Study on development of water electrolysis in the EU

IEA Annex 30 Workshop, Herten, Germany

MEGASTACK Workshop

Franz Lehner, 20 April 2015

Outline

- Objectives of the study
- Study approach
- Main messages
- Electrolyser status and technical trends
- Techno-economic analysis approach and sample results
- Summary of key study insights

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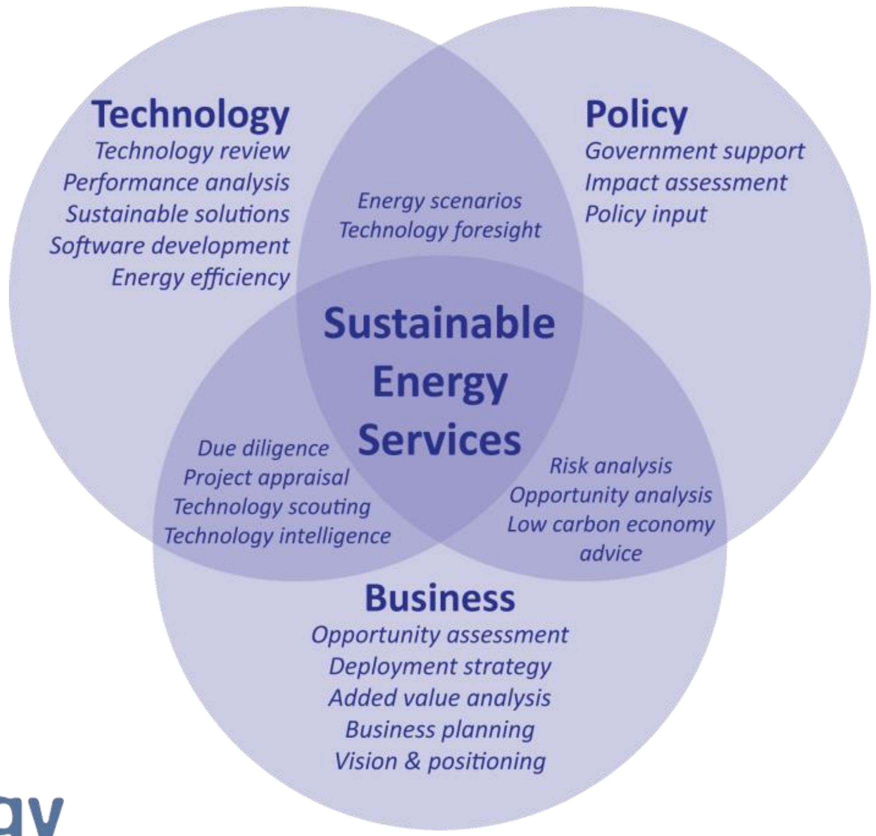
Objectives of the study

- Document stakeholder expectations on the status and development of water electrolysis technology
- Provide insight into the conditions necessary for the commercial viability of water electrolysis in emerging energy applications
- Identify technology development priorities to support progress towards commercial viability
- Provide an evidence base to inform FCH2 JU research priorities

E4tech is…

- An international consulting firm, offices in UK and Switzerland
- Established 1997, always independent
- Focus on sustainable energy
- Deep expertise in technology, business and strategy, market assessment, techno-economic modelling, policy support…
- A spectrum of clients from start-ups to global corporations



- We worked with on this study elementenergy

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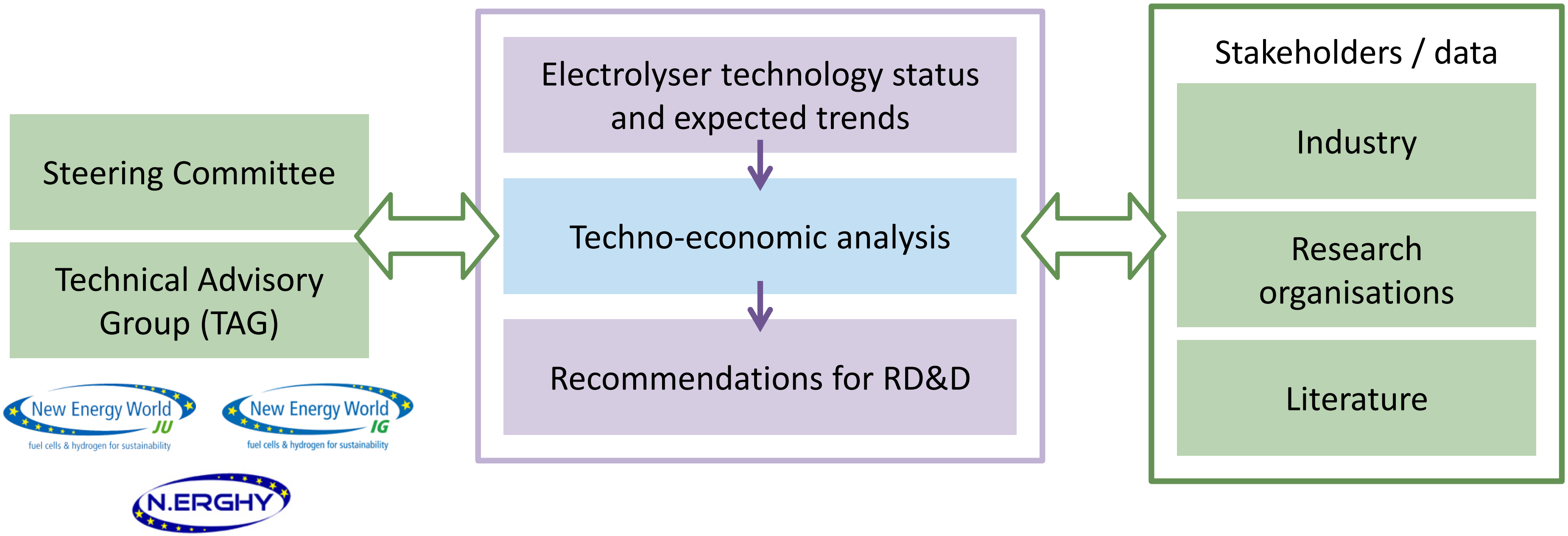
The study carefully compared water electrolysis options with their competing alternatives to examine viability



Task lead

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Water electrolysis can be commercially viable in transport applications – and some others – by 2030

- Water electrolysis (WE) can be a commercially viable element of the future energy system
  - Hydrogen for transport
  - Industrial hydrogen uses
- Gigawatt scale cumulative deployment is plausible by 2030
  - In line with stakeholder expectations
  - Coherent with emerging hydrogen infrastructure plans
- But this is hard to achieve and requires:
  - Continued technology development and cost reduction
  - Supportive regulatory and policy framework conditions
  - Clear requirements for emerging WE energy applications

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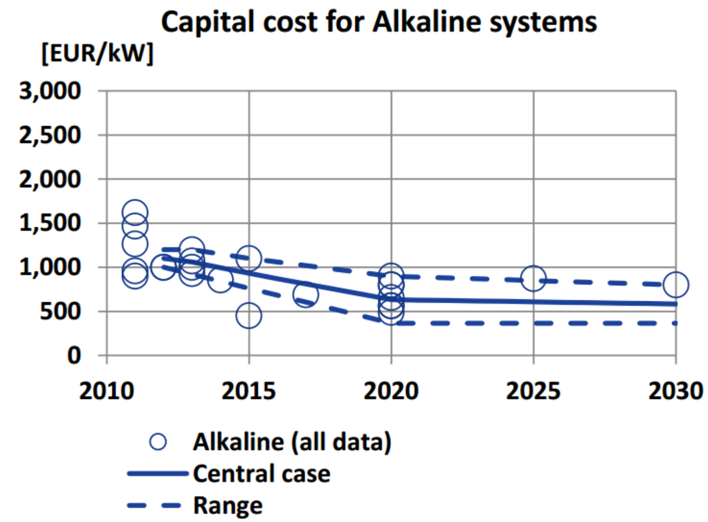
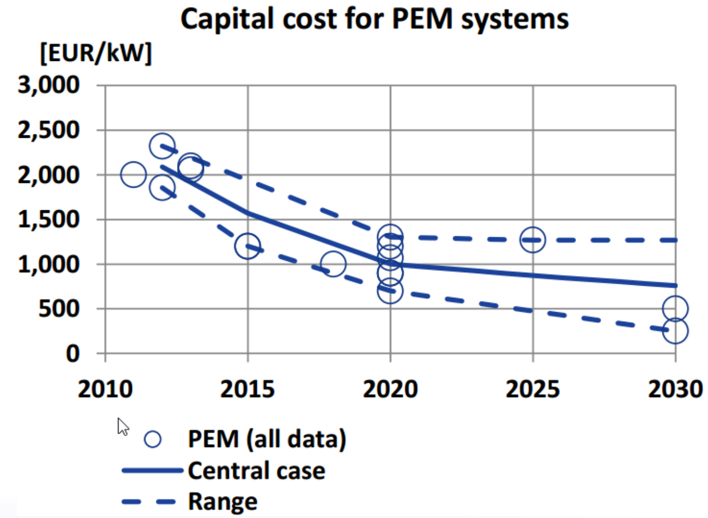
Data from literature and stakeholders allowed us to put together KPI* trends to underpin the analysis

- Data sources included literature and interviews with stakeholders
- KPIs were validated with the project TAG
- KPIs collected include:
  - specific capex
  - efficiency
  - system and stack size
  - lifetime
  - dynamic characteristics
  - system pressure
  - opex
  - availability
  - current density





* Key Performance Indicator

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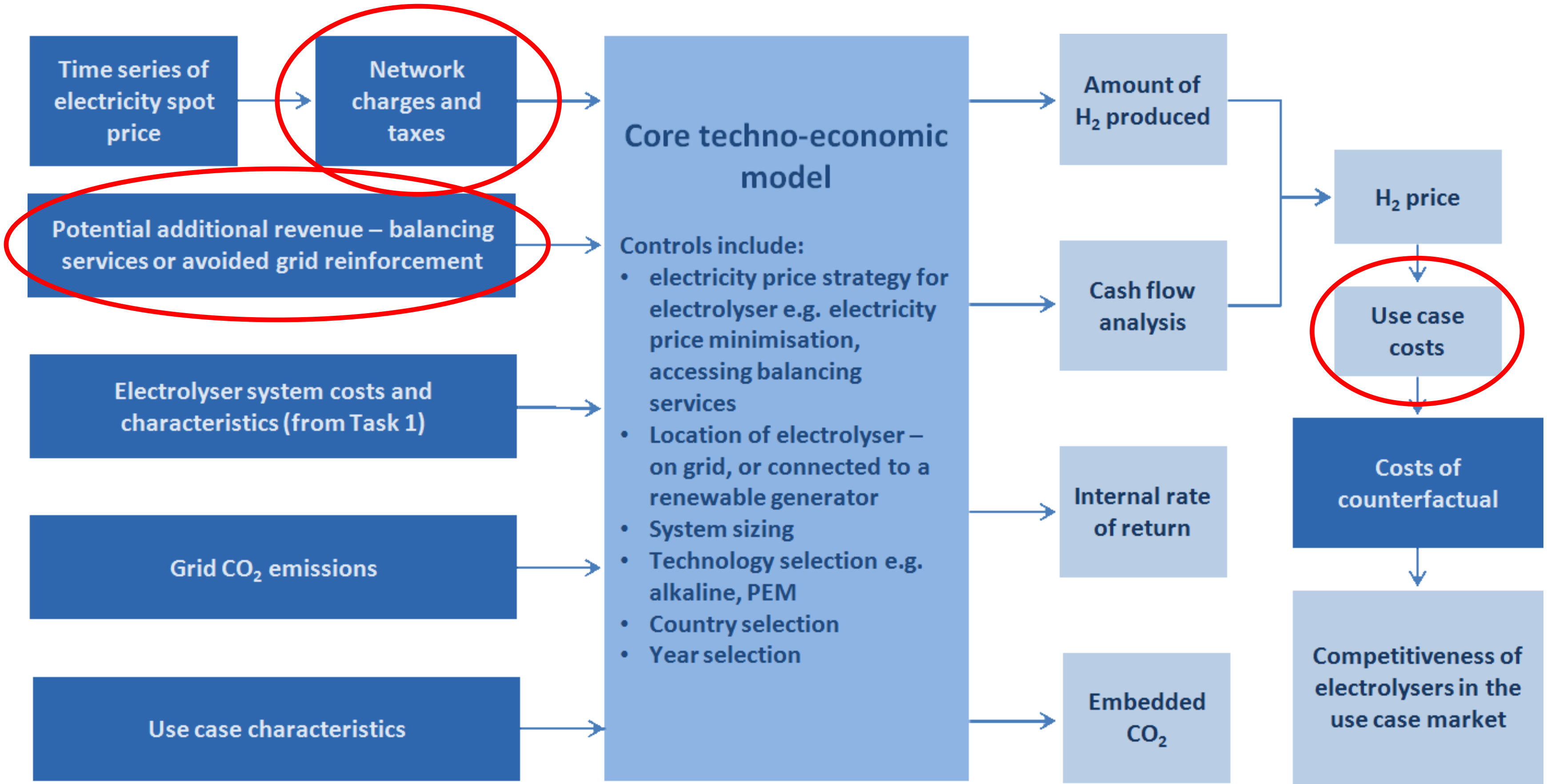
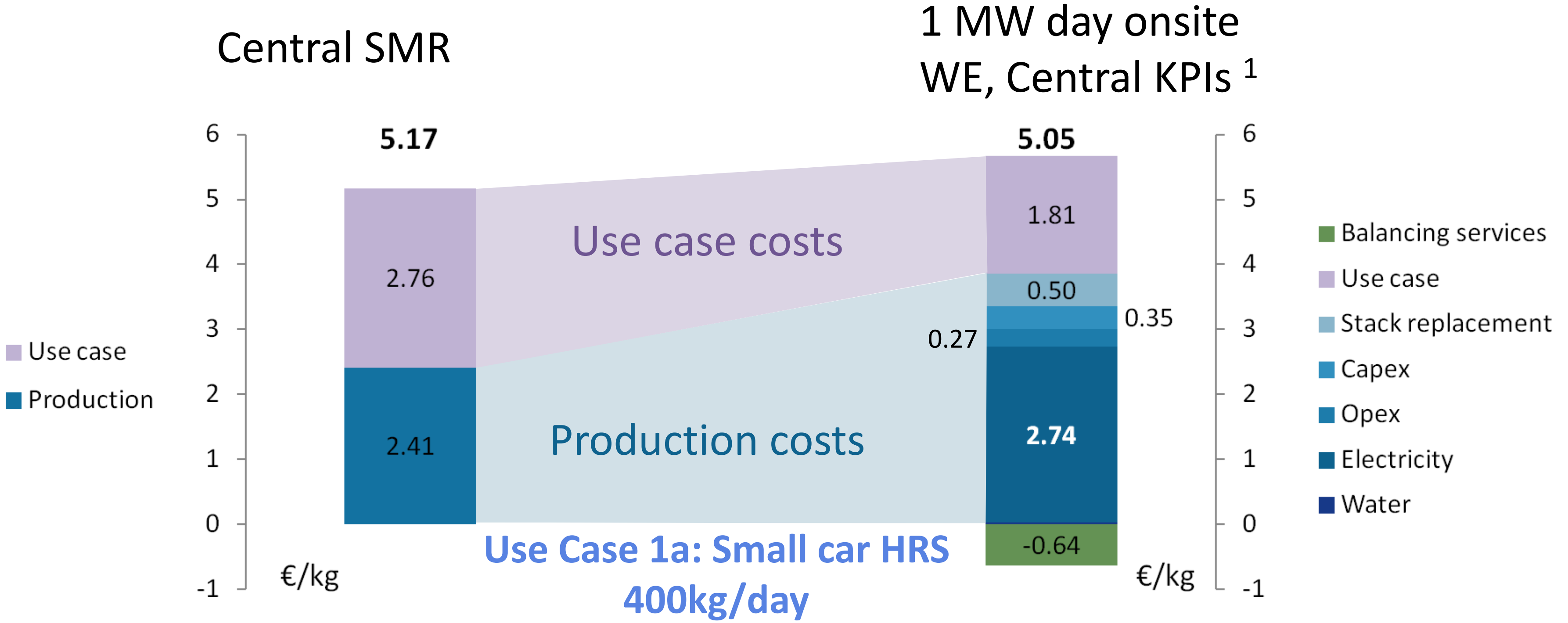
Techno-economic analysis (TEA) of a set of use cases was primarily compared to SMR*



* Steam Methane Reforming

The TEA calculated the total point-of-use hydrogen cost for a range of use cases and counterfactuals



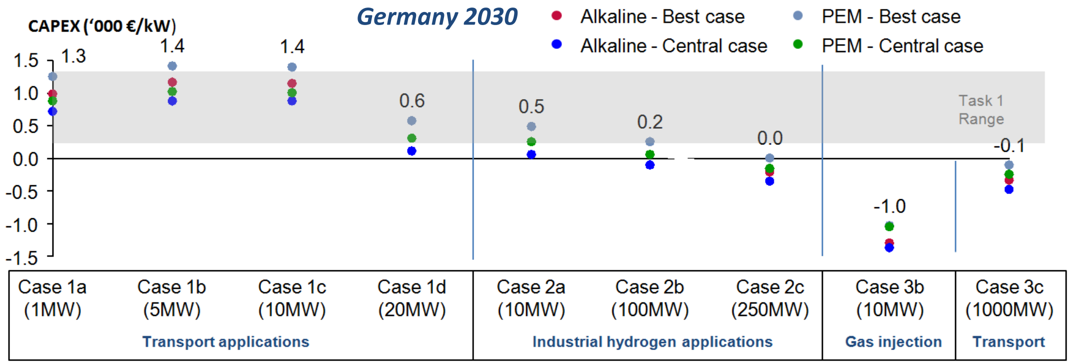
- Here, WE production cost is *higher* but final cost of hydrogen is *lower* at the refuelling station – due in part to revenues from balancing services
- Use case costs include refuelling station costs, compression, storage, and distribution as appropriate

[1] Germany 2030. PEM Water Electrolysers. Electricity price strategy: response services

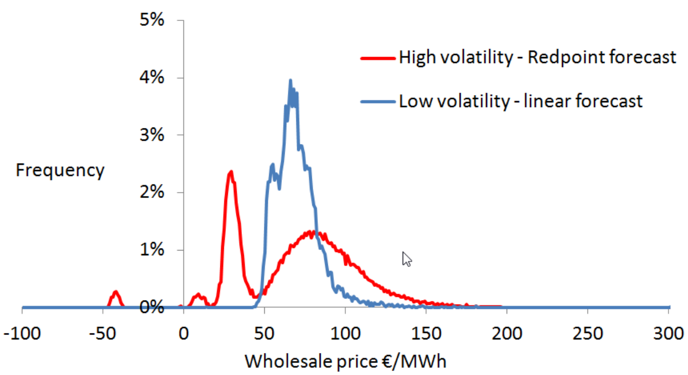
Full details of the analyses conducted are in the project report

Sensitivity analysis

- Capex
- Efficiency
- CO_2 price

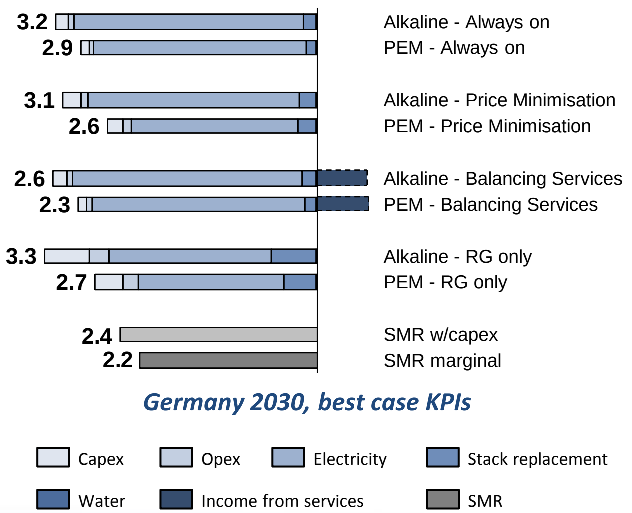


Electricity price volatility



Graph to show two scenarios for the volatility of UK electricity prices in 2030. The linear forecast takes the 2012 electricity spot price frequency distribution and modifies it to be consistent with the DG ENER price for 2030. The Redpoint forecast takes the "environmentally favourable conditions" frequency distribution curve (i.e. a high renewables penetration scenario) for 2030 and modifies it so that the mean is consistent with the DG ENER for 2030.

WE operational strategy



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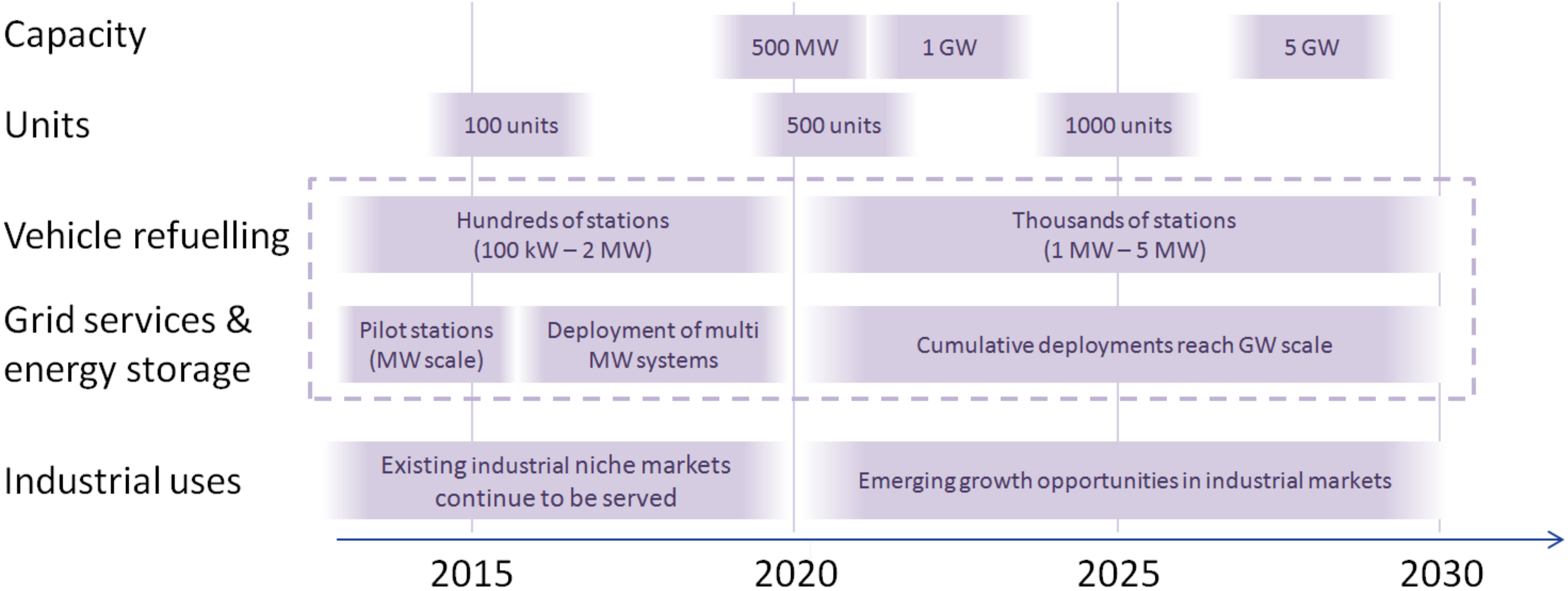
Insights from the study included several conditions that affect WE commercial viability

- The **cost** of electrolytic hydrogen is **dominated by the cost of electricity** (in high electrolyser utilisation use cases)
- Electrolyser capex is sufficiently high that **high utilisation is necessary** to amortise the system cost sufficiently
- **Distributed applications**, such as onsite production for vehicle refuelling, avoid high distribution costs
- A **favourable regulatory framework** can greatly reduce the effective cost of electrolytic hydrogen
- Continued or accelerated **technology development** pushes electrolyser KPIs towards the "better" edge of expectations
- A **high carbon price** increases the value of low carbon electrolytic hydrogen
- **Increased electricity price volatility** *could* provide meaningful quantities of low cost electricity

In markets with favourable conditions, WE could compete in vehicle refuelling applications by 2030

- Where favourable conditions already exist, such as in Germany, water electrolysis (WE) should reach competitiveness with large SMR by 2030 – for vehicle refuelling
- Broader adoption of such favourable conditions could extend the commercially viable markets for water electrolysis
- Maturation and rationalisation of the electrolyser manufacturing base and supply chain could:
  - bring down specific costs
  - broaden the range of viable use cases to include some industrial applications
- Hydrogen injection into the gas grid and re-electrification are likely to require significant policy support to be competitive

Gigawatt scale WE deployments by 2030 are coherent with stated hydrogen infrastructure plans



- Although vehicle refuelling seems the most viable application, the concurrent provision of grid services will be necessary to support this deployment
- GW scale cumulative deployments seem realisable by 2030, in line with stakeholder expectations

Specific areas require further research, and the electrolyser industry must evolve

- Stakeholder engagement highlighted areas that need further research
  - Detailed requirements for emerging electrolyser applications
  - Definition of standard test and duty cycles, particularly for dynamic operation
  - Demonstration of – and data on – dynamic operation and impact on system life
  - Clarification of novel use cases for emerging technology like SOEC
- The electrolyser industry will need to evolve significantly to capture emerging opportunities
  - Current commercial electrolysers are essentially mature, but system designs may not be well suited for new applications
  - Industry and supply chain are fragmented and will need to be rationalised to drive down costs

Acknowledgements

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  - Roel De Maeyer, Hydrogenics
  - Klaus Dieter Scheffer, Siemens
  - Ulrich Stimming, TUM
  - Daniel Hustadt, Vattenfall

- All interviewees

Thank you

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