International Research Collaboration Developing the Future Energy Grid

Dr Marion Erdelen-Peppler – Secretary General EPRG
Dr Klaas van Alphen – Chair APGA RSC

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TODAY'S STORYLINE

The Energy Transition

The Role of Hydrogen in our future energy grid

International Research Collaboration

EPRG / APGA Research Projects

Conclusion & Outlook

The Energy Transition – an international perspective

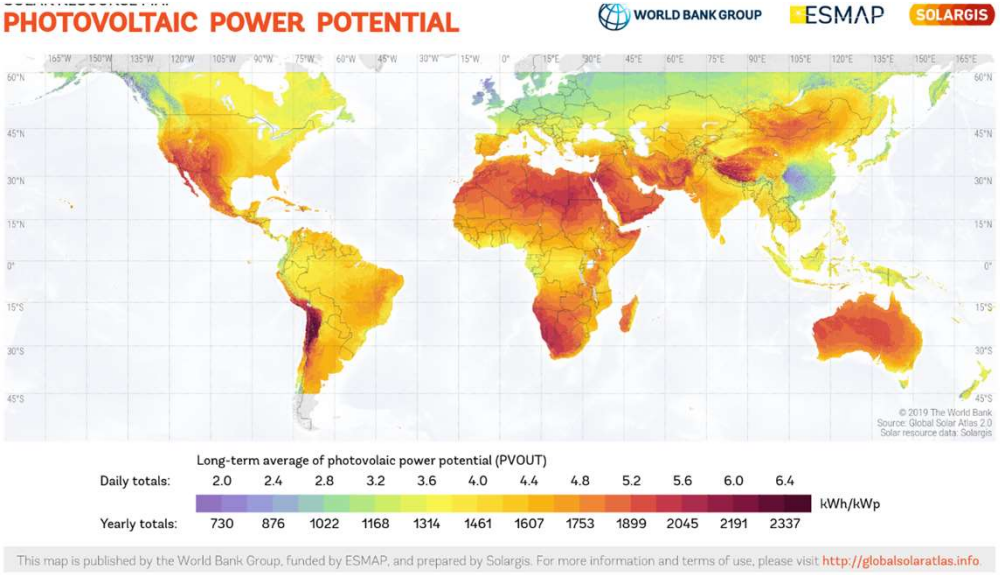
Australia's Long-Term Emissions Reduction Plan: Net Zero 2050

European Green Deal: Net Zero 2050

Potential of renewables – fact sheet solar

- 60% of emitted sun energy or 1.08x1014 kW/s reaches the surface of the earth
- Even if only **0.1%** of this energy could be converted at an **efficiency** of only **10%** it would be **four times** the world's **total generating capacity** of about 3 000 GW

- Total annual solar radiation falling on the earth is >7 500 times the world's total annual primary energy consumption of 450 EJ
- Solar radiation reaching the earth's surface in 1 year (~3 400 000 EJ) is an order of magnitude greater than all the estimated non-renewable energy resources



https://www.worldenergy.org/assets/images/imported/2013/10/WER_2013_8_Solar_revised.pdf

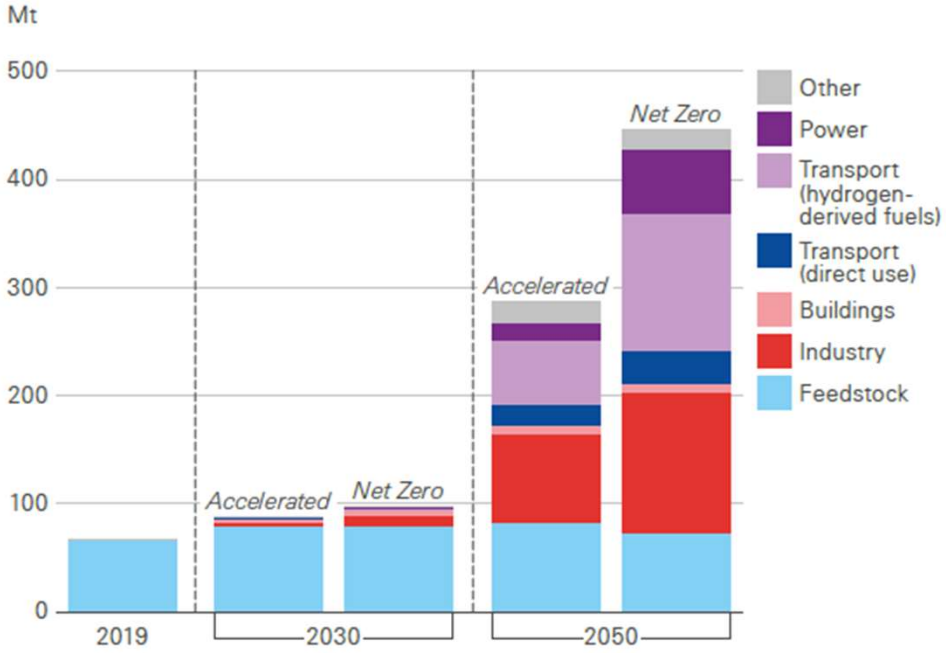
The role of hydrogen in the energy transition

- Renewables share of energy supply growing, and targets suggest further rapid growth
- However, we cannot electrify everything – we need low carbon molecules
  - Natural and renewable gas is critical for hard or expensive-to-electrify energy uses, incl. industrial heat, feedstock, peaking power generation, and heating
  - Cannot efficiently move electrons over long distances (or store in large volumes)
  - Building out electricity transmission grid in a timely matter has challenges
  - Existing gas infrastructure could be repurposed to accommodate renewable gases
  - An integrated clean energy system, combining both electric and low carbon gas networks --> least-cost approach to net zero emissions

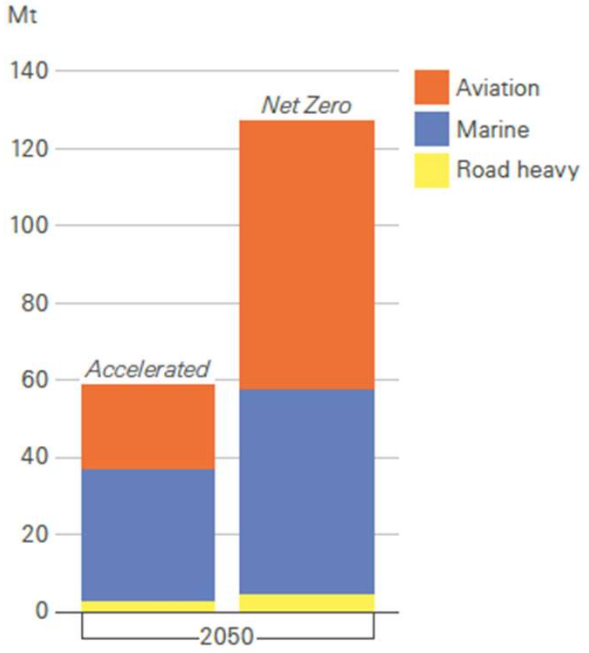
Hydrogen demand

Demand for low-carbon hydrogen grows as the world transitions to a low-carbon energy system

Hydrogen demand by sector

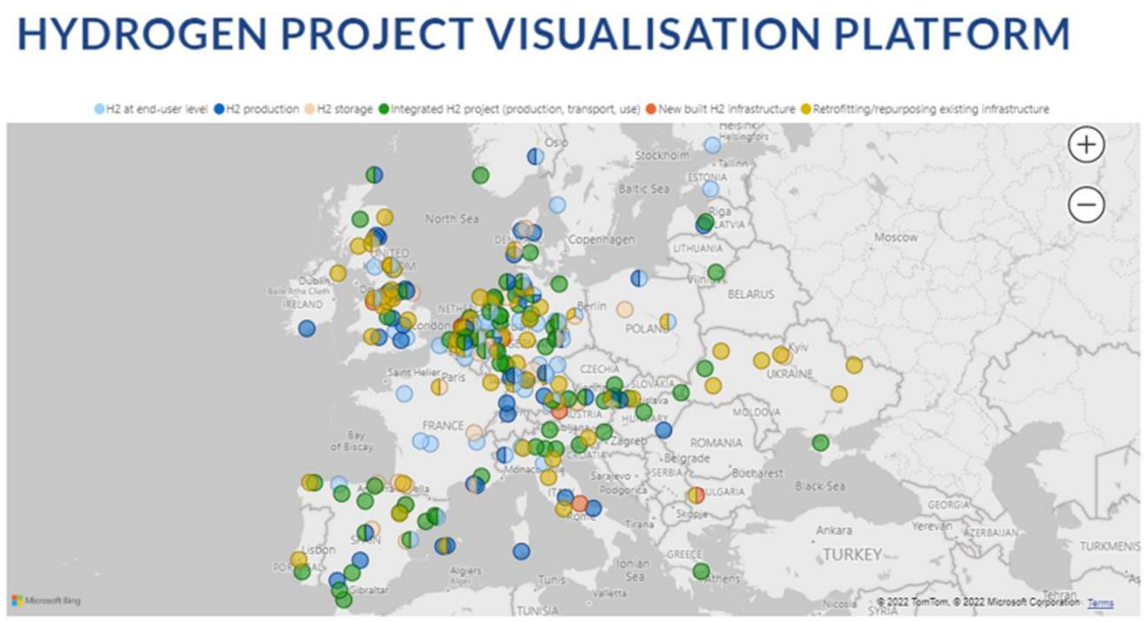


Demand for hydrogen-based fuels



https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2022.pdf

Australian and European project landscape



https://h2-project-visualisation-platform.entsog.eu/

https://research.csiro.au/hyresource/projects/

Hydrogen supply: options and cost

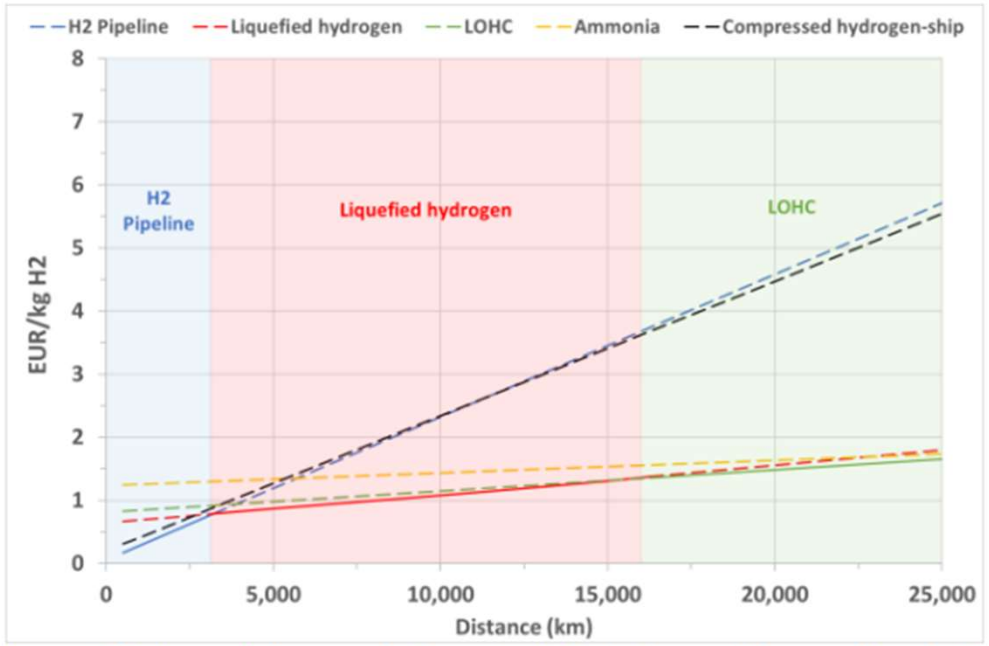


Figure 2 Hydrogen delivery costs for a simple (point to point) transport route, for 1 Mt H_2 and low electricity cost scenario.

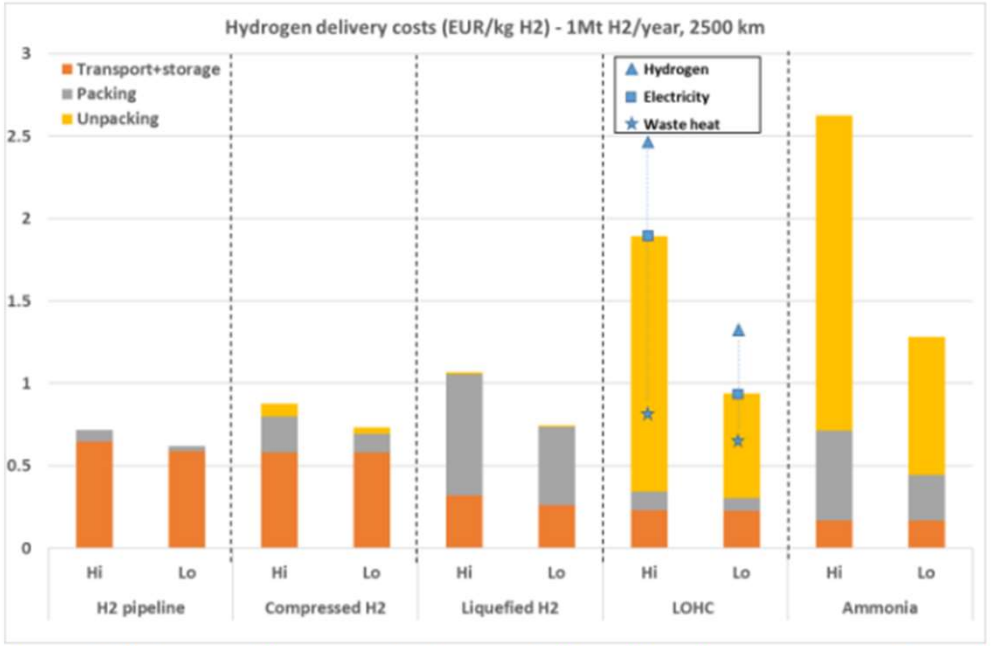


Figure 1 Hydrogen delivery costs for case A. Hi and Lo electricity prices for each carrier. Except for pipelines, all the transport options consist entirely of shipping.

https://joint-research-centre.ec.europa.eu/system/files/2021-06/jrc124206_assessment_of_hydrogen_delivery_options.pdf

Hydrogen supply: future hydrogen networks

- Investment in back bone ~ 80 – 143 bn EUR
- Investment in H2 production value chain 300 – 600 bn EUR over 10 years
- Gasunie (NLD) will invest 5 bn EUR in the next 10 years
- Recent pipeline announcements include:
  - Norway to Germany
  - Netherlands to Germany
  - Spain to France
  - North Africa to Italy

ehb.eu/page/european-hydrogen-backbone-maps

Transitioning safely

- *"Australian governments will not support the blending of hydrogen in existing gas transmission networks until such time as further evidence emerges that hydrogen embrittlement issues can be safely addressed…*
- *…**Industry and researchers will continue to complete relevant research** through initiatives such as the Future Fuels Cooperative Research Centre."*

Australian National Hydrogen Strategy – Nov 2019

Organisational level – Emerging Fuels MoU

The basis for success

A long history of collaboration

- Tri-partite agreement between APGA, EPRG and PRCI
- Bi-annual Joint Technical Meetings (since early 1980's)
- International technical working groups
- Joint research programs (e.g. CO2 pipelines)

CO2 Fracture Propagation Test – EPCRC 2017

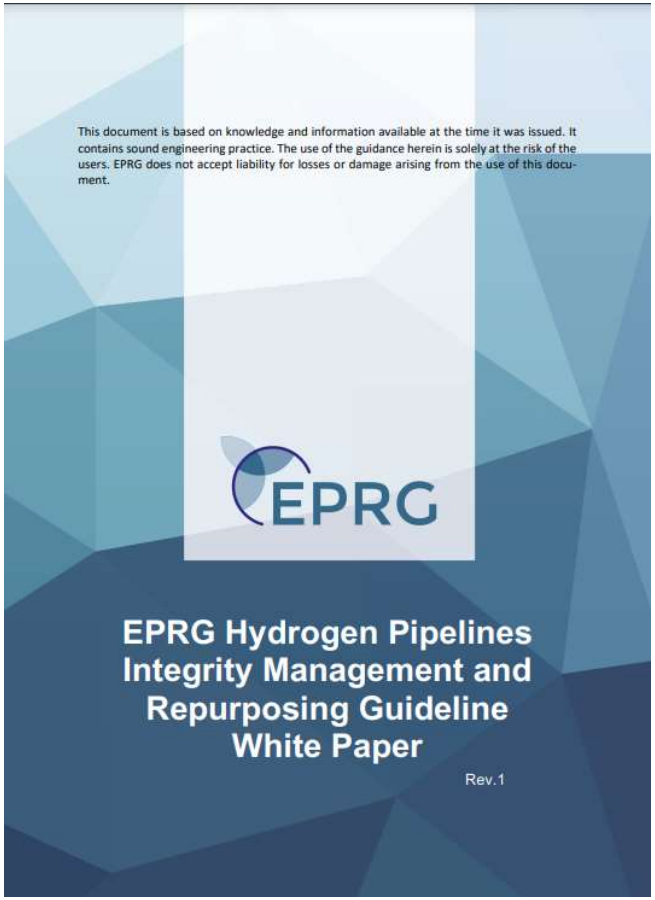
Current Research Projects – A snapshot

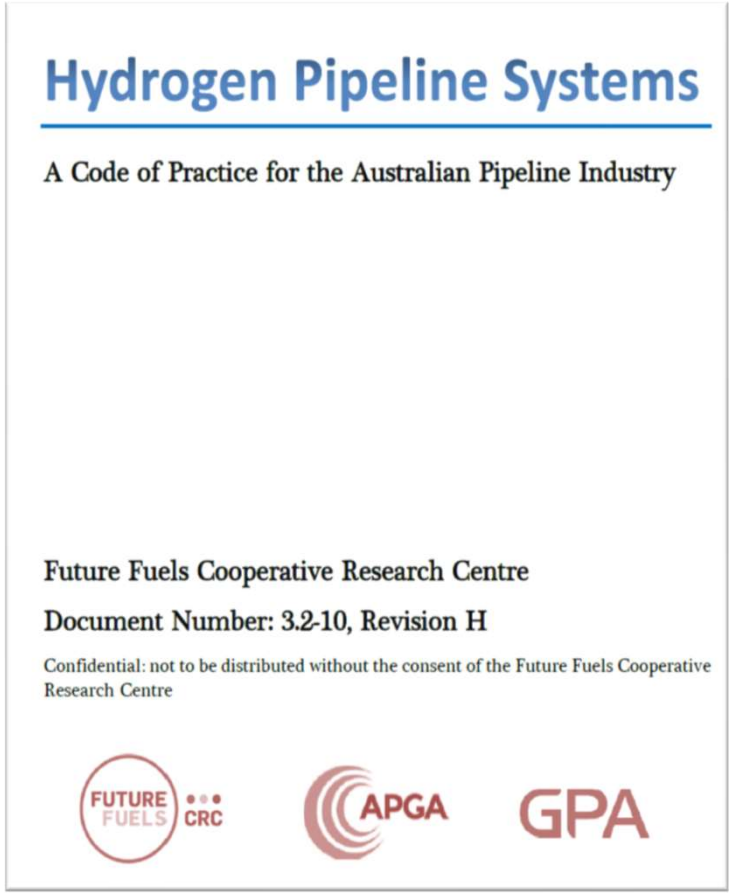
Main topics discussed at Emerging Fuels Symposium – Orlando - June 2023

- Hydrogen material testing
  - Fracture toughness, fatigue
- Full scale (fatigue) testing
- Weld hardness requirements / Hot tap welding
- End-user equipment testing
- Capacity modelling for H2
- Underground H2 storage
- Biomethane impurities
- CO2 pipeline research roadmap
- …..and much more!

Building hydrogen testing capabilities

Providing industry guidance



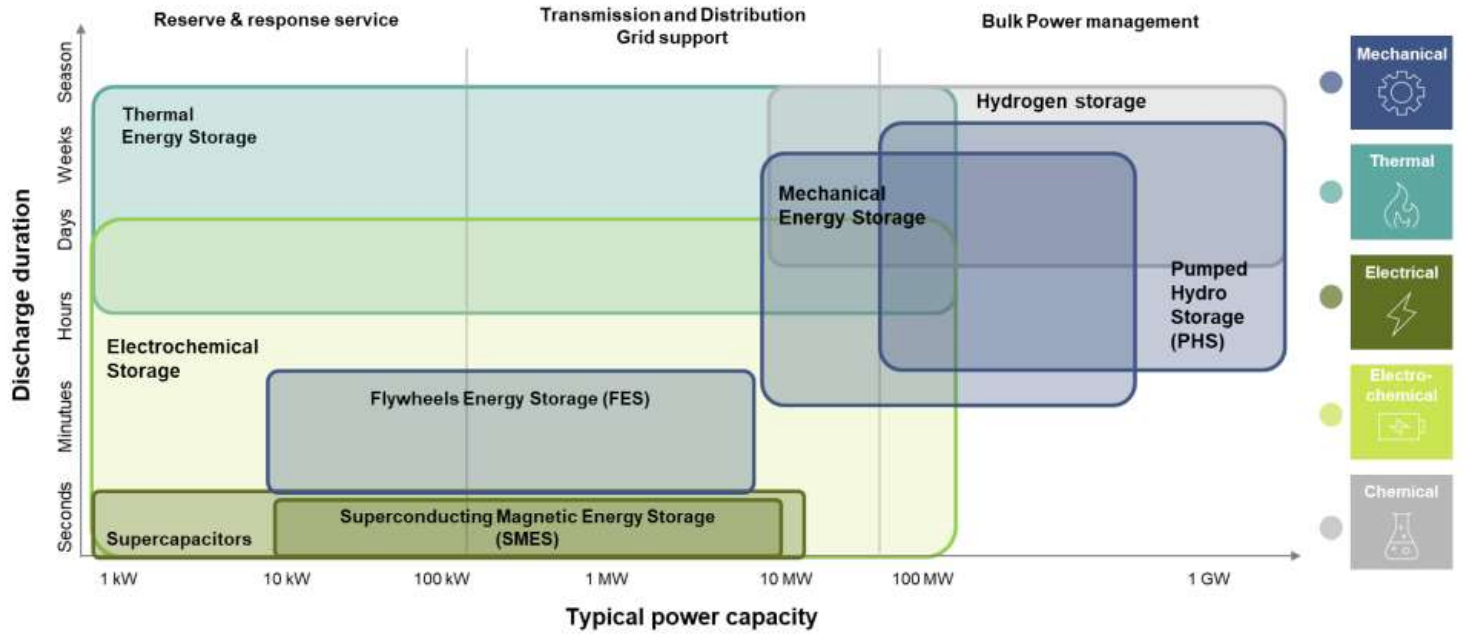


Conclusions and outlook

- Australia and Europe have an enormous decarbonisation challenge ahead, requiring a significant renewable energy build out
- Low carbon gas plays in important role in the energy transition
- Momentum building for the transportation and storage of future fuels such as hydrogen and CO2
- Research is critical to support the safe development, construction and operations of greenfield or reused hydrogen pipelines
- Solid research needs to underpin guidance material and standards to ensure safe and efficient industry practices
- International research collaboration is more important than ever to keep up with the pace of change in the energy system

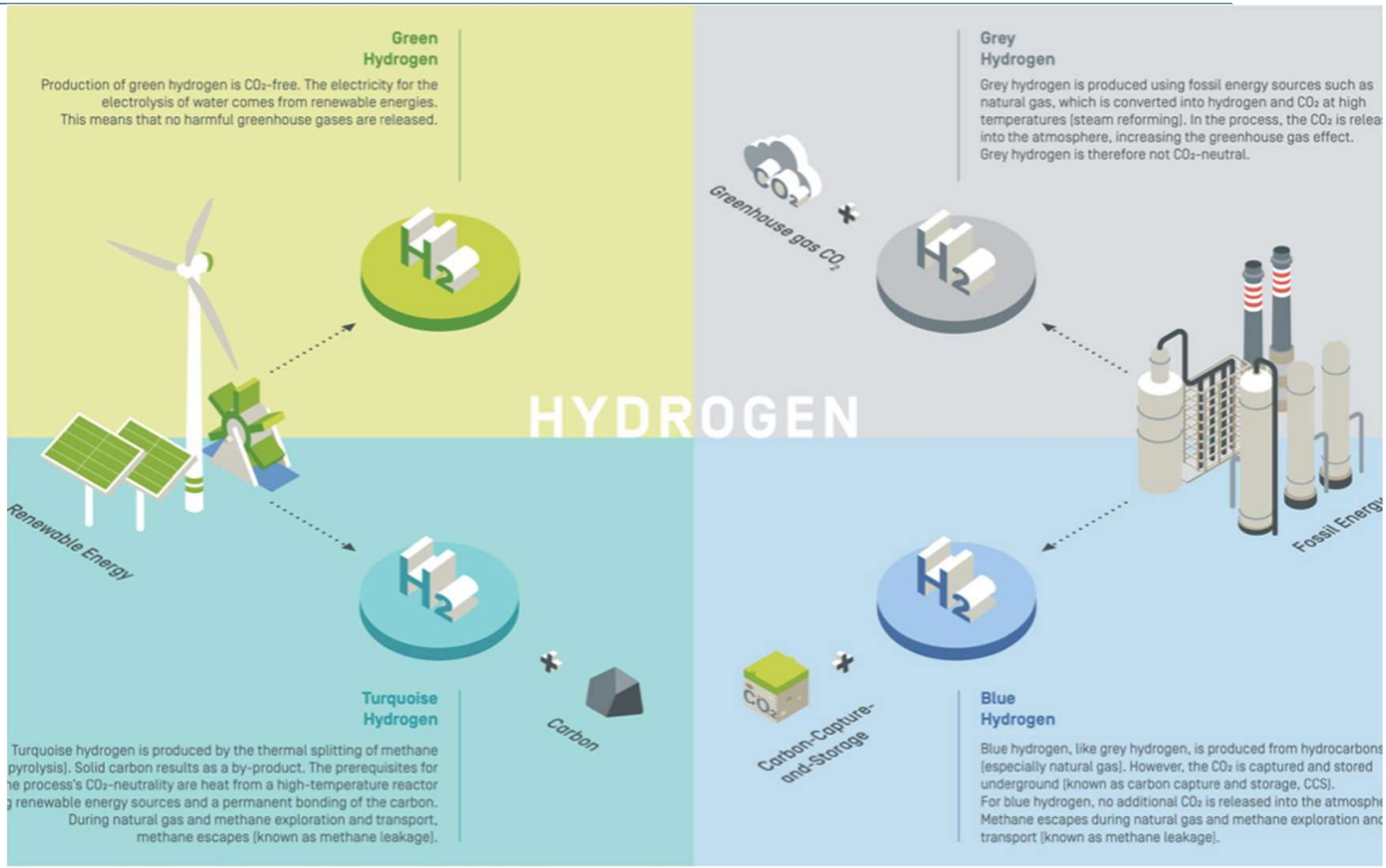
Thank you for your attention

Energy storage

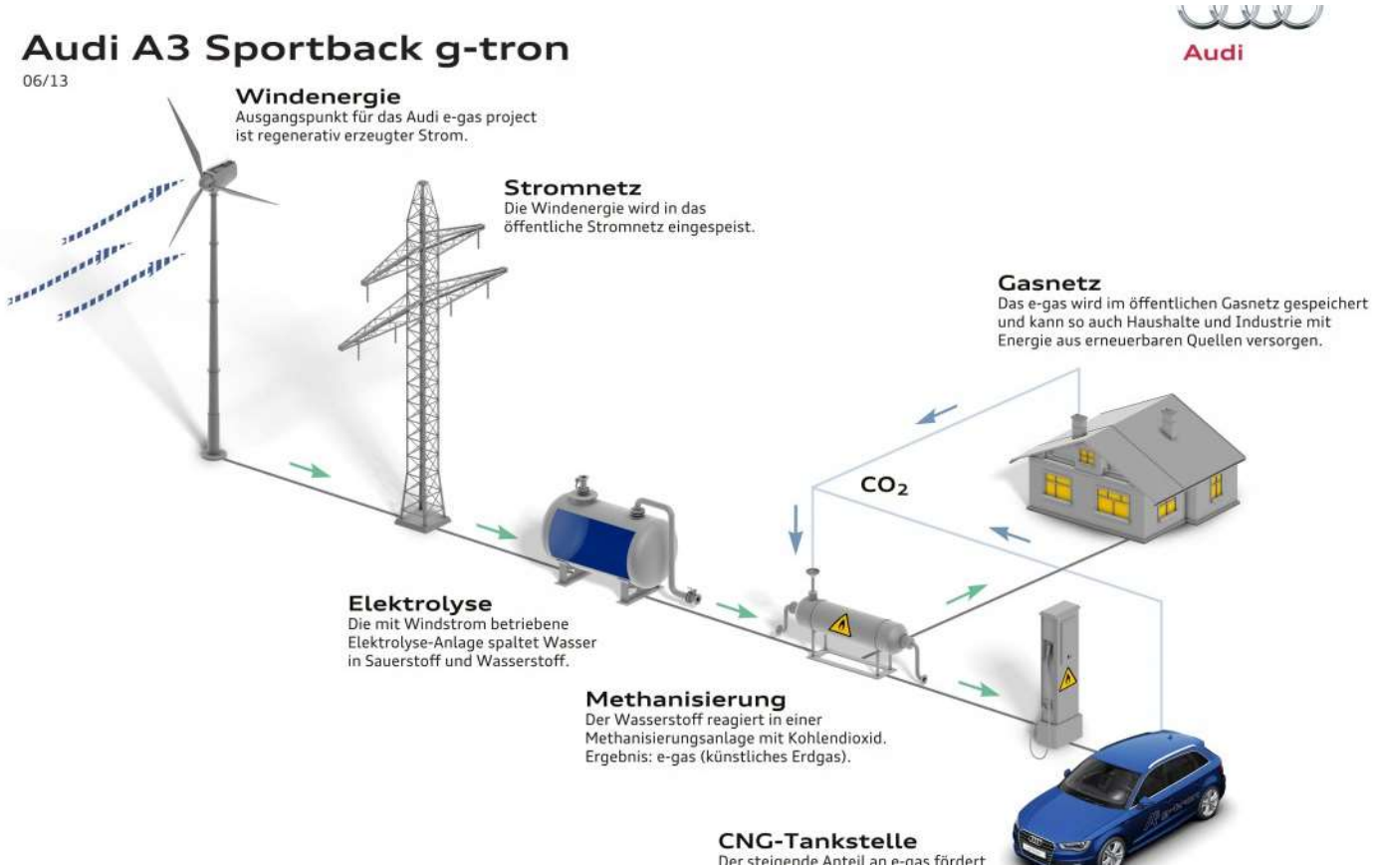


Source: Global Data (2019), IRENA (2020), WEC (2020), BNEF (2020), EU (2020), HEATSTORE project (2021)

The colours of hydrogen



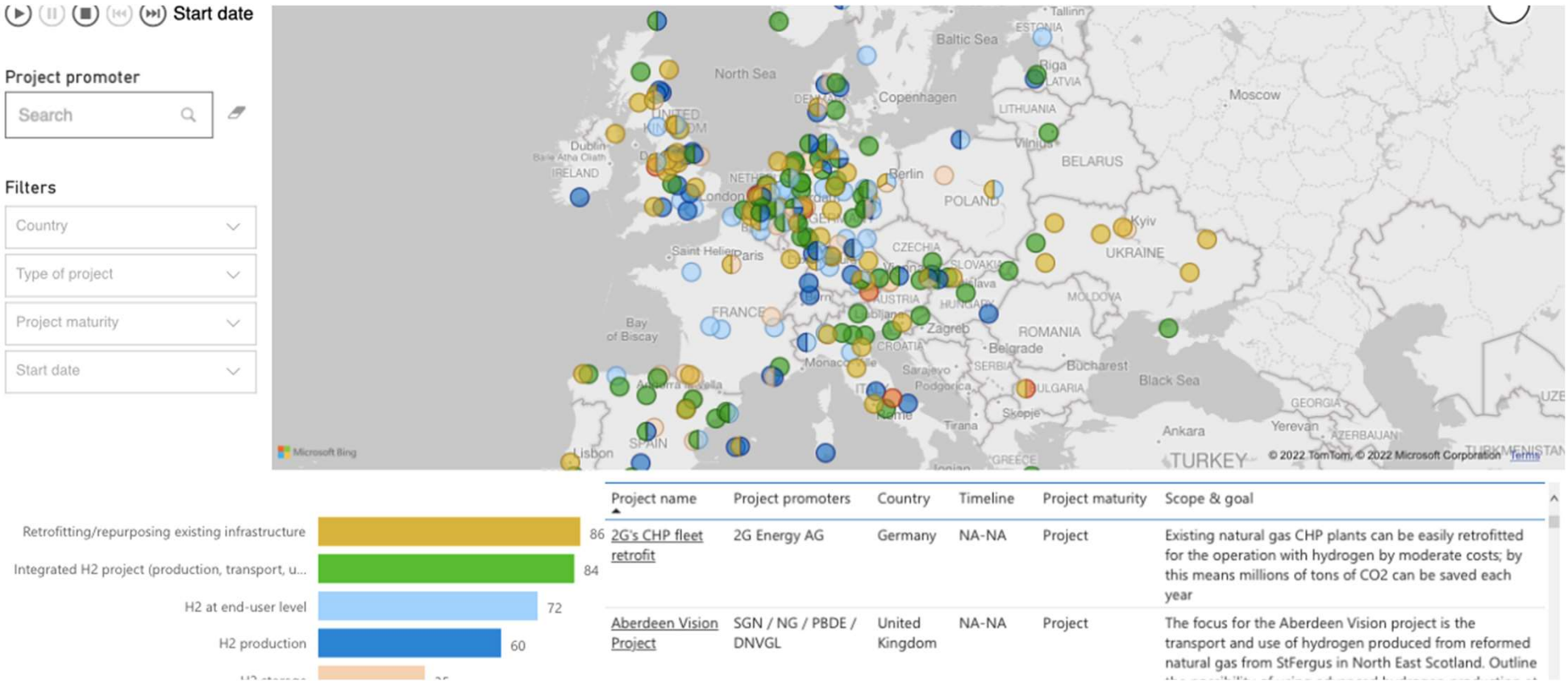
Mobility and e-fuels



E-fuels: CNG

https://www.audi-technology-portal.de

European funded project landscape

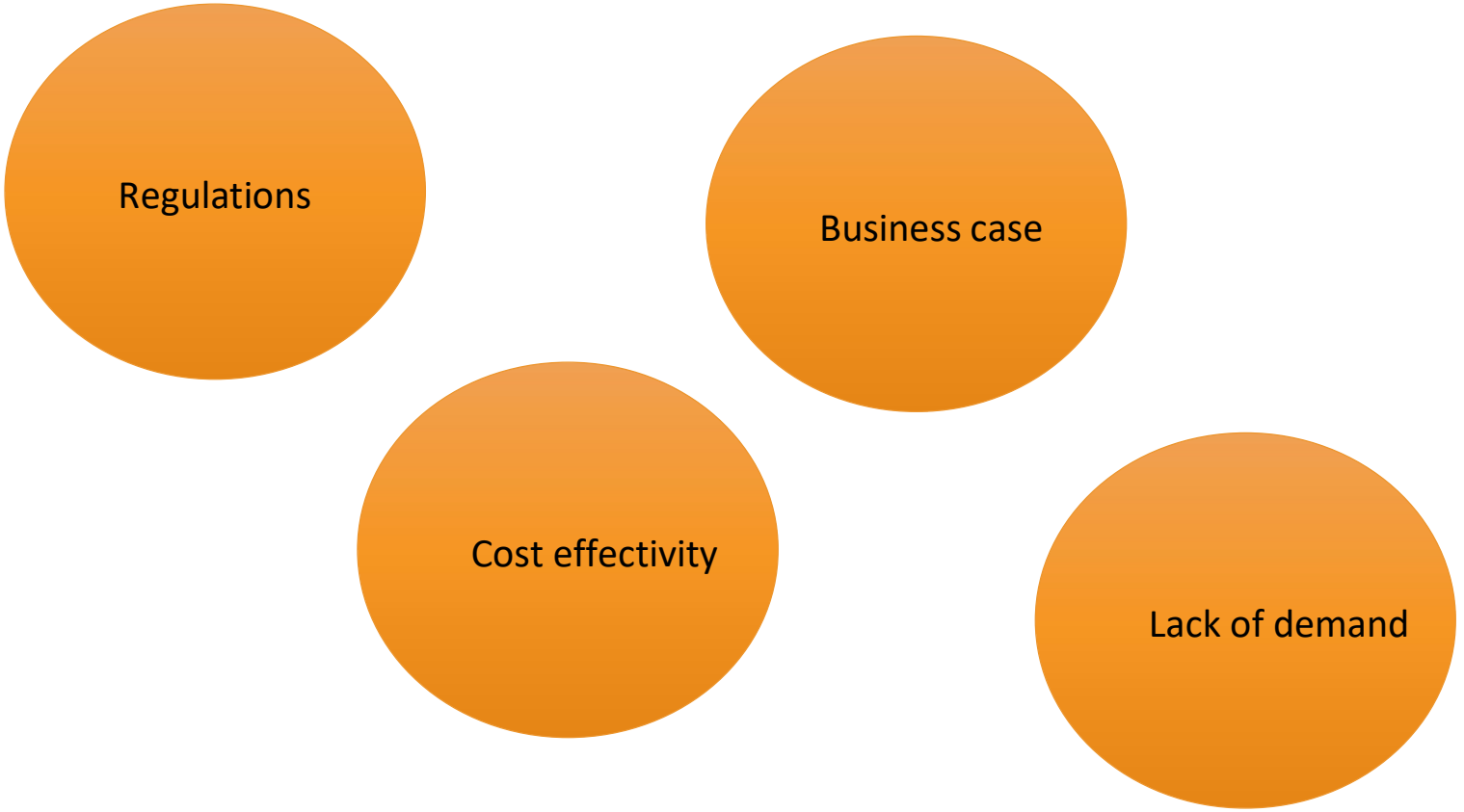


Project name	Project promoters	Country	Timeline	Project maturity	Scope & goal
2G's CHP fleet retrofit	2G Energy AG	Germany	NA-NA	Project	Existing natural gas CHP plants can be easily retrofitted for the operation with hydrogen by moderate costs; by this means millions of tons of CO2 can be saved each year
Aberdeen Vision Project	SGN / NG / PBDE / DNVGL	United Kingdom	NA-NA	Project	The focus for the Aberdeen Vision project is the transport and use of hydrogen produced from reformed natural gas from StFergus in North East Scotland. Outline

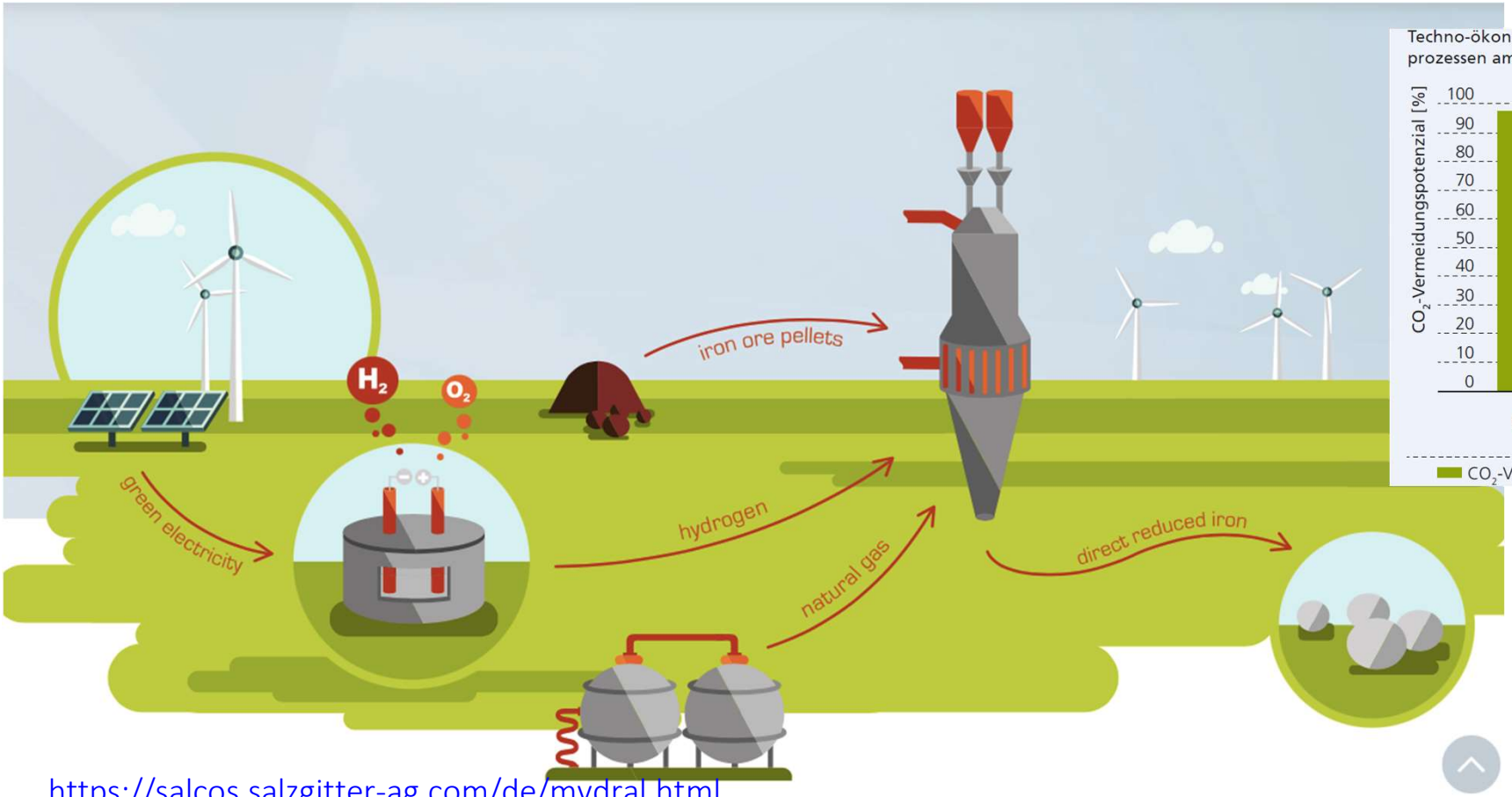
Funded project landscape

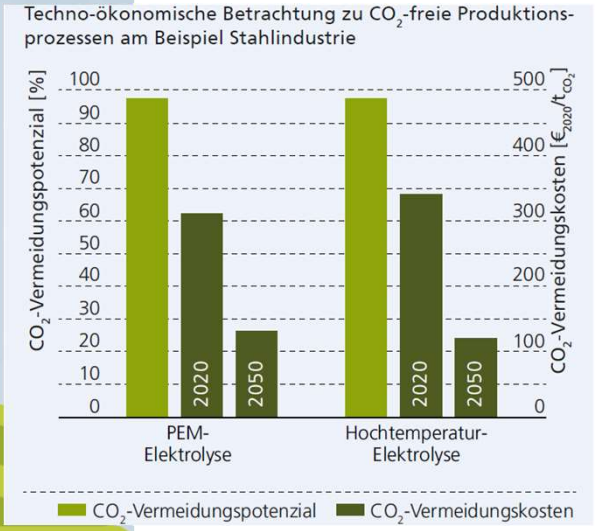
https://h2-project-visualisation-platform.entsog.eu

Barriers


Regulations
Business case
Cost effectivity
Lack of demand

Industrial applications





https://salcos.salzgitter-ag.com/de/mydral.html