QualyGridS

Unified and Standardized qualifying tests of electrolysers for grid services

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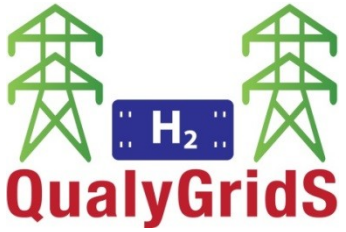
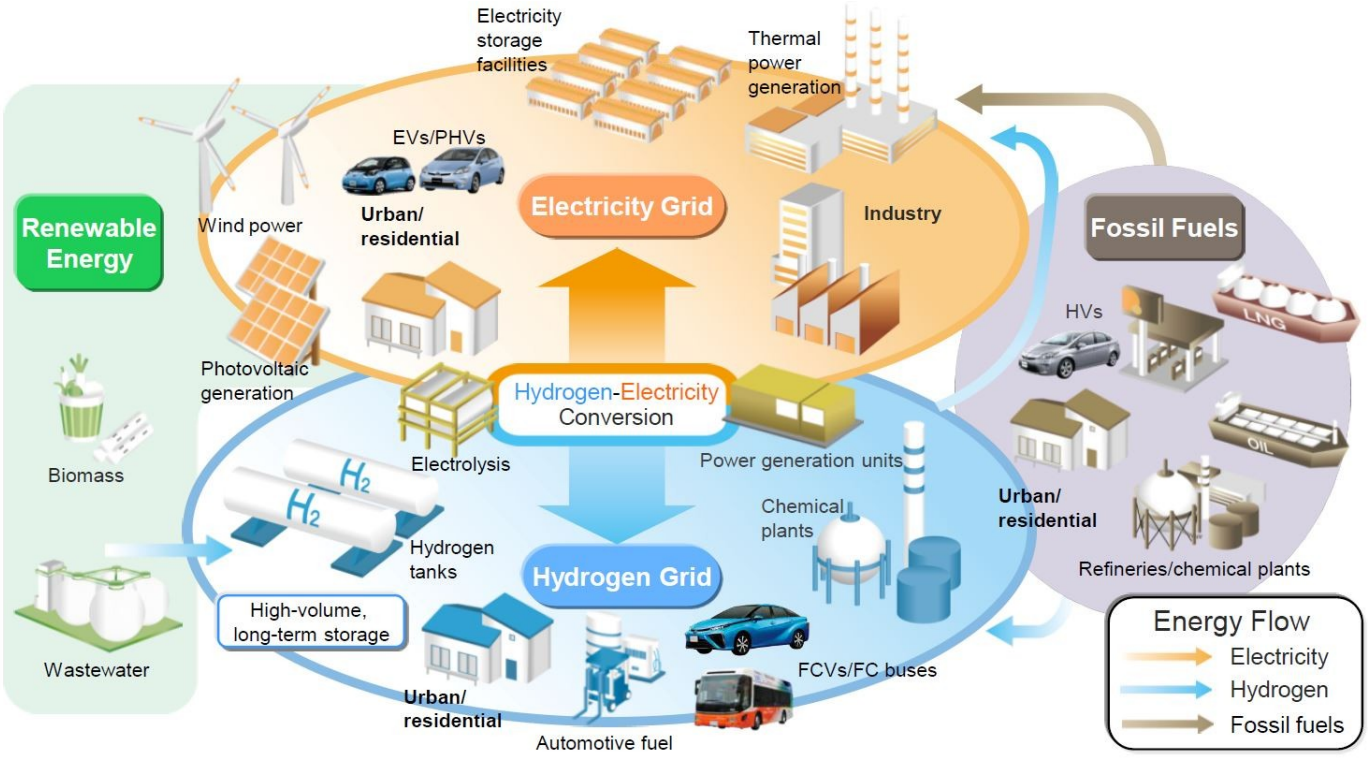
Hydrogen, Renewable Energy and the Electricity Grid



- Decarbonisation by renewable energies
- Water electrolysers converting electricity to hydrogen
- Hydrogen from renewable energy in transportation, industry, gas grid, electricity storage → sector coupling

Hydrogen, Renewable Energy and the Electricity Grid

QualyGridS



DLR nel ITM POWER Energy Storage | Clean Fuel iht EUROPEAN FUEL CELL FORUM FUNDACIÓN PARA EL DESARROLLO DE NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN cea DTU Technical University of Denmark Lucerne University of Applied Sciences and Arts HOCHSCHULE LUZERN NEN

Electrolyzers and Grid Service Markets

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

Types of electrolyzers and properties

PEM-electrolyser

Polymer electrolyte membrane

Reaching Megawatt size

Using Pt metals

Low footprint

High dynamics

Alkaline electrolyser

Decades of Megawatt experience

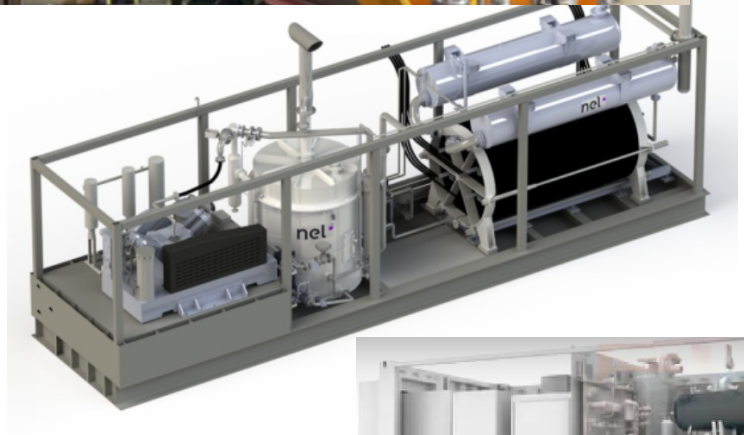
Cheaper materials

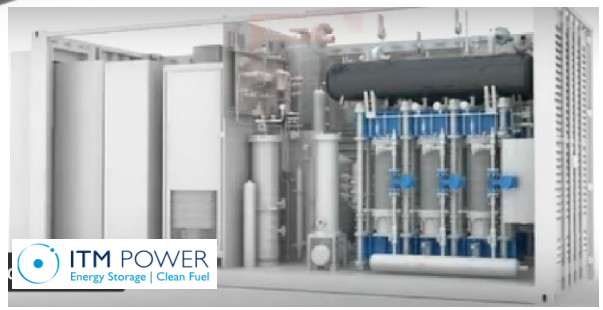
Normally lower dynamics

SOEC

Coming

High efficiency



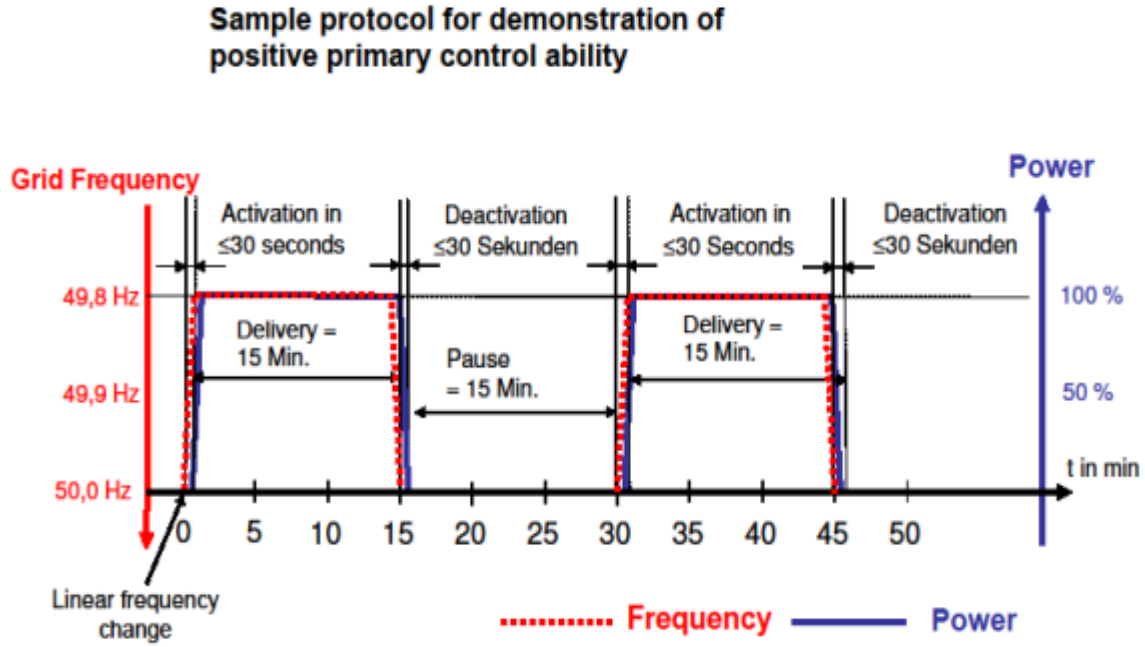


FCR

(Frequency Control Reserve)

Similarities in Prequalifications but differences in pass-criteria between the countries

Germany:

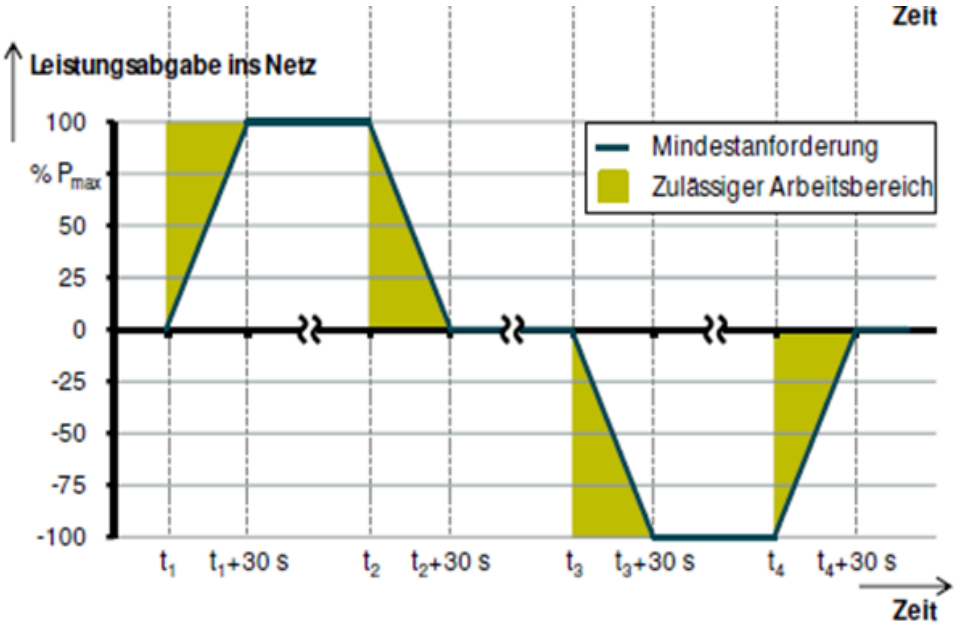


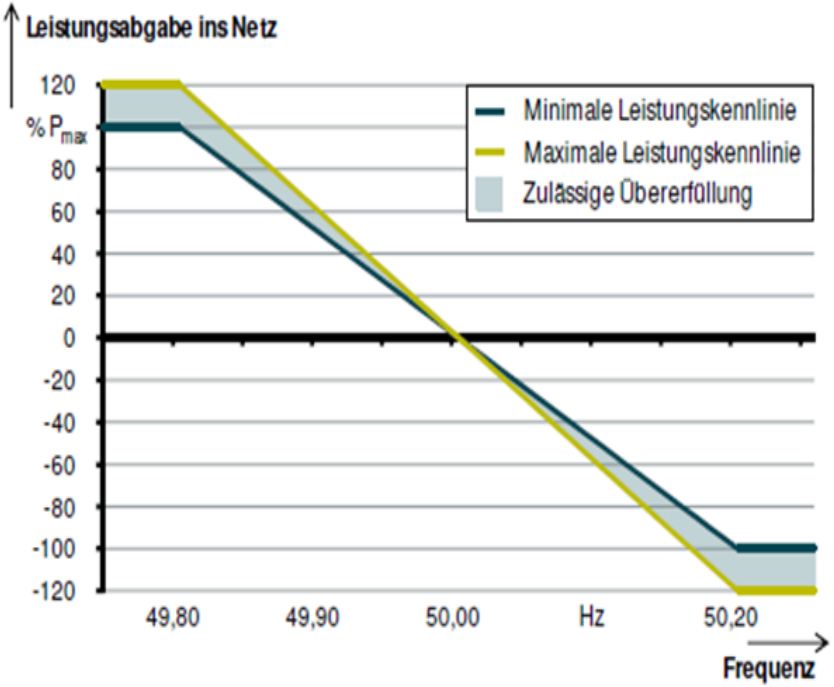
FCR

(Frequency Control Reserve)

FCR Germany

Pass criteria:





FCR

(Frequency Control Reserve)

FCR France

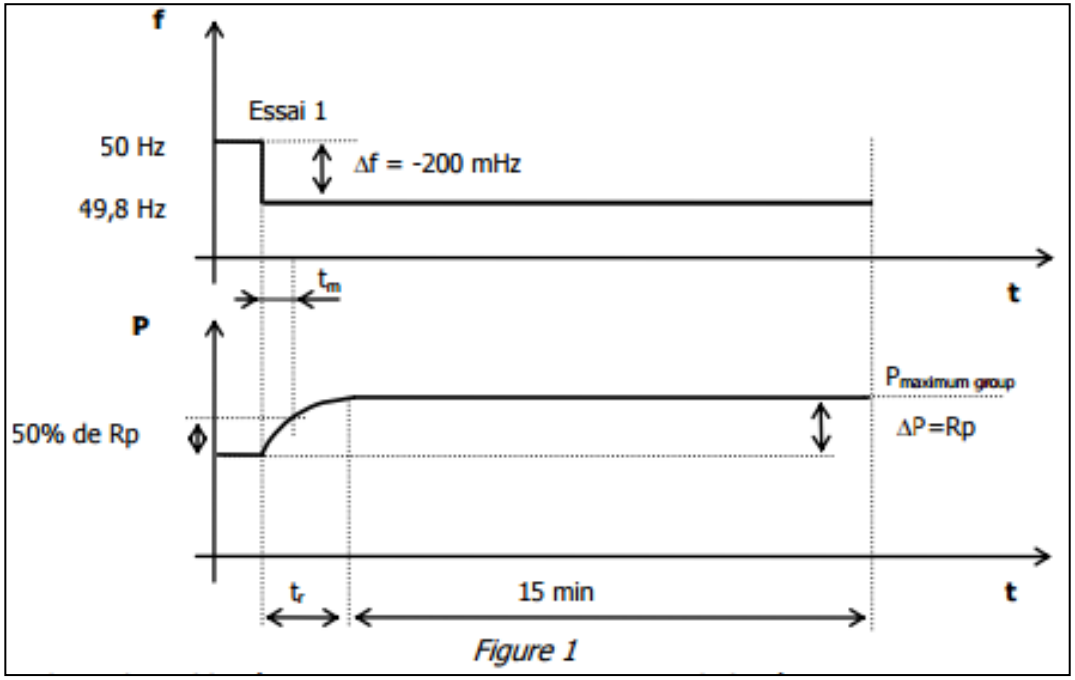


Figure 1

and several other, smaller steps

Pass criteria:

-Non oscillating waveform response

-Time t_r < 30 sec

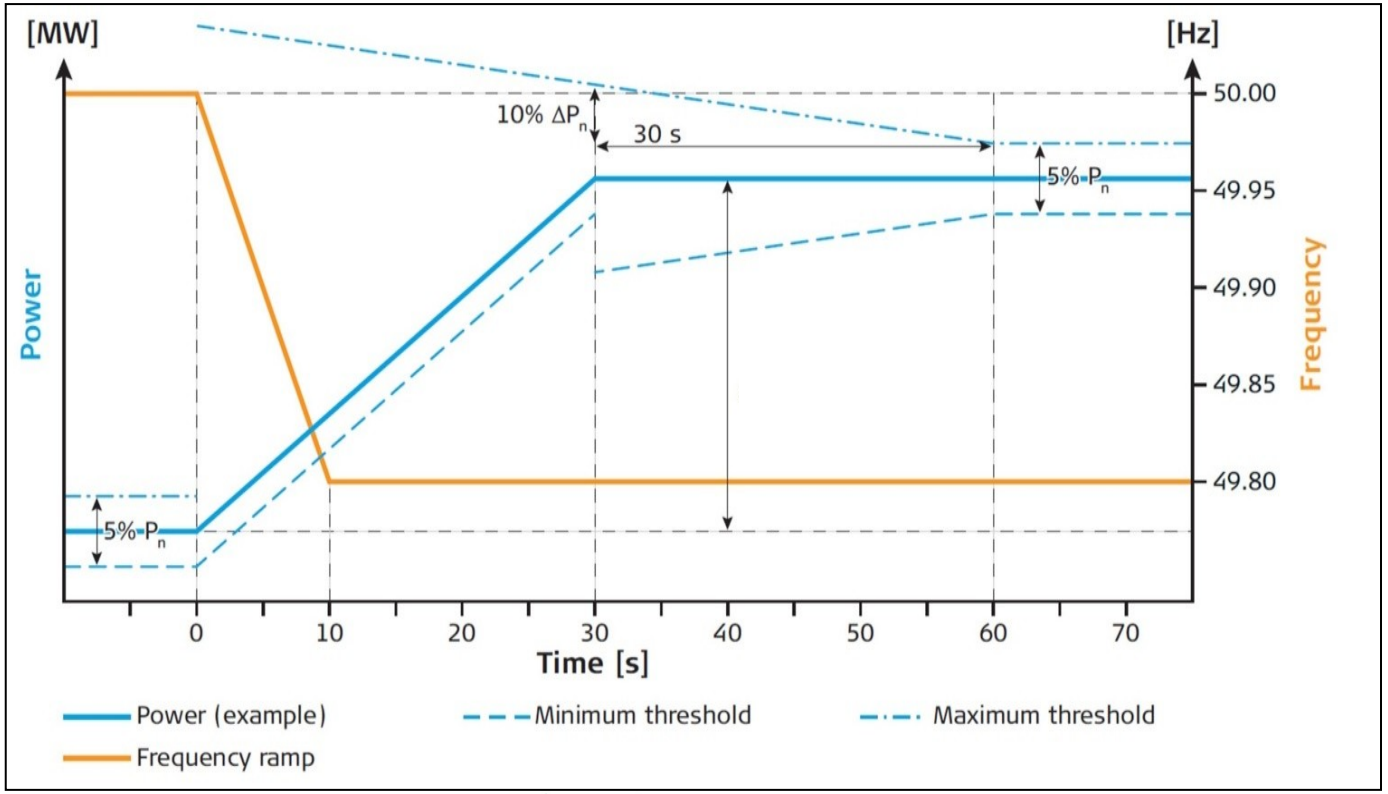
-Time t_m < 10 sec

-The variation $\Delta P = R_p$ maintained for 15 min (after t_r)

FCR

(Frequency Control Reserve)

FCR Switzerland

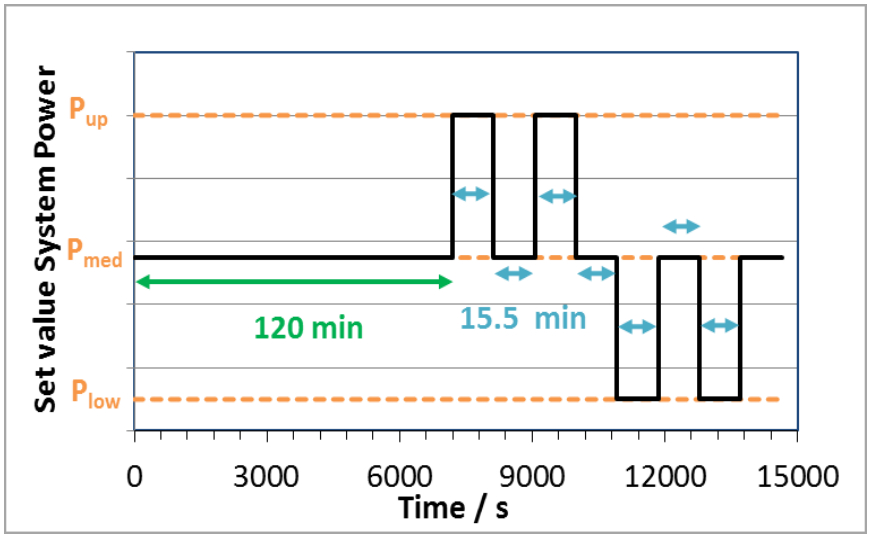


Testing protocols for electricity grid services

Protocols draft worked out for FCR, aFRR, mFRR, RR, both positive and negative.

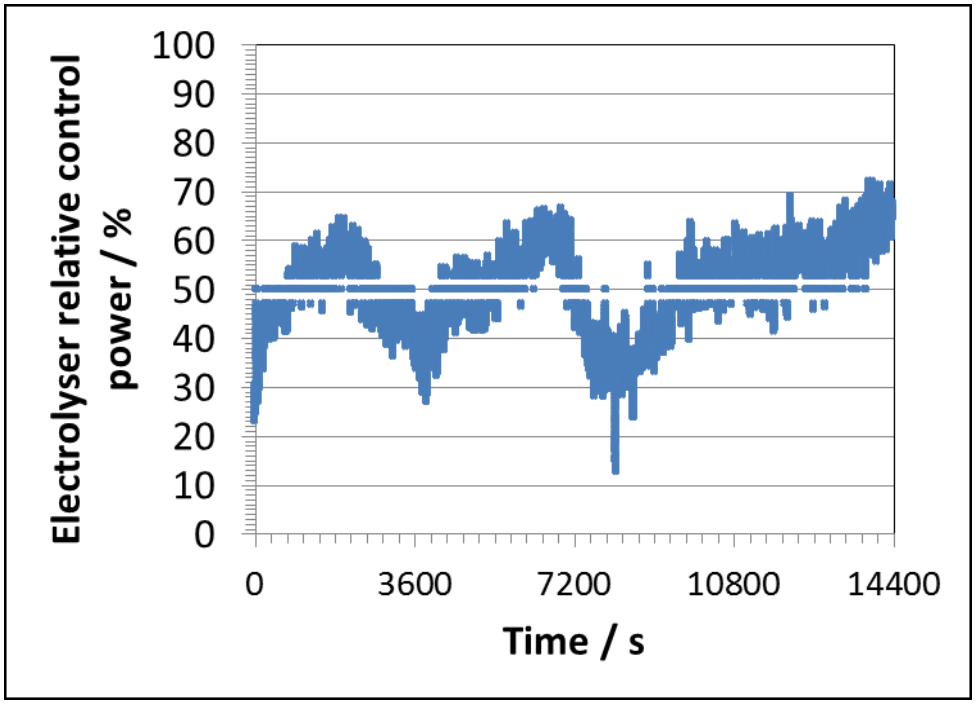
Example: FCR testing Protocol

Protocol first test



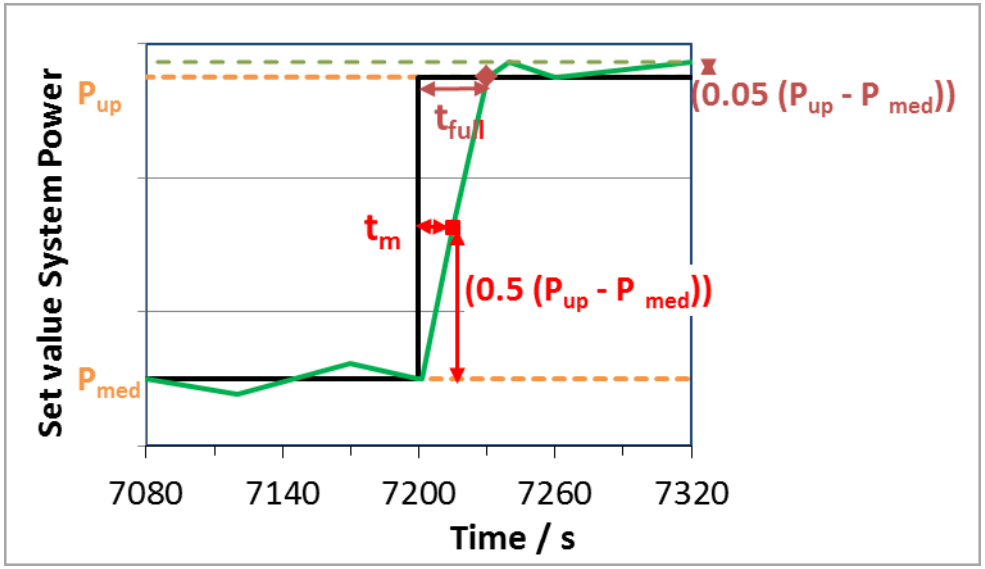
Protocol second test

(based on Fingrid frequency profile)



Testing protocols for electricity grid services

FCR testing protocol
Data evaluation

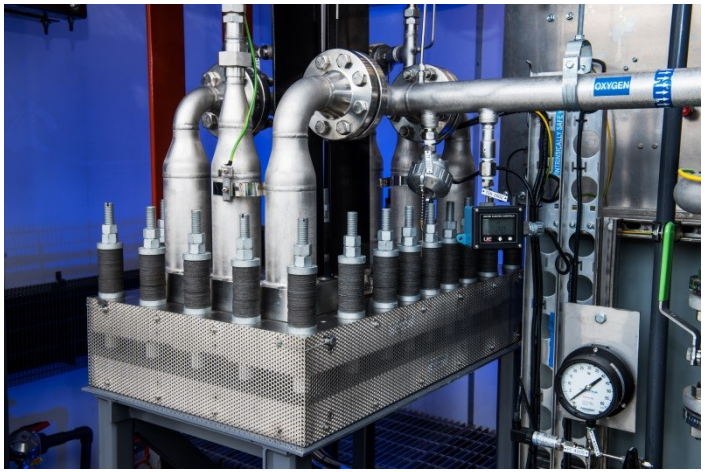


$t_m \leq 15$ sec
$t_{full} \leq 30$ sec
Initial response time ≤ 1.5 sec
Stability ($\pm 0.05 (P_{up}-P_{med})$)

Experimental verification

Hydrogenics 50 kW PEM electrolyzer operated at DLR

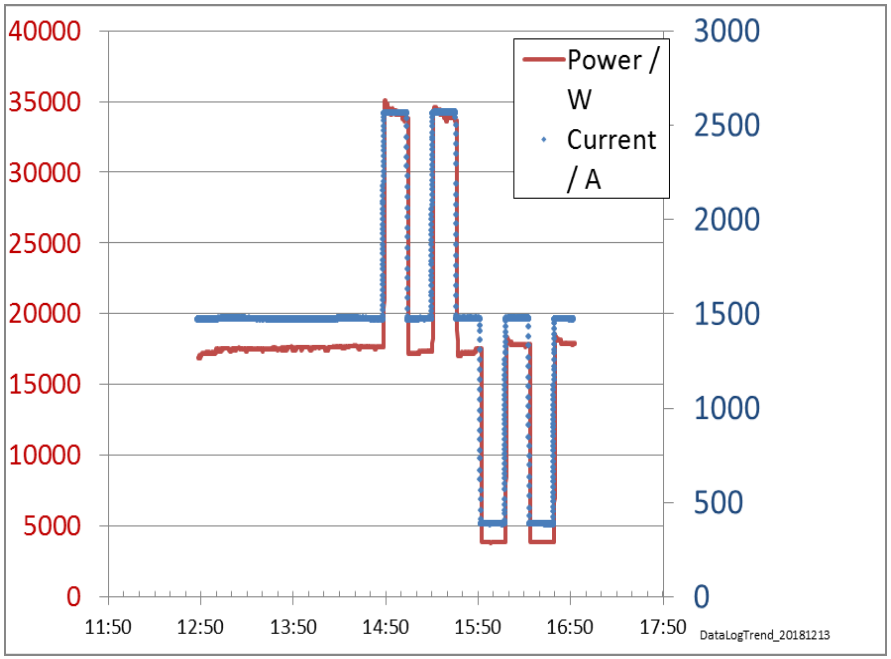
Compared to Hydrogenics 1.5 kW system

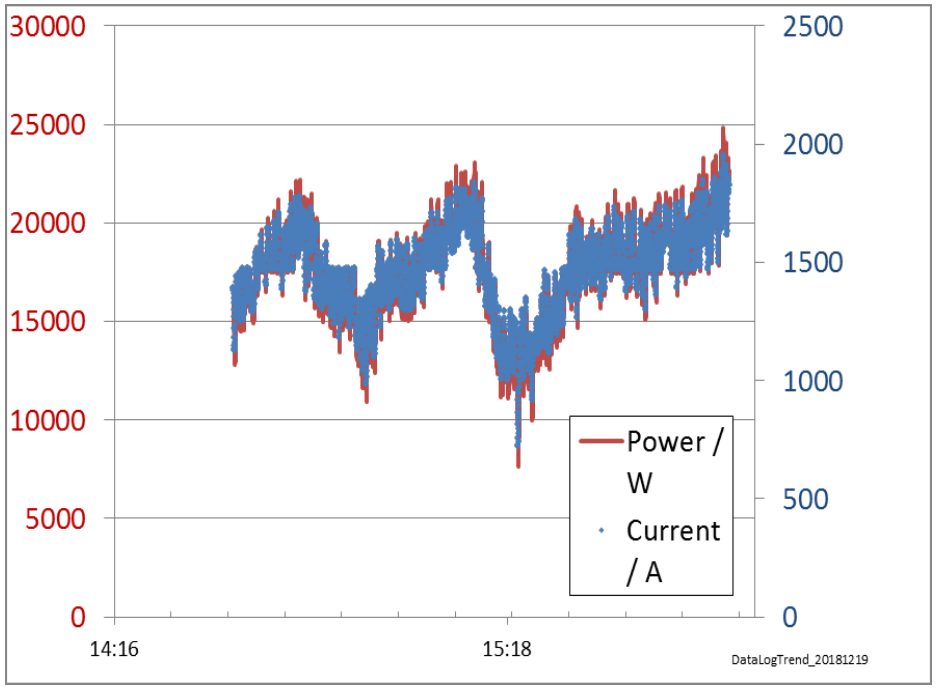


Experimental verification

Example: FCR testing Protocol

Experimental verification 50 kW PEM electrolyser test at DLR

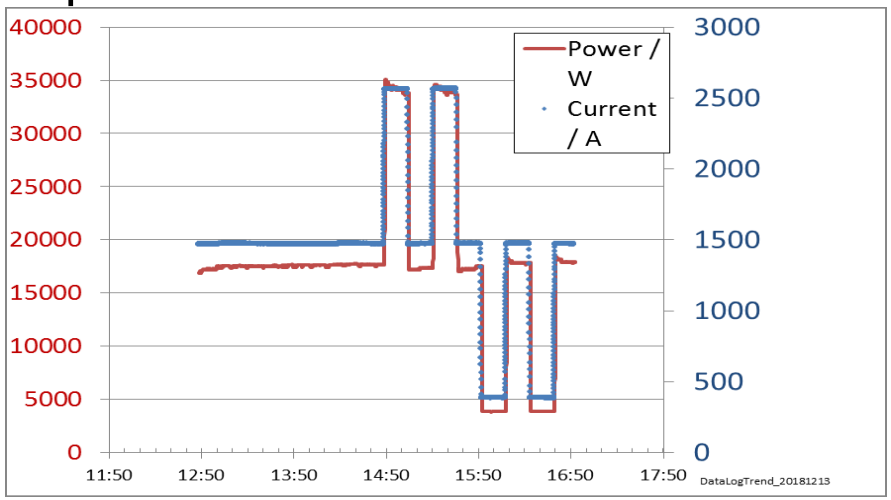


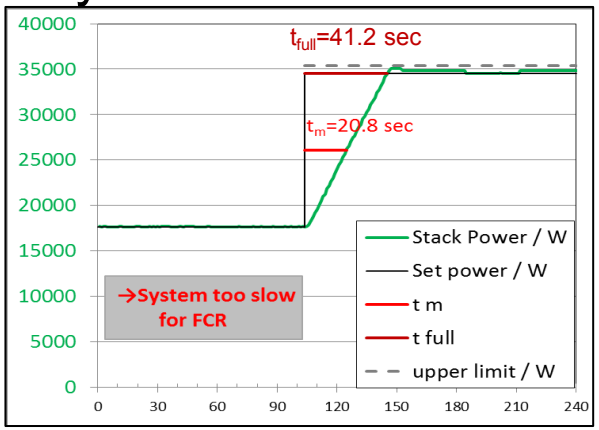


Experimental verification

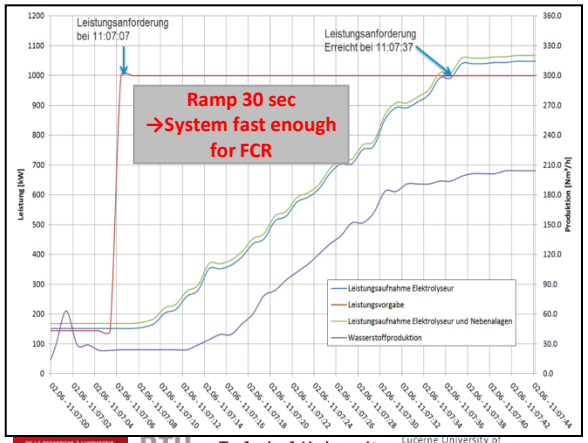
Example: FCR testing protocol

Experimental verification 50 kW PEM electrolyser test at DLR





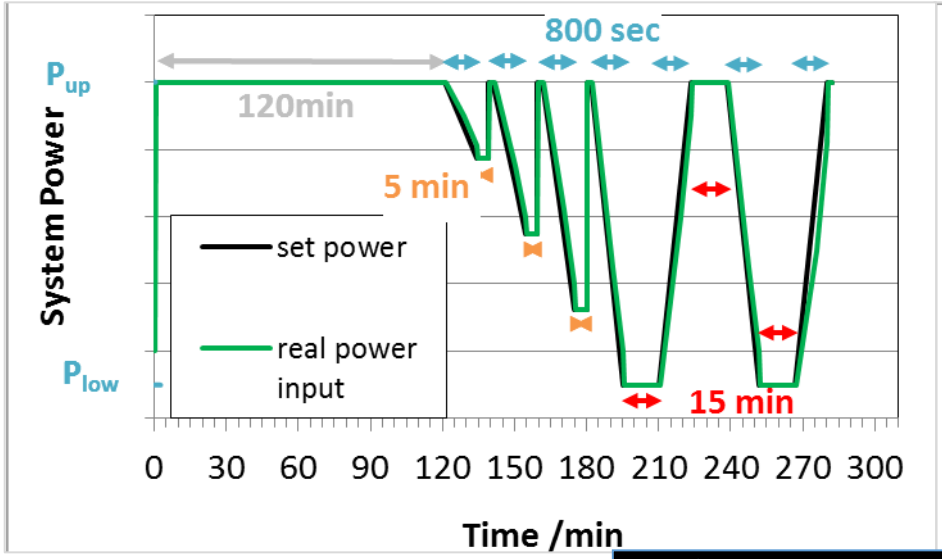
1.5 MW electrolyser:

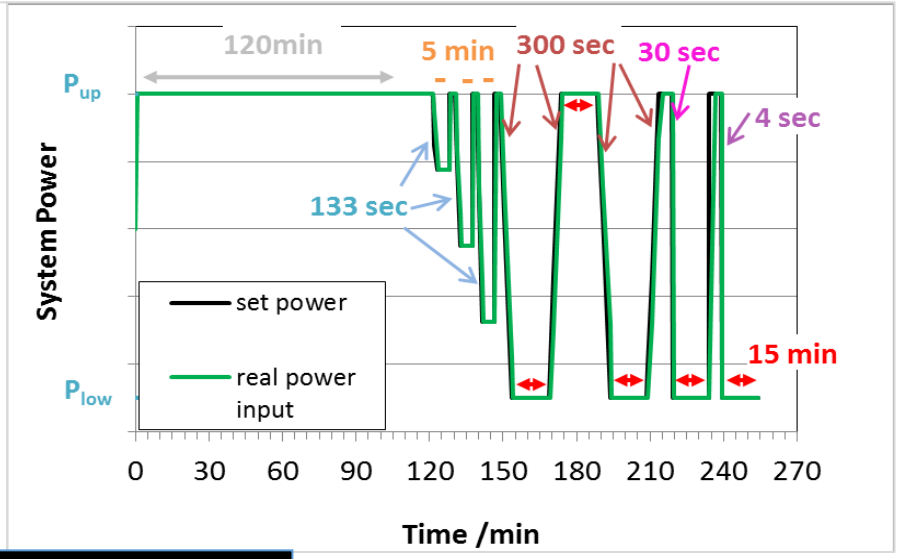


aFRR

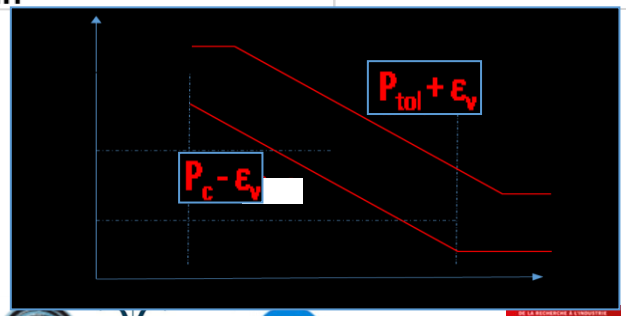
(automatically activated Frequency Restoration Reserve

- Varying activation times between countries, partial activation
- 2 series of tests suggested from slow to fast





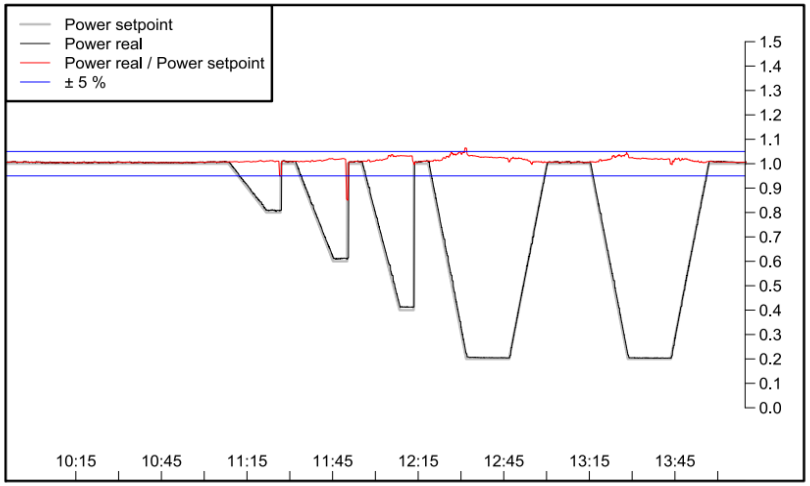
- Data evaluation:

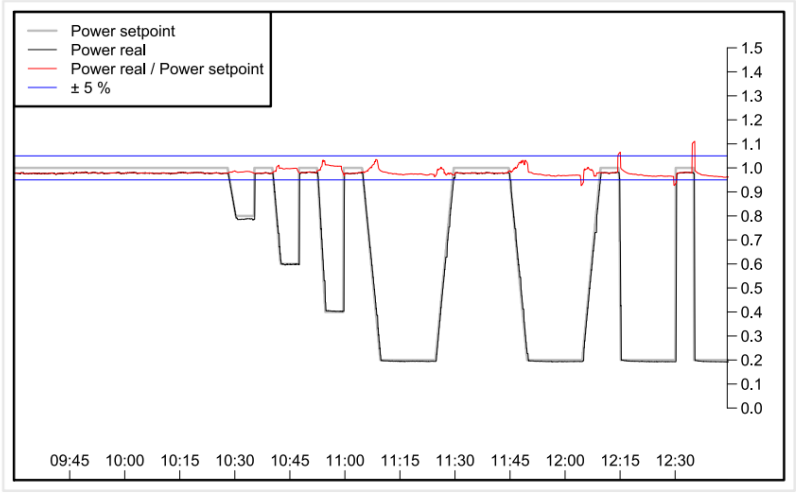


ε_v=1% of the target ΔP

aFRR experimental verification with alkaline electrolyser

NEL 300 kW alkaline electrolyser operated at NEL: state of the art electrolyser as used for refuelling stations but with faster rectifier and pressure controllers





Various grid services

- Considered with the definition of characteristic properties of the electrolyser:

5.13 Performance tests

The tests 5.13.1, 5.13.2, 5.13.3, 5.13.4, 5.13.5 and 5.13.6 are independent of each other. Users of this technical specification may selectively execute test items suitable for their purposes from those described in this technical specification.

5.13.1 Basic characterisation of electrolyser system for grid-service relevant parameters

5.13.1.2.1.1 *Protocol for determination of Cold Start Time to Nominal Power*

5.13.1.2.1.1.1 Protocol for determination of start-up time from standby mode

5.13.1.2.1.2 *Protocol for Identification of available range*

5.13.1.2.1.3 *Protocol for Determination of Minimum-Maximum-Dynamics*

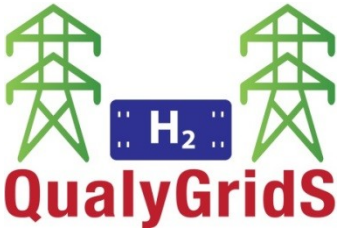
5.13.1.2.1.4 *Protocol for Determination of Nominal-Maximum-Dynamics*

5.13.1.2.1.5 *Protocol for determination of power down to standby time*

- Available Power Range ΔP
- Time to power up t_{up}
- Time to power down t_{down}
- Power stablity
- Characteristic time t_m and t_{full} for steps up and steps down / ramp duration
- Initial response time
- The Total Response Time Maximum Power to Minimum Power $t_{max->min}$
- Time from nominal to standby state:

  $t_{down\_to\_standy}$

Status Electrolysers for Grid Services



- Can do FCR, aFRR, mFRR
- System adaptations compared to standard product: precise power control, BOP power consumption smoothened or on separate grid connection point

Conclusions Testing Protocols

- Next steps: work out improved protocols based on feedback from experimental tests, updates in grid services etc.
- Experimental verification ongoing
- Draft testing protocols can be shared with interested persons – we would be happy about feedback if the protocols are applicable and appropriate
- Unified testing protocols might be used also for other electricity consumers providing grid services

Thank you

Contact details

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