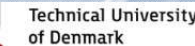




Testing Protocols for Electrolysers

Regine Reissner, DLR German Aerospace Center, Institute for Engineering Thermodynamics, Germany



This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 735485. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N.ERGHY

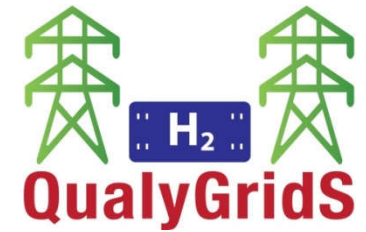


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

State Secretariat for Education,
Research and Innovation SERI

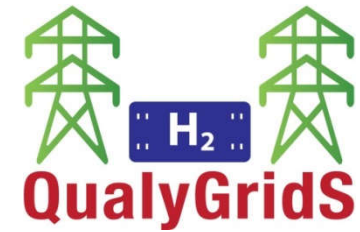
This work is supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 17.00009.

Objectives



- Development of testing protocols for electrolyser systems performing electricity grid services
- Reflect the maximum amount of possible grid services
- Key performance indicators (KPIs) set up

Development of Testing Protocols



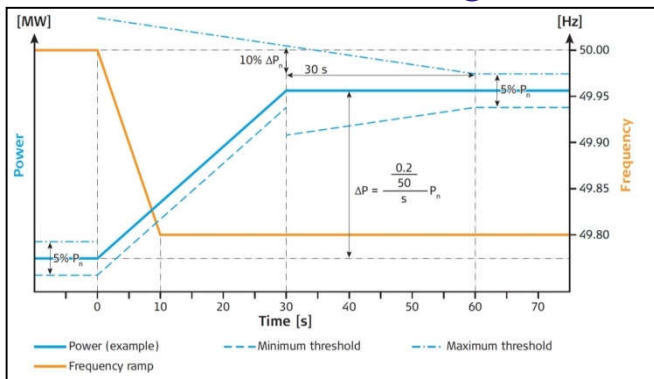
- Uses JRC electrolyser terminology
- All tests are independent
- Basic characterisation protocols identify range, dynamics etc. relevant for grid services
- Based on TSO's published prequalification procedures status August 2019 trying to unify the countries' differences, taking the most strict requirements
- Operator selects lower and upper power level
- Evaluations performance indicators and pass criteria
- Experimentally validated

Development of Testing Protocols



- FCR 1st based on prequalification procedures

e.g. CH



DE

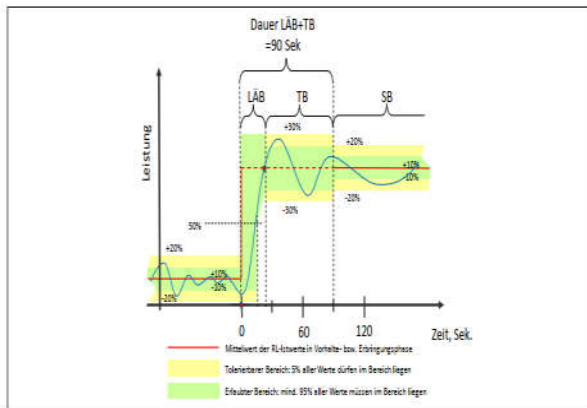
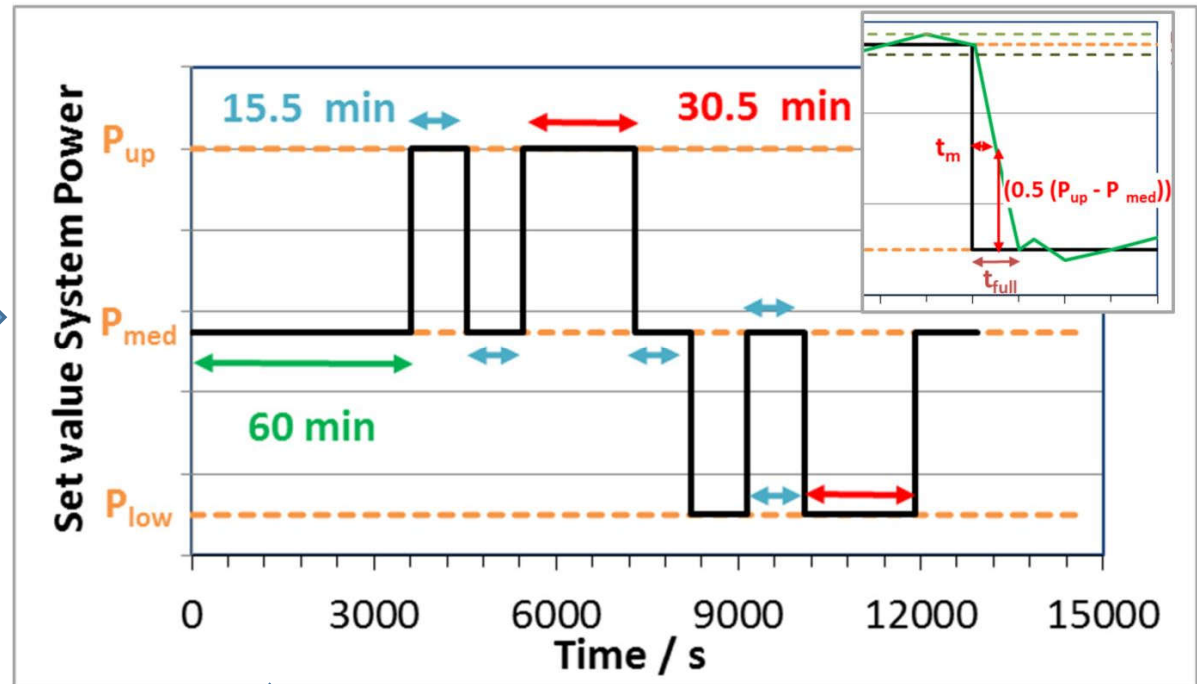


Abbildung 7: Schematische Darstellung der "erlaubten" und "tolerierbaren" Intervalle (FCR)

WVZ | 2020/06/29



D

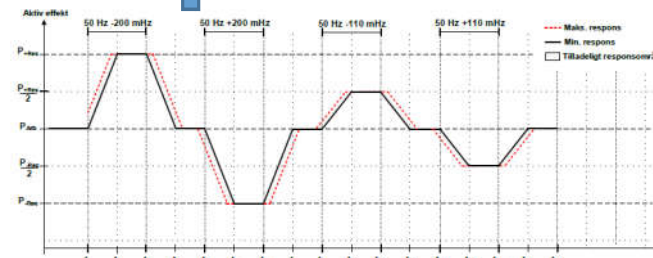
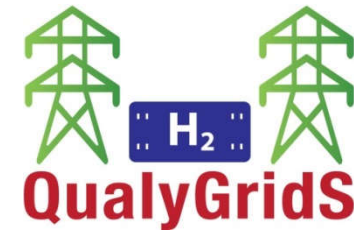
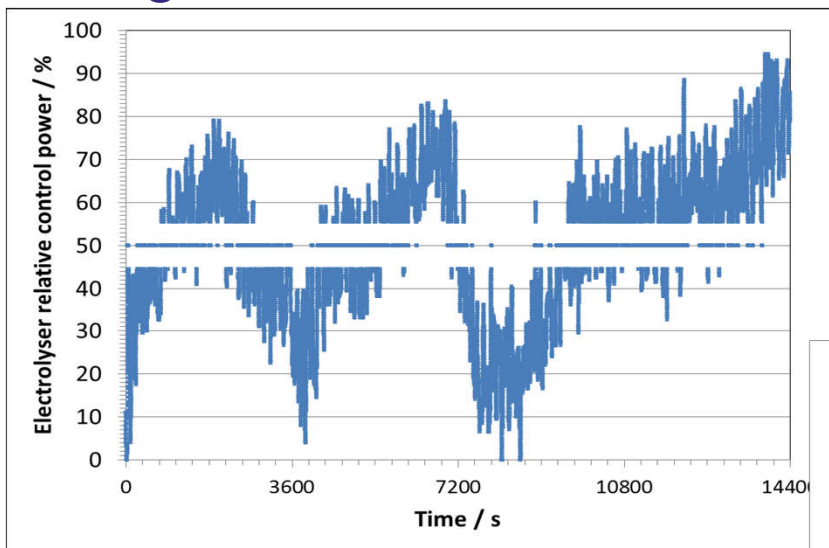



Figure 4 - Tests of minimum requirements for FCR response.

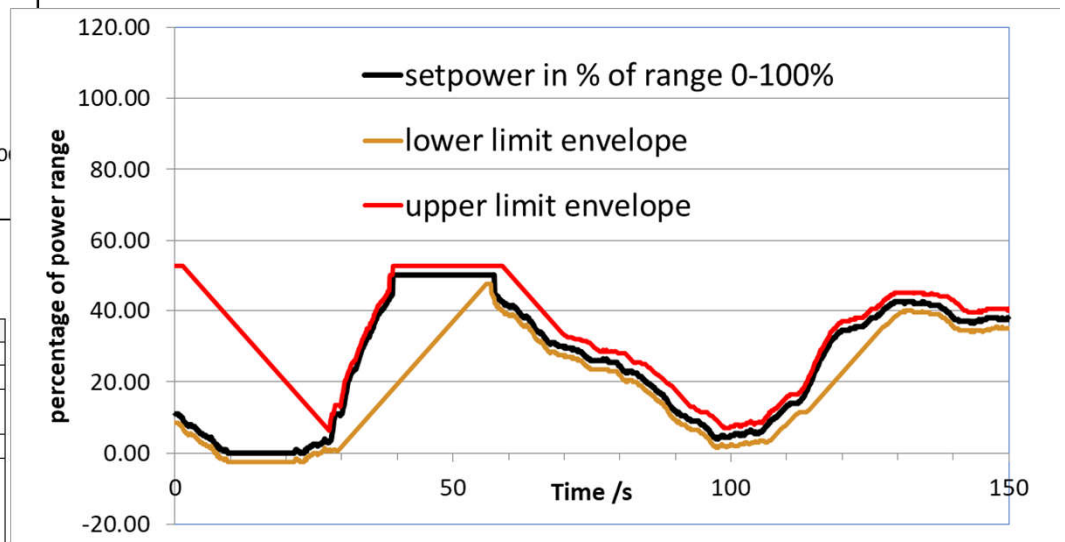
Development of Testing Protocols



- E.g. FCR 2nd test based on real grid frequency curve



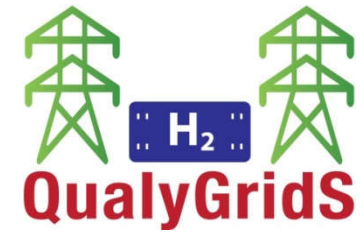
Data evaluation –

 inside envelope?



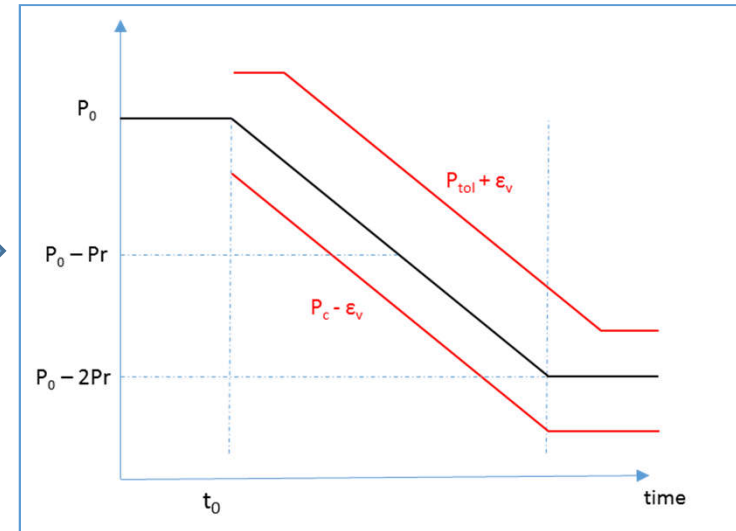
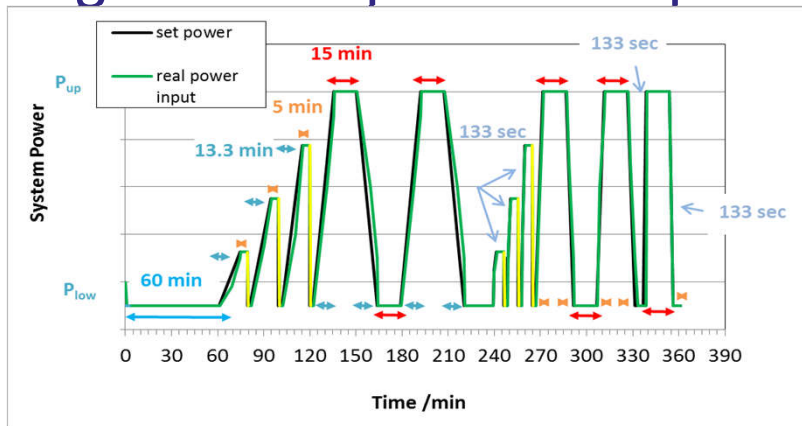
FCR results:

Performance indicator	Symbol	This system's value	TSO's requirement
Ramp duration	t_m	...	$\leq 15 \text{ sec}^*$
	t_{full}	...	$\leq 30 \text{ sec}$
Stability: maximum deviation	Δ_{max}	...	$\leq 0.05 (P_{med}-P_{low})$
Initial response time	t_{init}	...	$\leq 1.5 \text{ sec}^{**}$
Percentage of data points outside the envelope for FCR second test		...	0%
for power levels Capacity	$P_{low} = \dots \text{ kW}$ $\Delta P = P_{up} - P_{med} = \dots \text{ kW}$	$P_{med} = \dots \text{ kW}$	$P_{up} = \dots \text{ kW}$

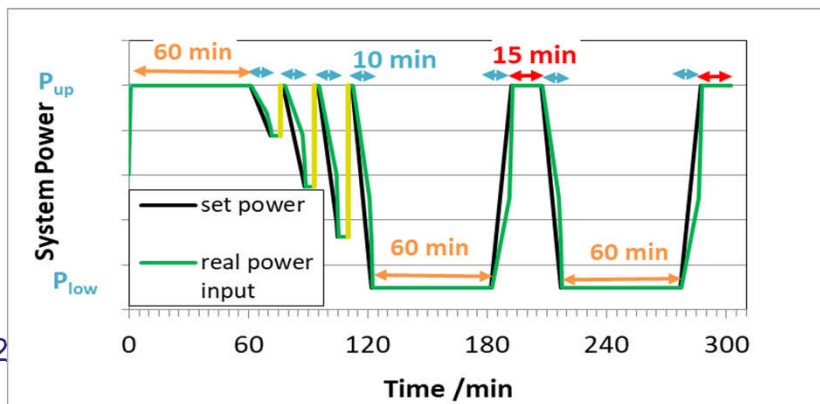
Development of Testing Protocols



- Various ramp profiles
e.g. aFRR upward ramps



- e.g. mFRR downward ramps

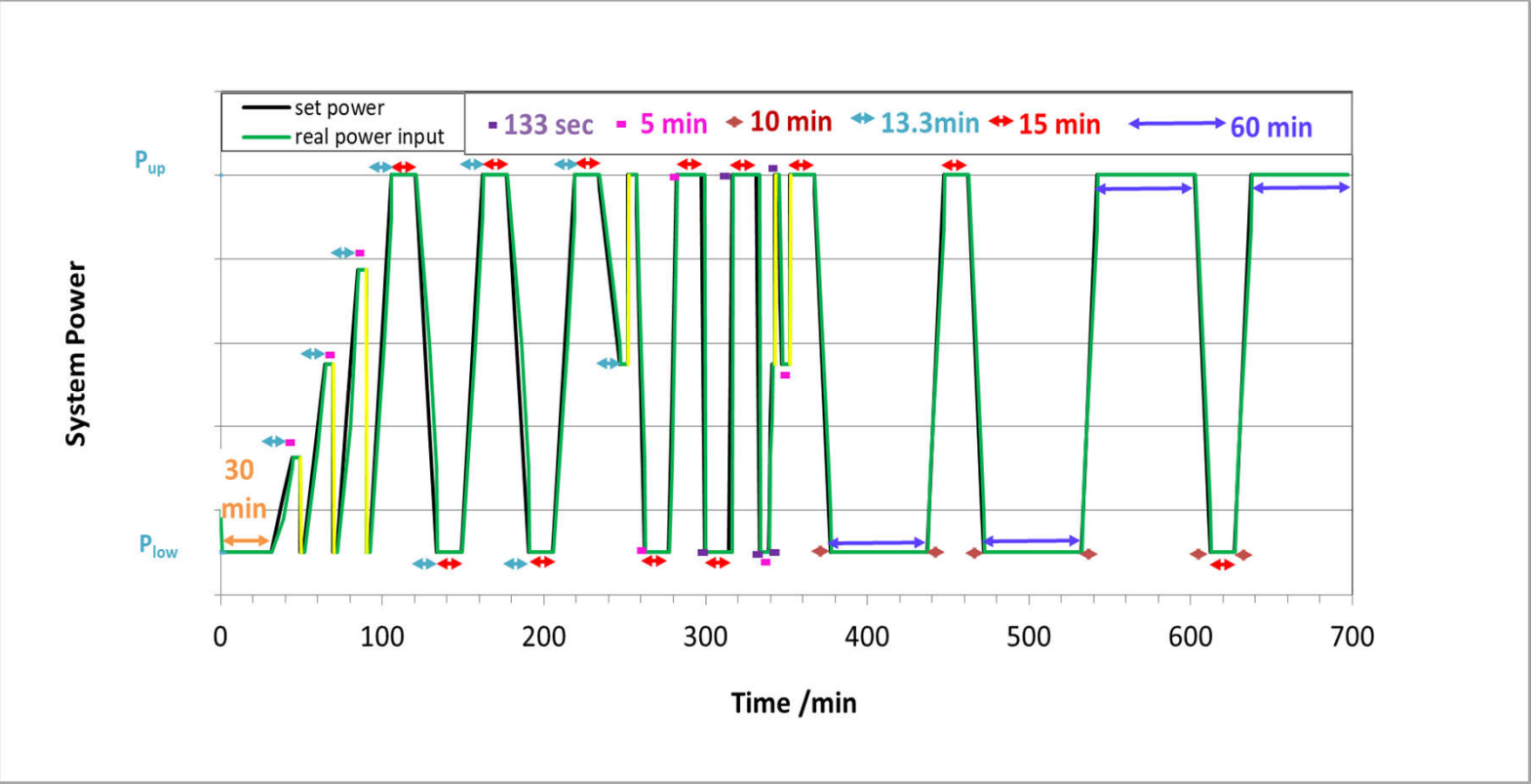


Performance indicator	Symbol	This system's value	TSO's requirement
Percentage of data points outside the range for constant power periods		...	≤ 5%
Percentage of data points outside the range for the ramps		...	≤ 5%
for power levels kW		$P_{up} = \dots$ kW	$P_{low} = \dots$

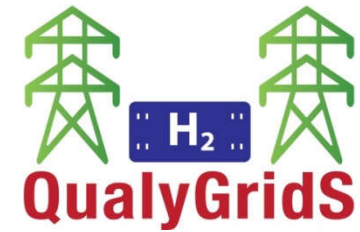
Development of Testing Protocols



- Aggregated protocols to save time



Performance indicators



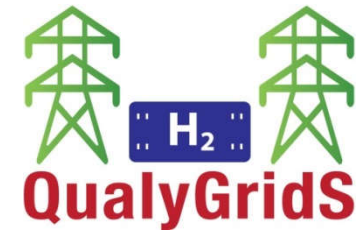
- Primary performance indicators: prerequisites for doing grid service

PPI	Description	Target value	Related FCH-JU KPI
1	Dynamics: Ramp duration for step power change t_{full}	10 (30) sec	KPI 5: H ₂ production electrolysis, hot start from min to max power. Target 2 sec
2a	Stability in constant power sections in %:	<5%	No corresponding KPI
2b	Ramp precision: percentage of data points outside the defined range	0-5%	No corresponding KPI
3	Reliability	>99%	No corresponding KPI

Other performance indicators grouped in secondary performance indicators: helpful, especially for business case

Tertiary performance indicators: good to know

Outlook



- Last version of testing protocols will be made available on QualyGridS web site and via <https://doi.org/10.5281/zenodo.3937273> after Sept.2020
- Protocols will be worked out as an ISO technical report

Thank you

Contact details

Regine Reissner
Regine.reissner@dlr.de
+49 711 6862 394



QualyGridS

www.qualygrids.eu