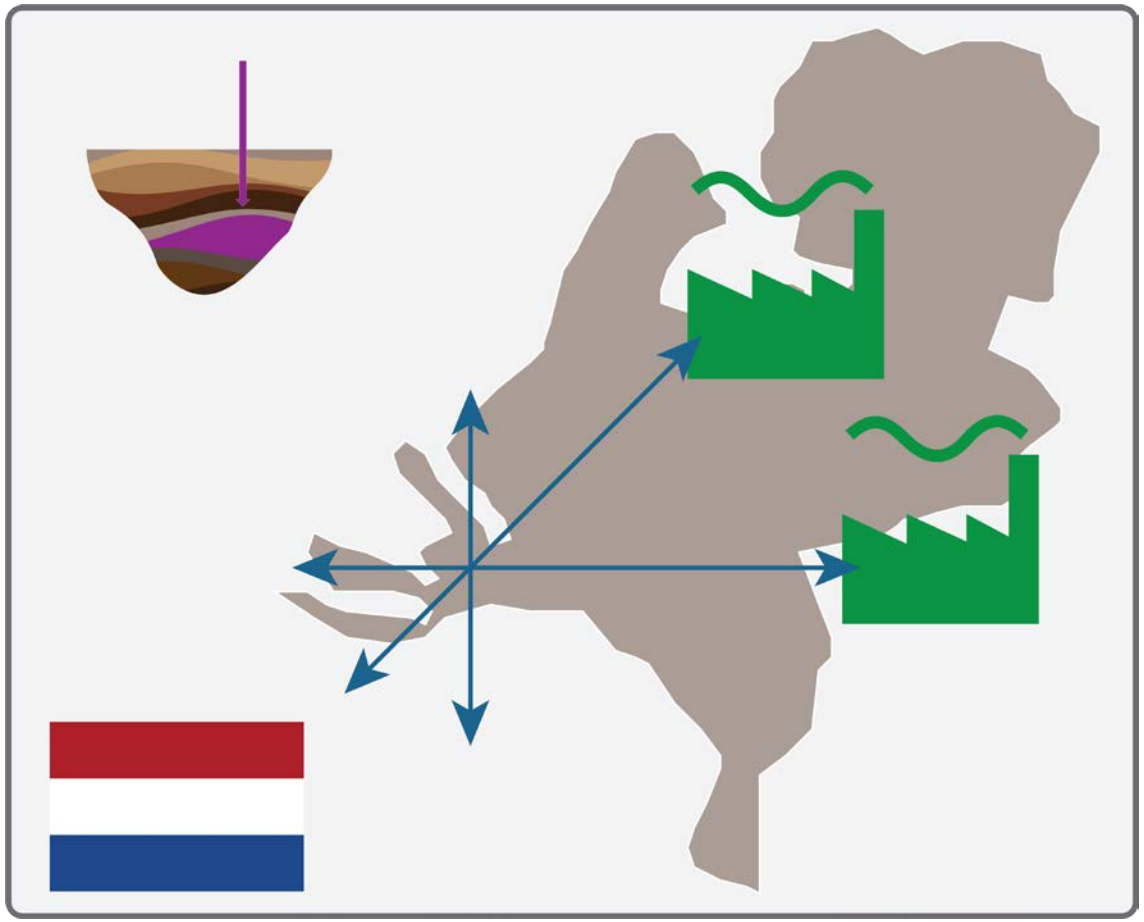
Acknowledgement

ACT ELEGANCY, Project No 271498, has received funding from DETEC (CH), BMWi (DE), RVO (NL), Gassnova (NO), BEIS (UK), Gassco, Equinor and Total, and is cofunded by the European Commission under the Horizon 2020 programme, ACT Grant Agreement No 691712.



Decarbonizing the Dutch economy

- Establishing the H-vision consortium committed to decarbonizing the Rotterdam cluster industry
- Developing a Roadmap for decarbonization of the Dutch economy

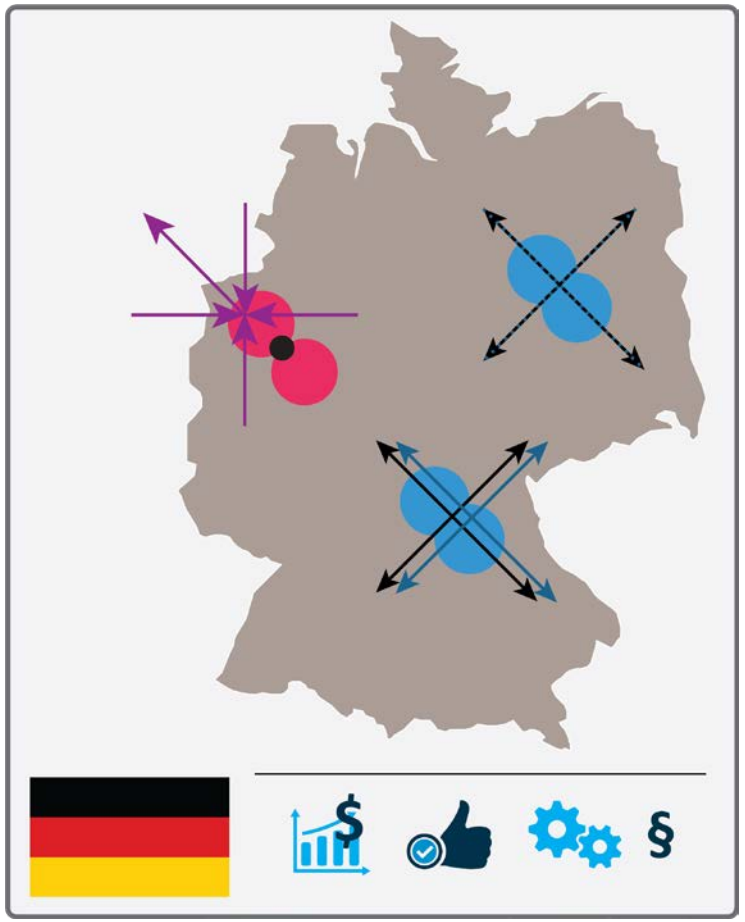
The Norwegian full scale CCS chain and synergies with H_2 production

Showing that large-scale hydrogen production in Norway for export and national demand can help to enable significant economies for scale in the development of a Norwegian CCS infrastructure, thus making Norway furthermore attractive as large-scale CO_2 storage for European CO_2 emissions.

Decarbonization of UK cities and industrial clusters

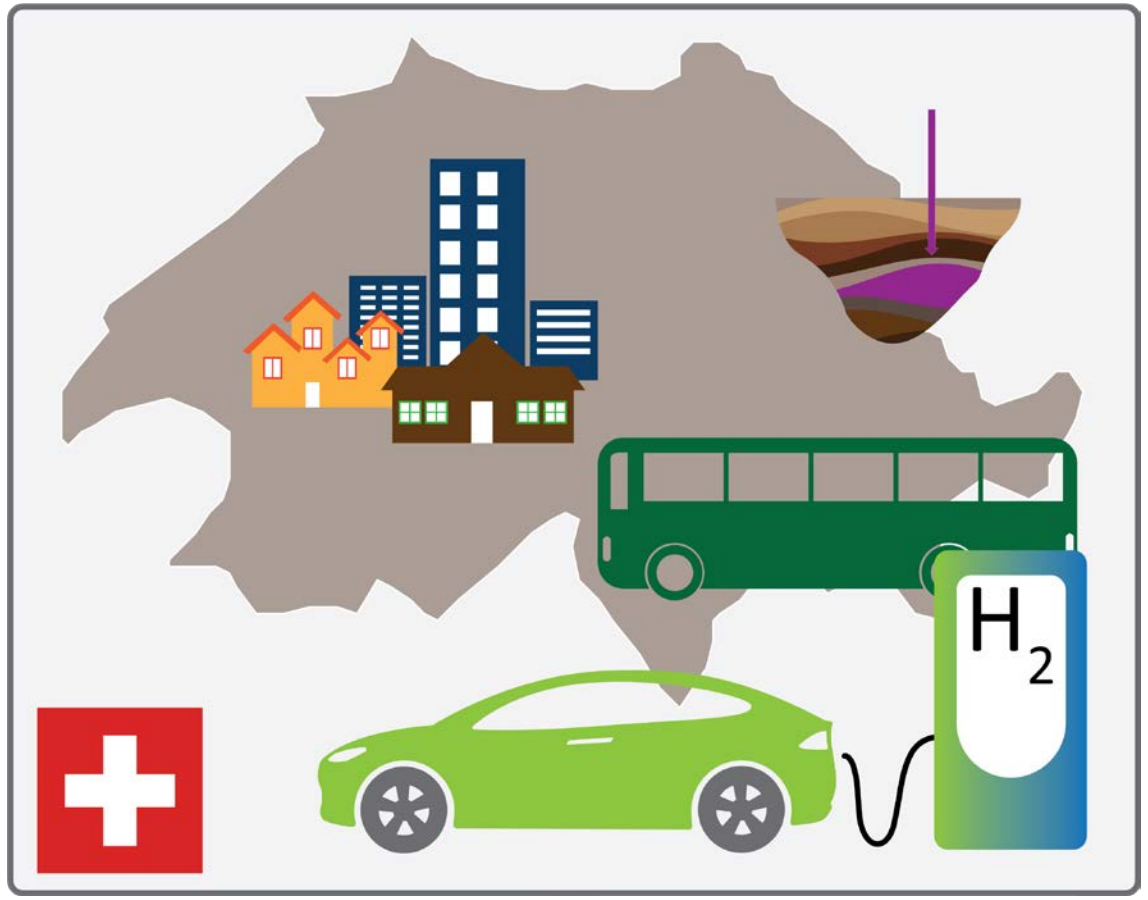
- Identifying the key possibilities and constraints to realise the hydrogen and CCS infrastructure of the H21 Roadmap – in terms of infrastructure development and business case solutions

- Confirming the UK sub-surface storage capacity for hydrogen is sufficient for the decarbonization projects planned for H21 projects at Teesside, and identifying storage capacity and an injection strategy for CO_2 from Grangemouth, including Acorn CCS project, and from Teesside.



Performing a multi-disciplinary analysis and evaluation of carbon capture and hydrogen infrastructures to build a best case option using social acceptance, legal aspects and macro-economic scenarios to understand the prerequisites for a successful transition

Adapting gas infrastructure to H_2 and CCS in Germany



Enabling Swiss CO_2 –free transport by H_2 and CCS

- Identifying the role of hydrogen and CCS for reaching the Swiss climate targets. Negative emissions are required to compensate emissions from non-energy sectors, and to reach the net-zero target in 2050. These are best realized with a combination of hydrogen production from biomass resources and CCS.
- Revealing the need for a two-pronged approach for CCS in Switzerland due to the characteristics of Swiss geology that are challenging for the deployment of CCS:
  - Improve understanding of the Swiss subsurface
  - Develop alternatives, i.e. the export of CO2 to storage sites as it is being planned by the Northern Lights consortium.