QualyGridS

Application of qualifying testing protocols in alkaline electrolysers

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FUNDACIÓN PARA EL DESARROLLO DE NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

iht INDUSTRIE HAUTE TECHNOLOGIE

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Protocols testing

Main grid services:

- Frequency Containment Reserve (FCR)
- Frequency Restoration Reserve (FRR)
- Replacement Reserve (RR)

Protocols tested in 3 different alkaline electrolysers:

- FHa testbench: up to 10 kW IHT stack
- IHT electrolyser: up to 50 kW IHT stack
- NEL electrolyser: up to 300 kW NEL stack

The **Foundation for the development of New Hydrogen Technologies in Aragon** is a private, not-for-profit entity, created to promote the use of hydrogen as an energy vector, focused on public-private collaborations and industrial development.

Key instrument for the promotion of strategic projects around the hydrogen, renewable energy, electric vehicles, energy efficiency. In this way it aims to foment research, technological development.

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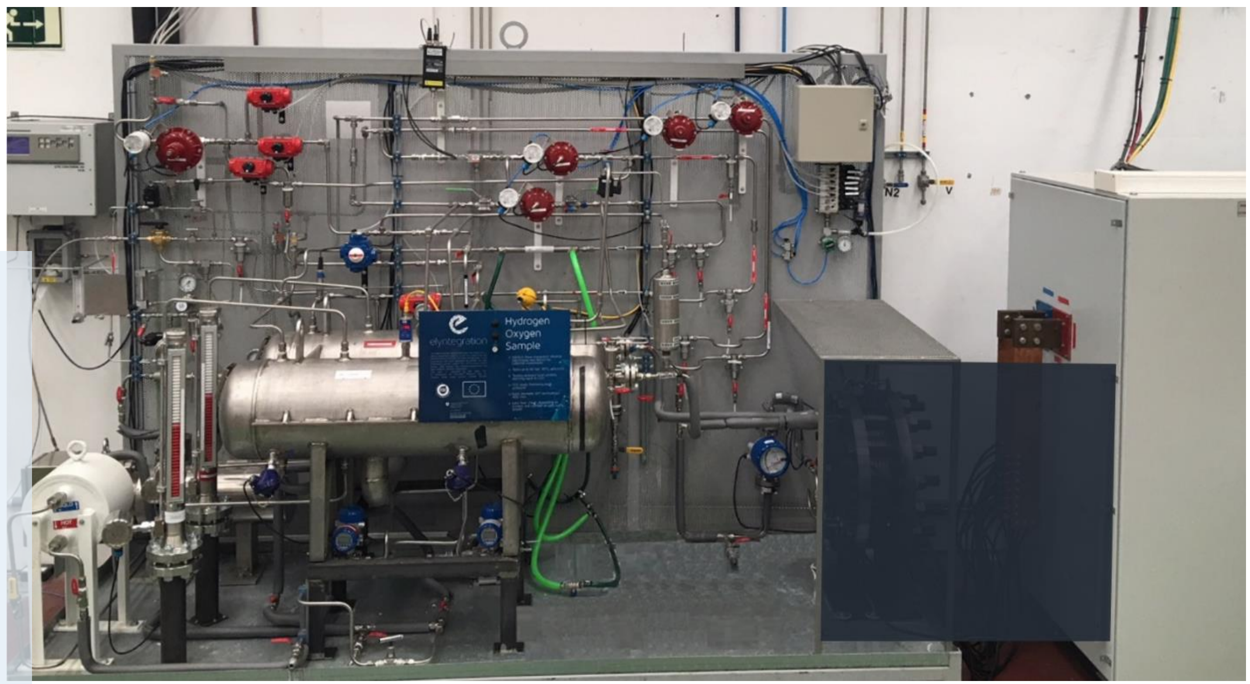
Test bench at FHa

QualyGridS

Facilities:

- Unique in Spain: 8.5 meter in height, safety measures (ATEX), gas detection equipment and ventilation
- Suitable infrastructure to work with large scale hydrogen equipment/systems.

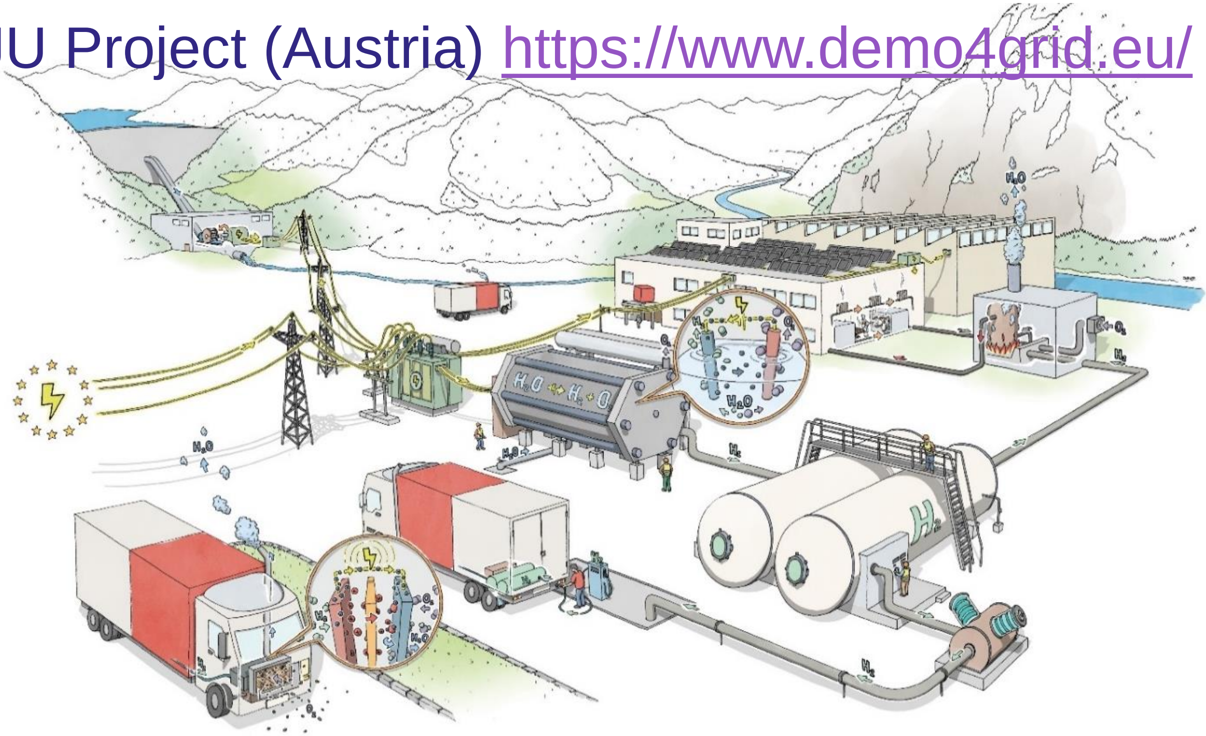
✓ IHT alkaline stack
✓ Current controlled
✓ Up to 60 bar and 95ºC
✓ Up to 25 kW and 3,5 Nm^3/h
✓ Remote control
✓ Data acquisition rate:
  - 1 Hz for typical operation parameters
  - Up to 10 Hz for power measurements



Manufacturer of alkaline high Pressure MW electrolysers (32 barg), located in Switzerland.

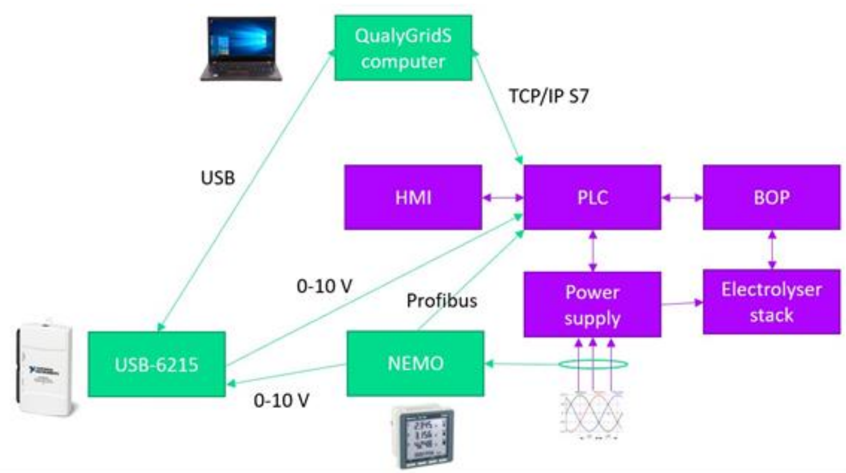
IHT involvement with grid services provision

- DEMO4GRID – FCH-JU Project (Austria) https://www.demo4grid.eu/
- Large scale single stack (3,2 MW)
- H2 for industrial process heat
- Grid services to be demonstrated at MW scale

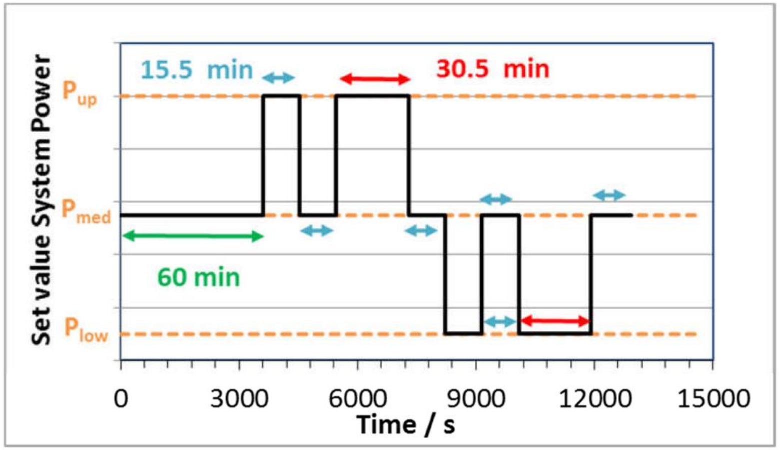


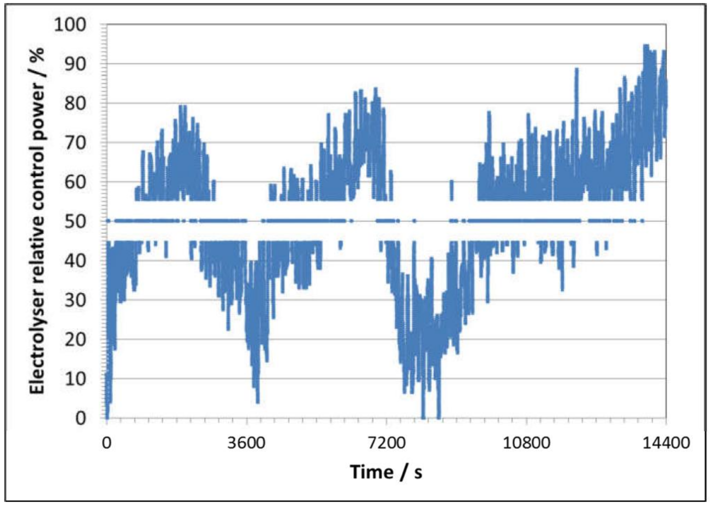
Alkaline test bench

- Test facility at Notodden, Norway
- 300 kW alkaline stack
- Current and power control
- 10 Hz setpoint frequency
- 10 Hz logging frequency
- Absolute time clock to secure synchronization
- Redundant XMTC and SERVOMEX gas analysis



FCR test protocol





Test duration: ~ 4 hours

Protocol evaluation consists on:

FCR 1st method:

1- Power stability when a) no grid service is provided, b) P_{up}, c) P_{low}

2- Duration of ramps up and ramps down

a) time to reach 50% of the value of the set step response

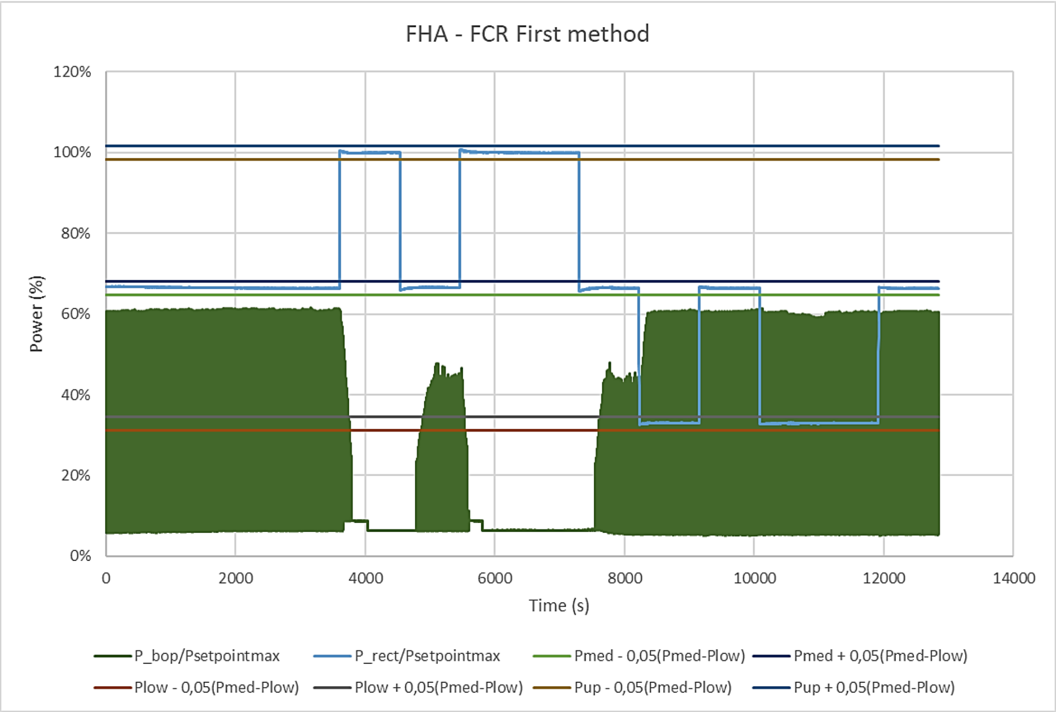
b) time to reach the full set step response

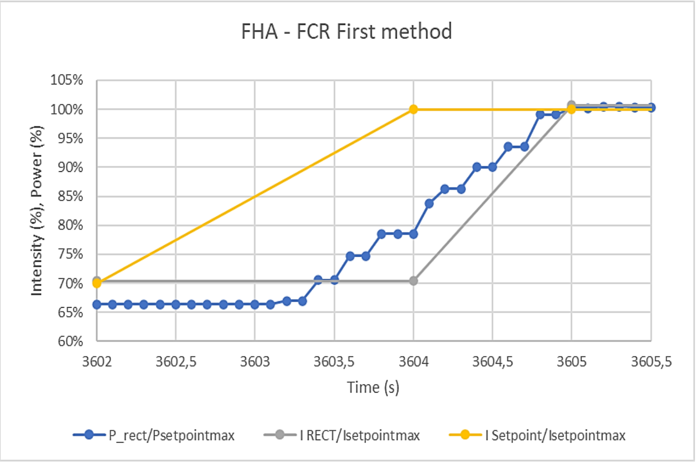
3- Initial response time: time between the set point change and the system reaction

FCR 2nd method:

4- System power remains within the envelope defined by the lower and upper envelope limit given by the protocol

FCR test protocol – results at FHa

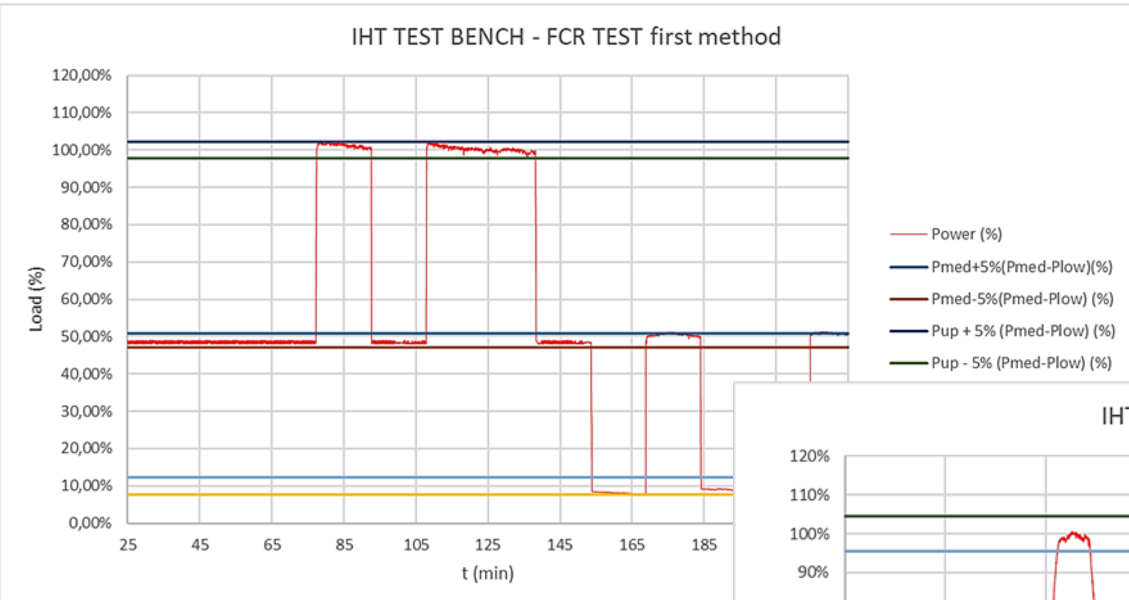




Performance indicator	Symbol	This system's value	TSO's requirement	
Ramp duration	t_m		≤ 15 sec*	✓
	t_{full}	5 seconds	≤ 30sec	✓
Stability: maximum deviation	Δ_{max}	0.061 kW (2.1 %)	≤ 0.05 (P_{med}-P_{low})	✓
Initial response time	t_{init}	0.9 sec	≤ 1.5 sec **	✓

IHT Qualygrids results

- Alkaline electrolyser test bench (50 kW)
- Protocols tested successfully: FCR, aFRR, mFRR
- Protocols lessons learnts: useful to test elys under Dynamic requirements.



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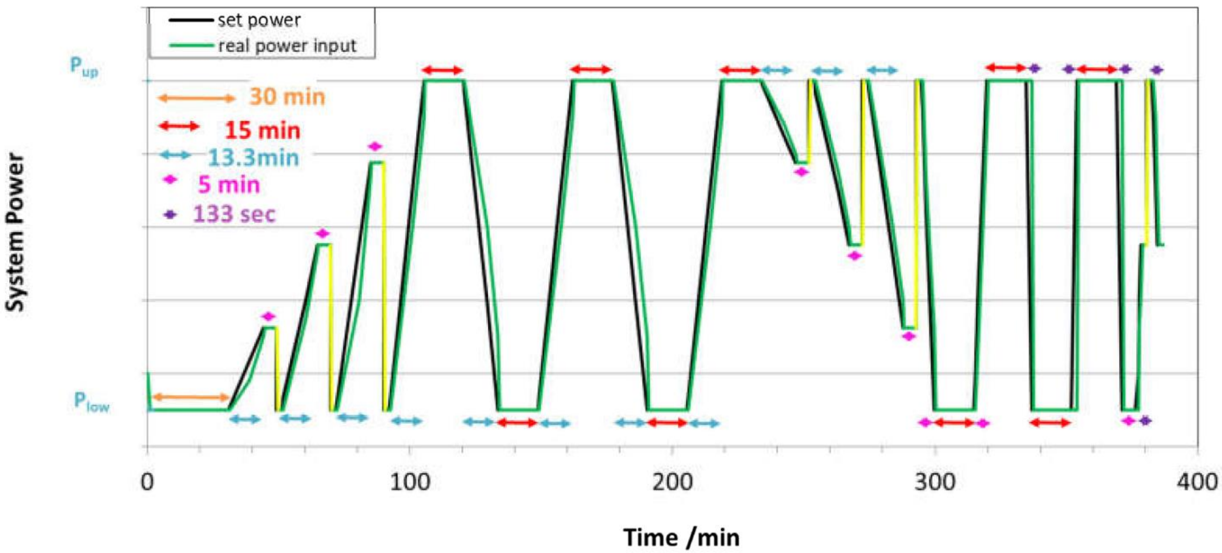
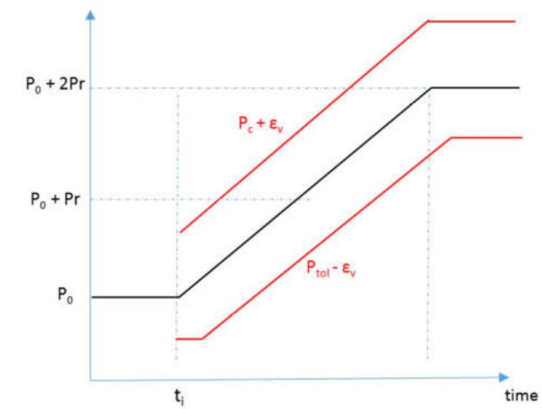
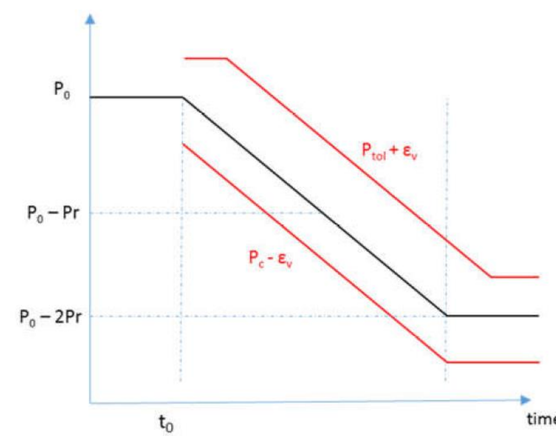




- Percentage of data points outside the range for constant power periods
- Percentage of data points outside the range for the ramps



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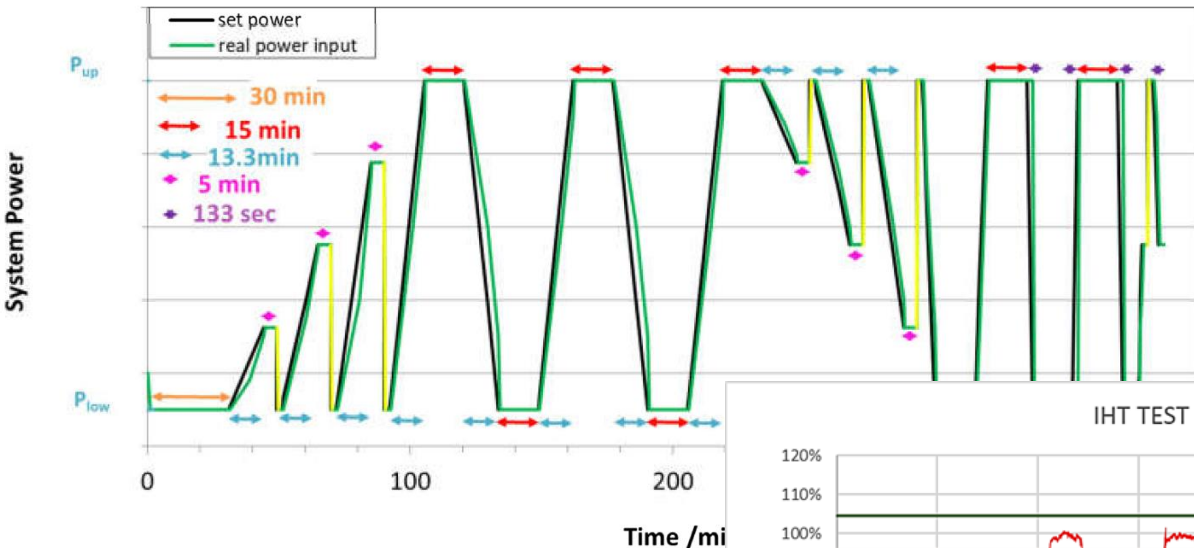
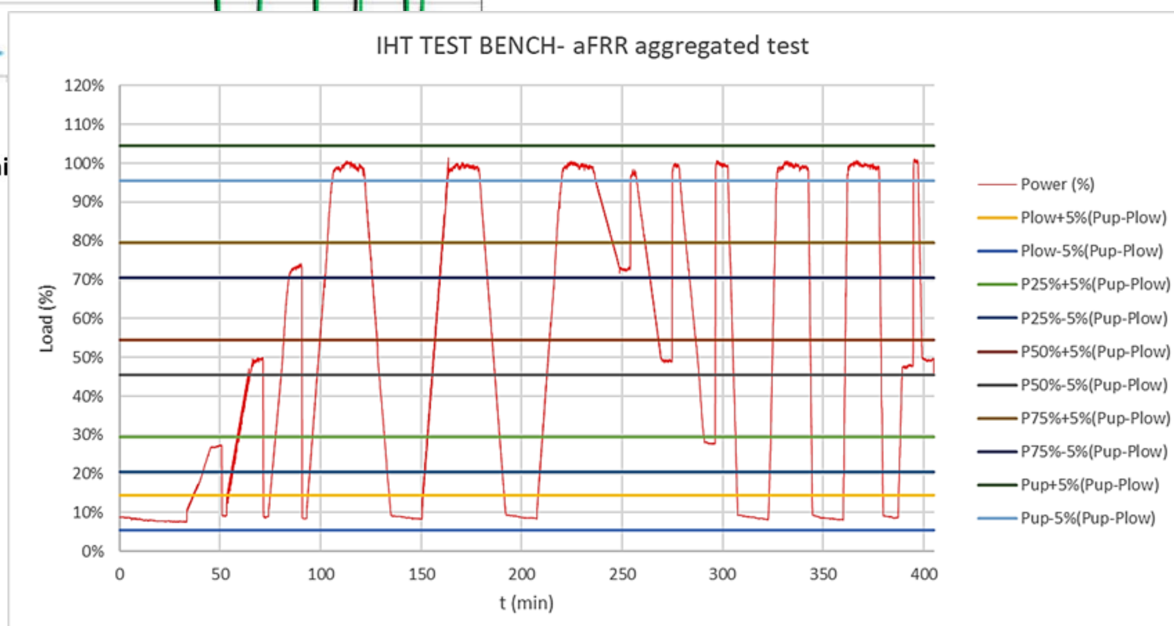
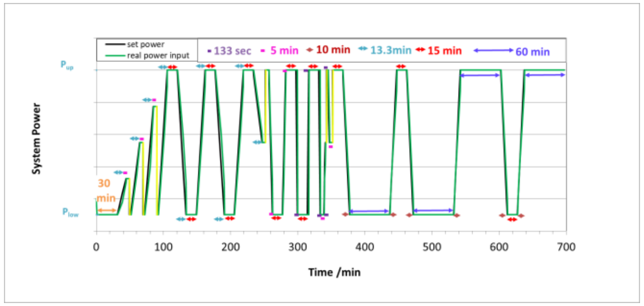
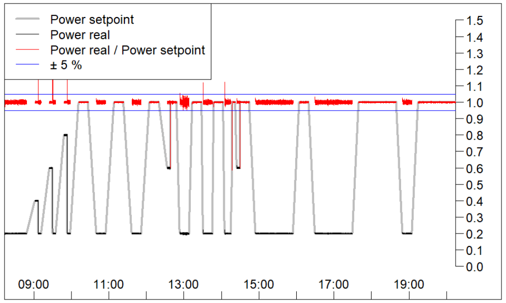


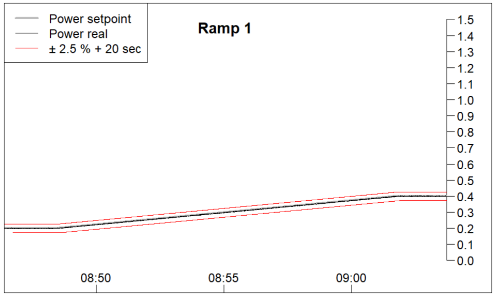


Alkaline test results

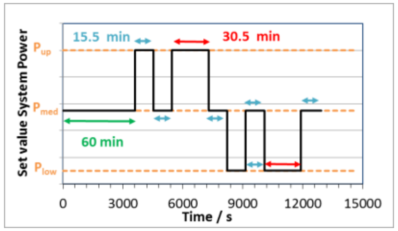
Frequency Restoration Reserve (FRR)
Aggregated automatic FRR (aFRR) and manual FRR (mFRR) testing protocol

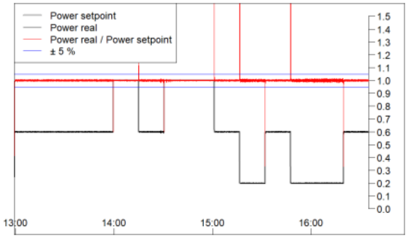


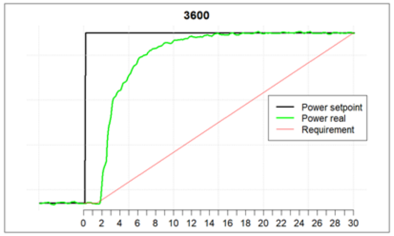


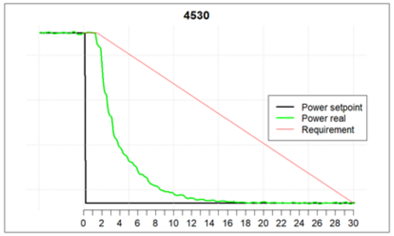


Frequency Containment Reserve (FCR)
Generic prequalification protocol









www.nelhydrogen.com

Lessons learnt

- Main grid services have been considered in QualyGridS testing protocols and validated in FHa, IHT and NEL facilities, among others partners.
- As a general requirement for water electrolysers providing grid services, they must be able to react to power changes as fast it is required depending on the service (FCR, FRR, etc), respecting the tolerances and grid constraints defined by each grid operator.
- Alkaline electrolyser are able to react to power changes requests in just few seconds and as fast as PEM electrolysers
- The Control and Communication System and the Power Electronics are main players in the provision of grid services. They have high influence on grid service performance (activation time, changes load, etc)

Thank you

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QualyGridS

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