Qualifying tests and economic analysis of electrolysers for grid services

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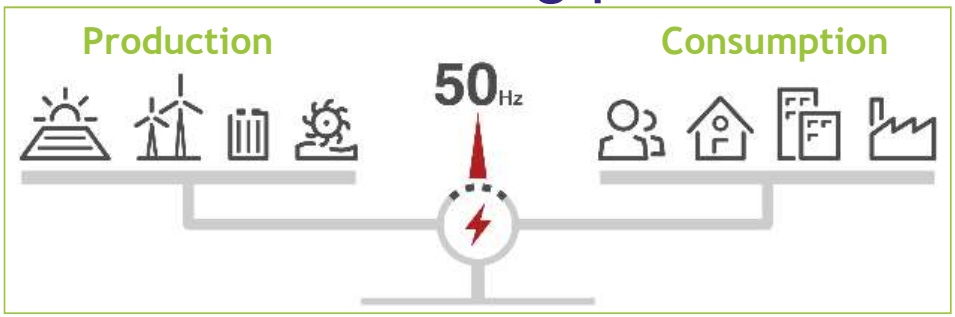
Rationale

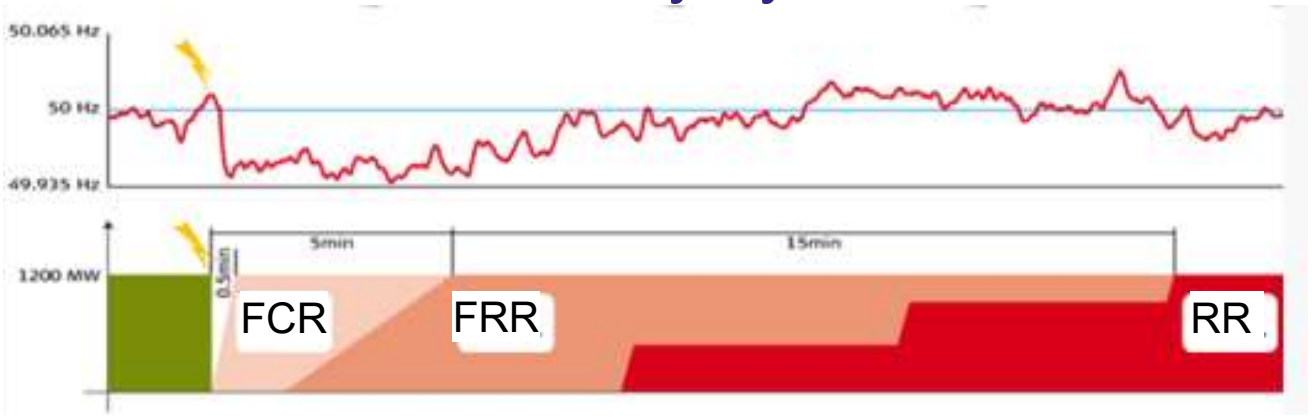
- Strong market entry of electrolysers today still limited by costs
- Performing electricity grid services → possibly improved revenues for electrolysers
- Approved and standardised electrolysers tests to verify which service an electrolyser can perform → help OEMs and customers

Electricity Grid Services Europe

- TSO use grid services for balancing production and consumption

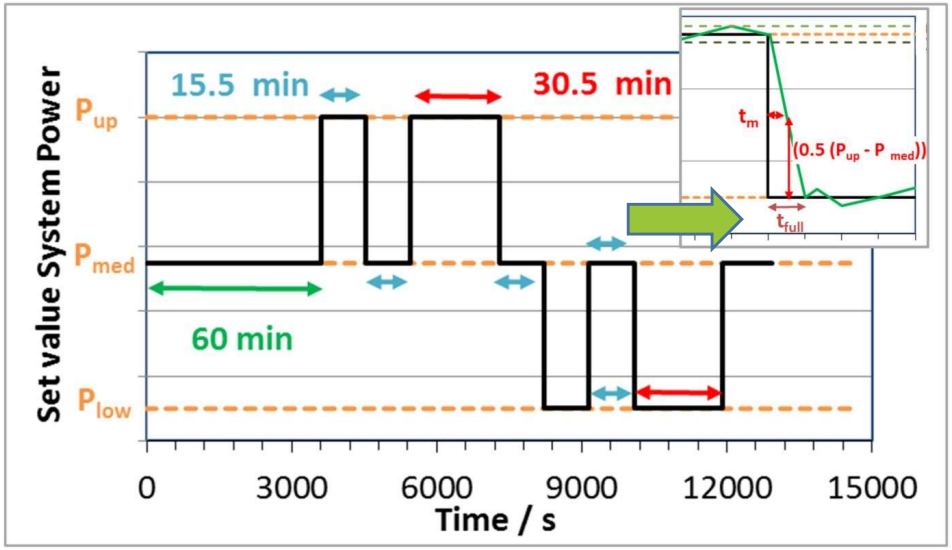


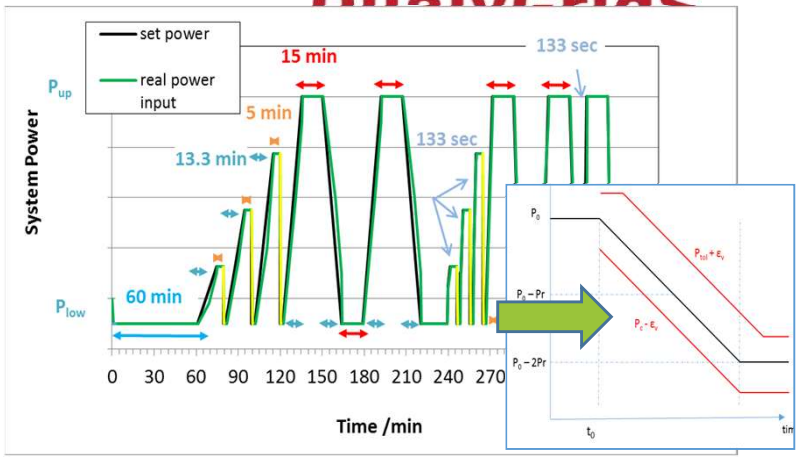
- Increase/decrease electricity production or consumption on request
- Differentiation of services mostly by time for activation

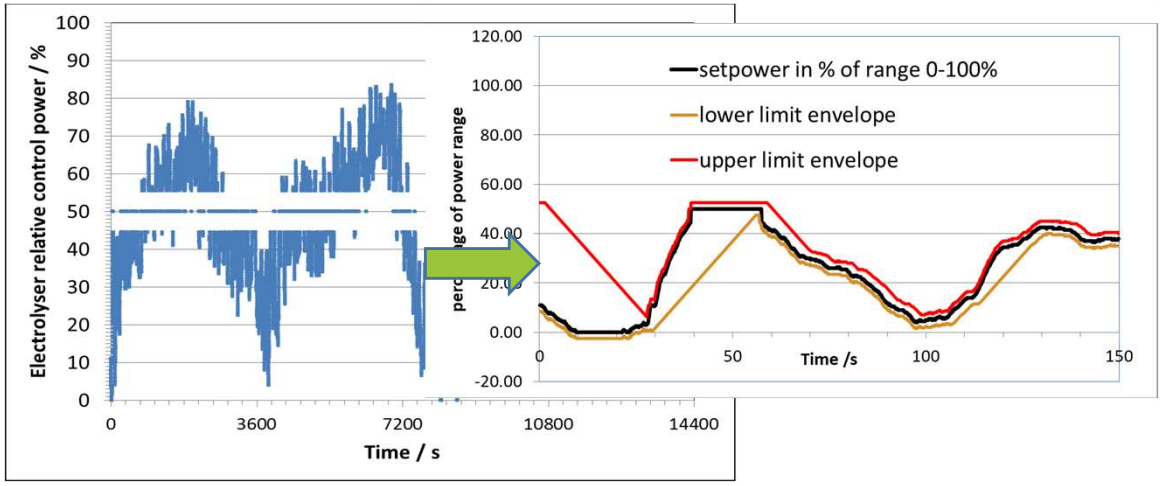


Testing protocols to investigate grid service ability

- Variations in grid service requirements and prequalifications of European countries harmonized







All protocols download DOI: https://doi.org/10.5281/zenodo.3912063

Grid service performance of PEM electrolysers

50 kW

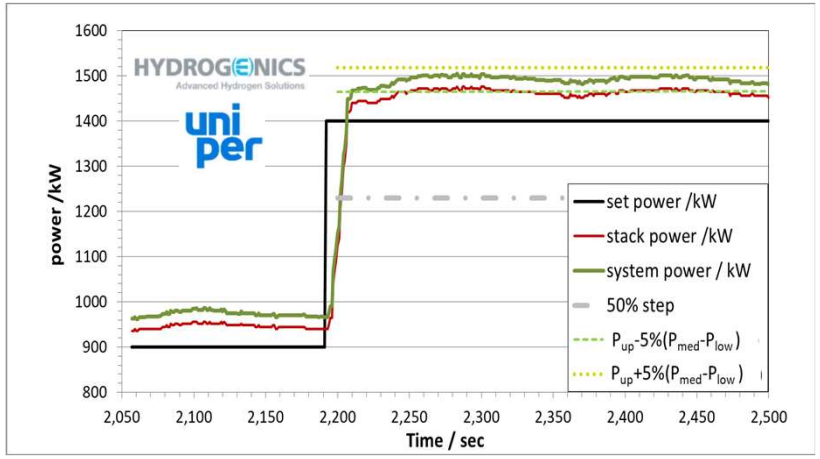
Hydrogenics/DLR

Stuttgart

1 MW

Hydrogenics/Uniper
Hamburg

Test results PEM

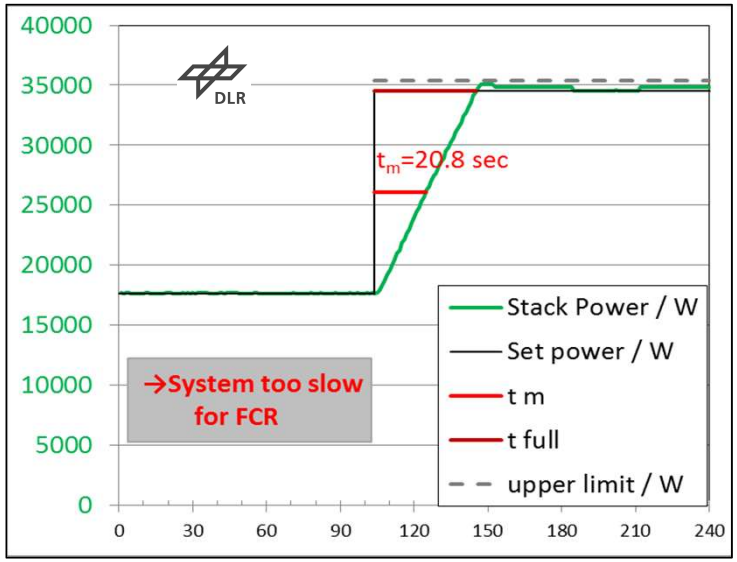


1 MW system Hydrogenics/Uniper Hamburg Reitbrook	System power	Stack power
Duration ramps up t_m	10 sec	10 sec
Duration ramps up t_{full}	18 sec	18 sec
Duration ramps down t_m	7 sec	7 sec
Duration ramps down t_{full}	11 sec	11 sec

Stack power (per unit)

1MW

50 kW



Findings:

- Systems should have power control
- With some feasible adaptations in control and communication system PEMWE are able to perform grid services

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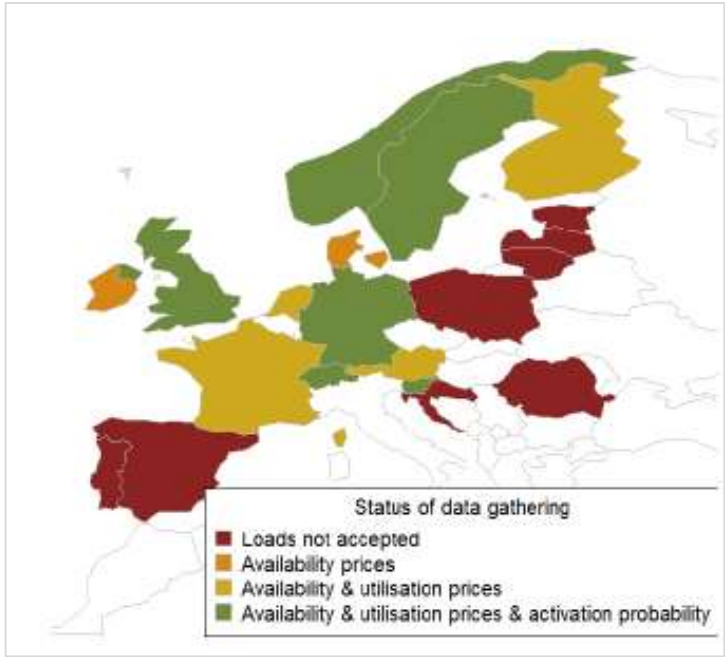
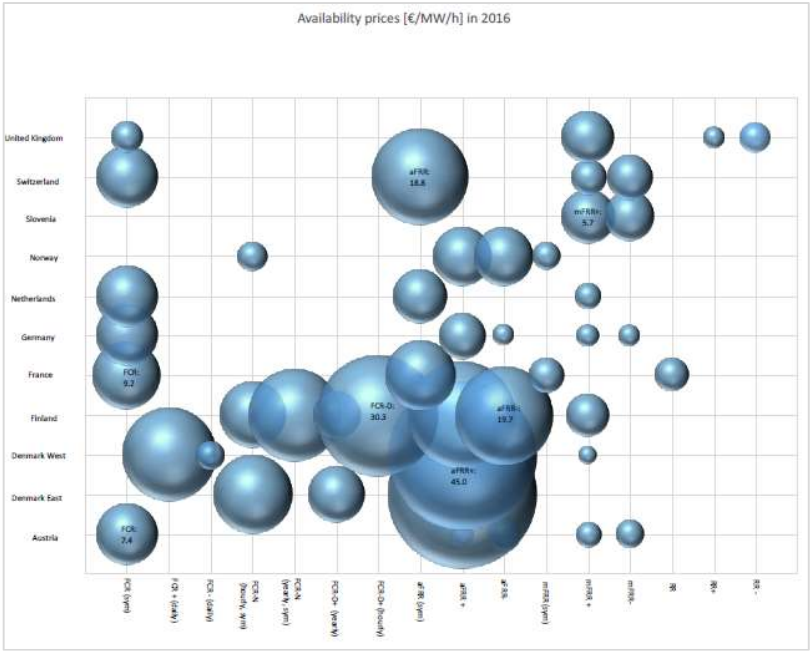
HOCHSCHULE LUZERN

Technoeconomic evaluation

QualyGridS

- Comprehensive grid services catalogue at European level
  - Identification of grid services opened to loads (data base 2016 market data)
  - Comparison of grid services remuneration in European countries (data base 2016 market data)





Impact of grid services on business models

- In today's situation, providing grid services is a secondary value stream for WE.
- Main possible revenue streams :

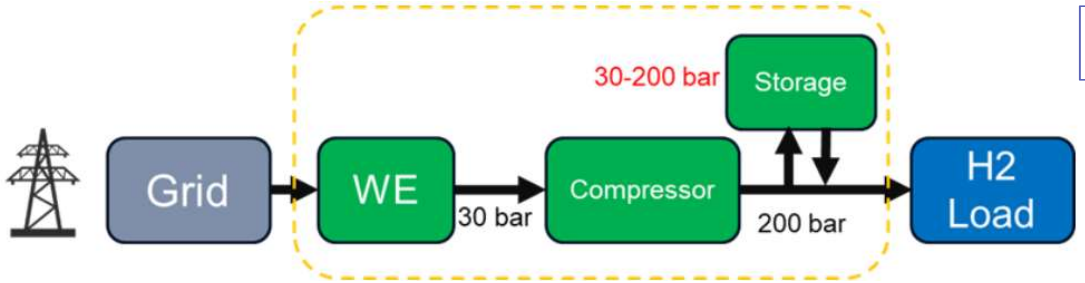
	 H_2 for industrial processes	 H_2 for mobilty
Target H_2 cost for profitability	*~1,5-3€/kg in average (very dependent of the location)*	*~4-7€/kg at the outlet of H_2 production site*

- For WE, the priority is to supply the recurring H_2 load to serve these markets.

➔ *If WE are participating in grid services, they will need :*
- *An H_2 storage (to secure load supply)*
- *An advanced control management system*

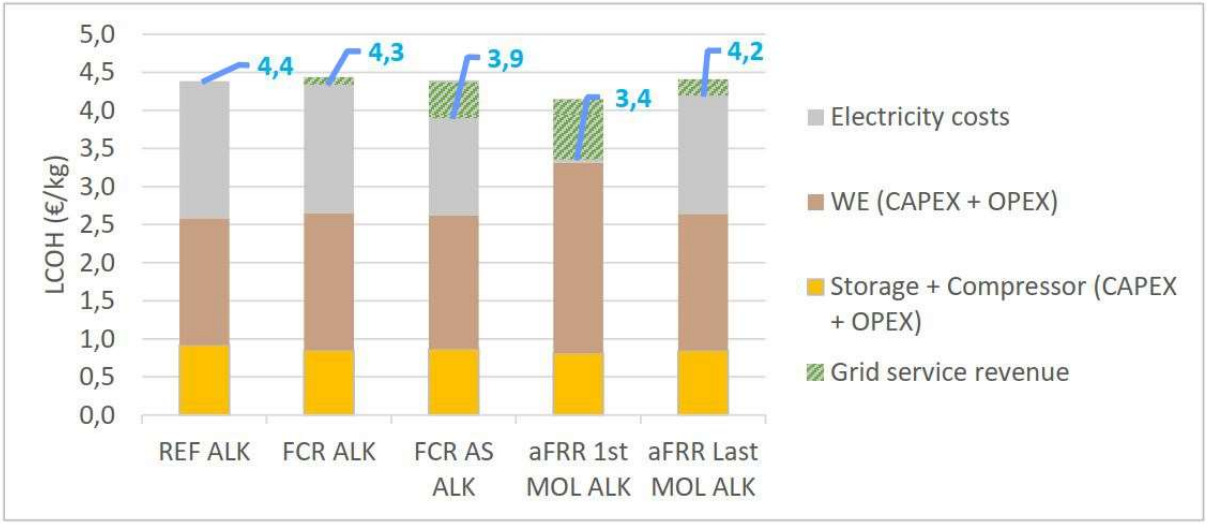
Impact on H2 cost

- One of the studied business cases



Germany, 2017, FCR and aFRR

LCOH= Levelized cost of hydrogen



Potential interest for grid service

Our analysis remains theoretical

It will depend on the capability of the operator to place interesting bids. Additionnal costs to participate in grid services (such as aggregator's cost) have to be considered.

Towards Standardisation

- Standardisation: QualyGridS testing protocols as basis for ISO **Technical Report**
- DLR Regine Reissner Convenor, CEA Cyril Bourasseau
- Contacts to working groups IEC/TC8 (System Aspects of electrical energy supply), IEC/TC105 (Fuel Cell Technologies), IEC/TC120 (Electrical Energy Storage Systems)
- Foreseen Finalisation September 2022

Next step:

Testing protocols for large size electrolyzer

GreenH2Atlantic

A 100 MW flexible green hydrogen production process sourcing hybrid renewable energy and supplying green hydrogen to multiple end-uses

Call European Green Deal 100 MW
December 2021 – November 2027
Total budget 150 M€, total funding 30 M€

- *A scalable 100 MW ALK electrolyser platform*
- *Demonstrate CapEx reduction, improvement in efficiency, BoP, lifetime, current density and flexibility*
- *Flexible green hydrogen production directly coupling renewables with the electrolyser*
- *Target LCOH < 3 EUR/kg*
- *Novel, pressurized large scale ALK electrolyser modules*
- *Supplying H_2 to multiple use-cases*
- *AI-enhanced Hydrogen Management System (AHyMS)*

The project GreenH2Atlantic has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 101036908.

Application of Grid service testing protocols

- Update and collection of new information about new grid services
- Protocols are applied to 16 MW alkaline electrolyzer modules during development phase
- Protocols are applied to 100 MW electrolyzer plant
- Update of protocols
- Evaluation of grid services as part of business model for electrolyzer

The project GreenH2Atlantic has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 101036908.

Summary

- PEM and alkaline water electrolysers can perform electricity grid services
- Standardizing requirements and tests will avoid individual design of each electrolyser and reduce costs
- Potential hydrogen cost reduction when participating in grid services but grid services remain a secondary revenue stream for WE
- More European harmonisation of grid services technical requirements and markets needed + updated databases
- Need for strong WE CAPEX reduction and market incentives
- Large scale demonstration on the way

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www.qualygrids.eu

QualyGridS

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Schweizerische Eidgenossenschaft
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Confederaziun svizra

State Secretariat for Education, Research and Innovation SERI

Thank you

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Impact tomorrow

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More details

All testing protocols for download DOI: https://doi.org/10.5281/zenodo.3912063

1 MW system pictures, data from:
Haubner, Bastian und Föcker, Helge und Bayer, Armin und Pitschak, Bernd und Gago, Aldo und Lettenmeier, Philipp und Voglstätter, Christopher und Smolinka, Tom (2017) Wie kommen Wind und Sonne ins Gasnetz? Pilotprojekt zur elektrolytischen Wasserstofferzeugung erfolgreich abgeschlossen. DVGW energie | wasser-praxis, Seiten 12-16. wvgw Wirtschafts- und Verlagsgesellschaft Gas und Wasser mbH. ISSN 1436-6134; https://elib.dlr.de/112792/1/ewp_0317_12-16_Foecker.pdf
WESpe - Wissenschaftliche Forschung zu Windwasserstoff-Energiespeichern, Teilprojekt DLR : Endbericht. P. Lettenmeier, A. Gago, K.A. Friedrich; https://doi.org/10.2314/GBV:1029363986;
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Test results in https://DOI.org/10.51/zenodo.3999607 and doi: 10.1093/ce/zkaa015

Techno-economic evaluation: V. Klemenz, T. M. Mbavarira, C. Imboden in https://zenodo.org/record/3355399; and

S. Crevon, V. Seguin in GSM2020Proceedings DOI 10.5281/Zenodo.4284325