

# Electricity Grid Services

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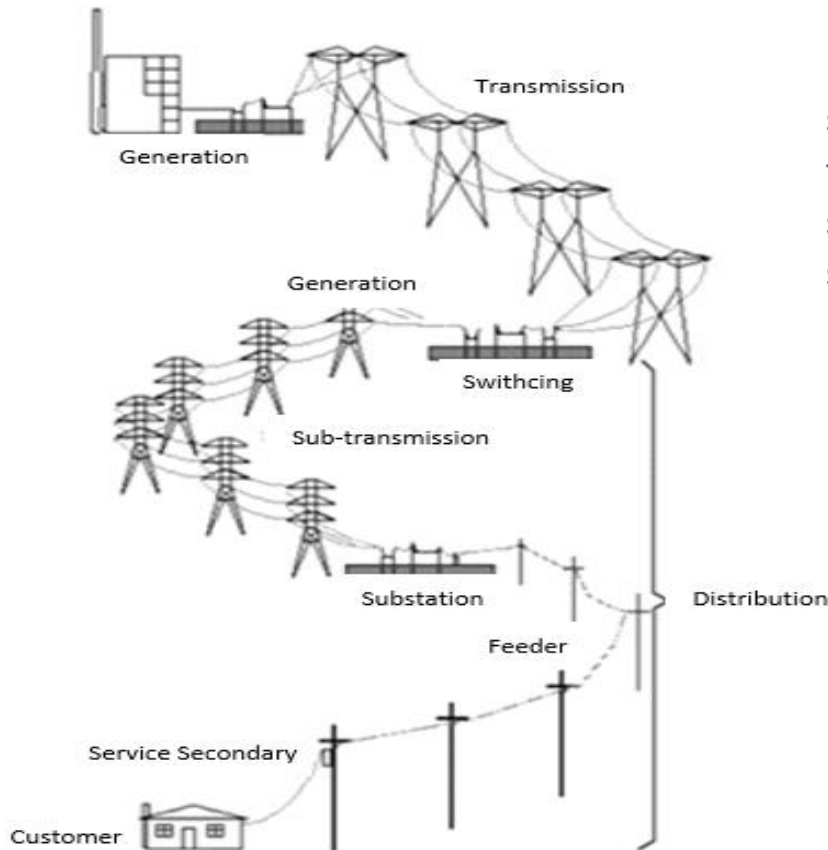


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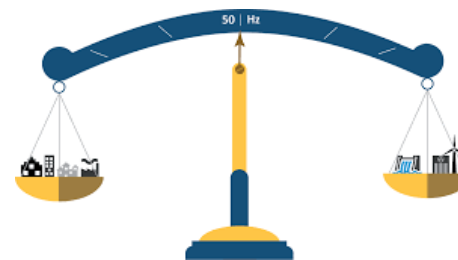
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# Electricity Grid Services



**Electricity grid services** (also known as ancillary services) are services and functions applied by the electricity grid operators to facilitate and support the continuous flow of electricity so that supply will continually meet demand.

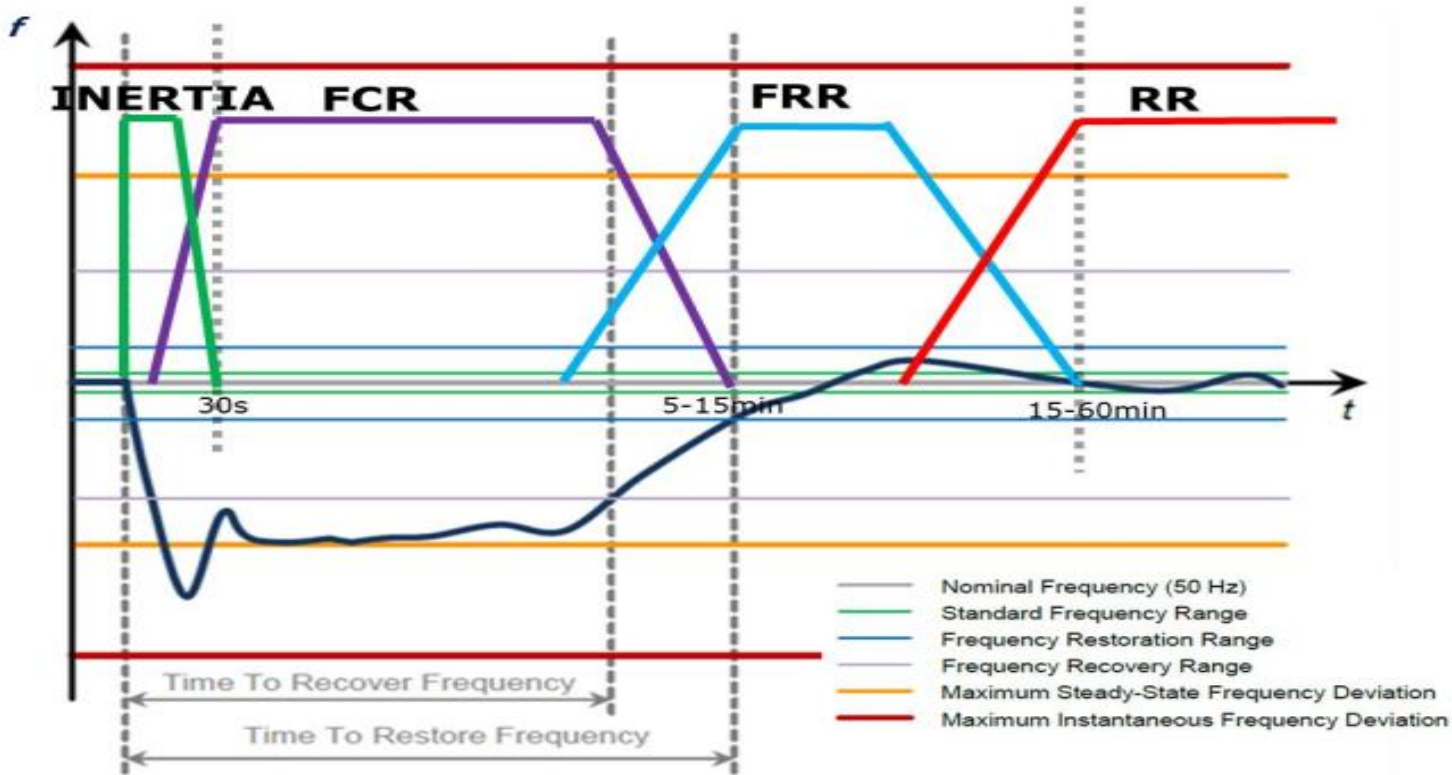


Balancing  
(global)



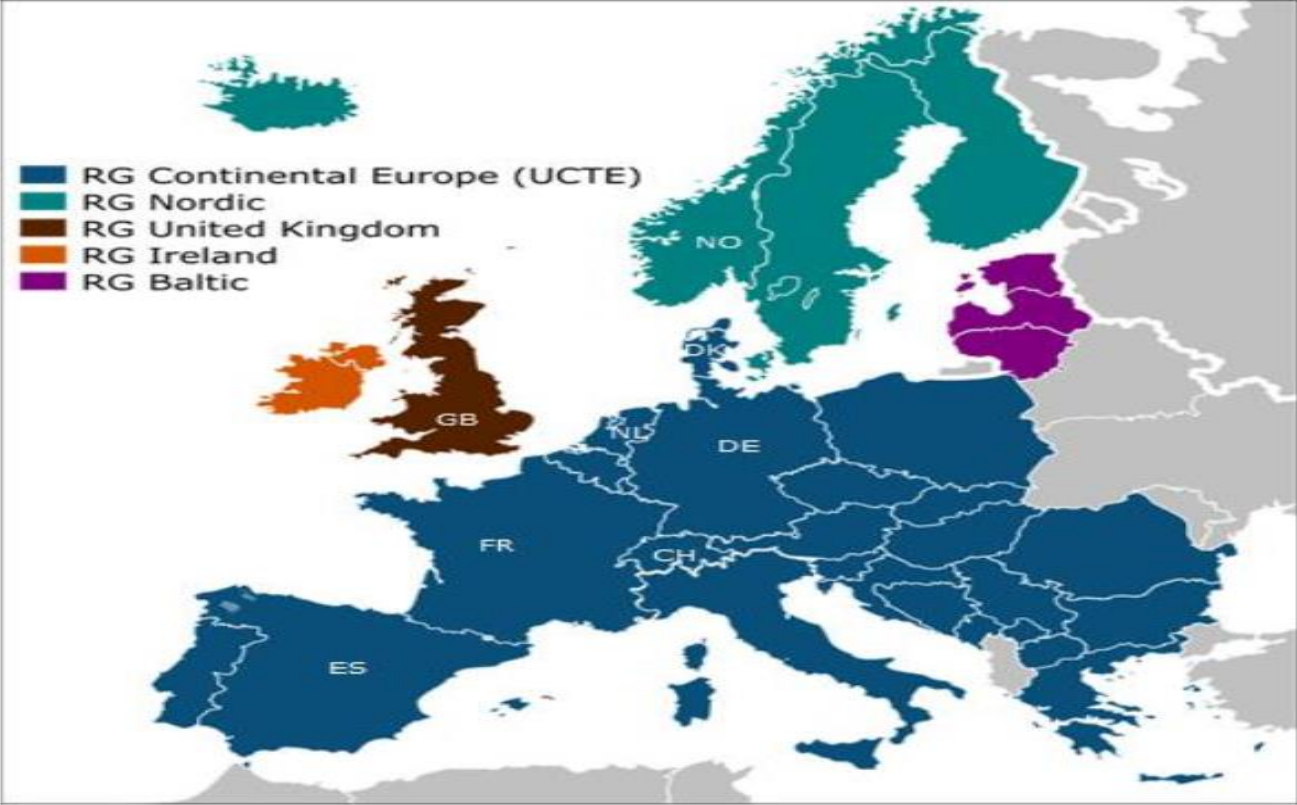
Congestion  
(local)

# Operation Principle of Grid Balancing



Frequency control services with approximate time scales

# Electricity Grid Services in Europe

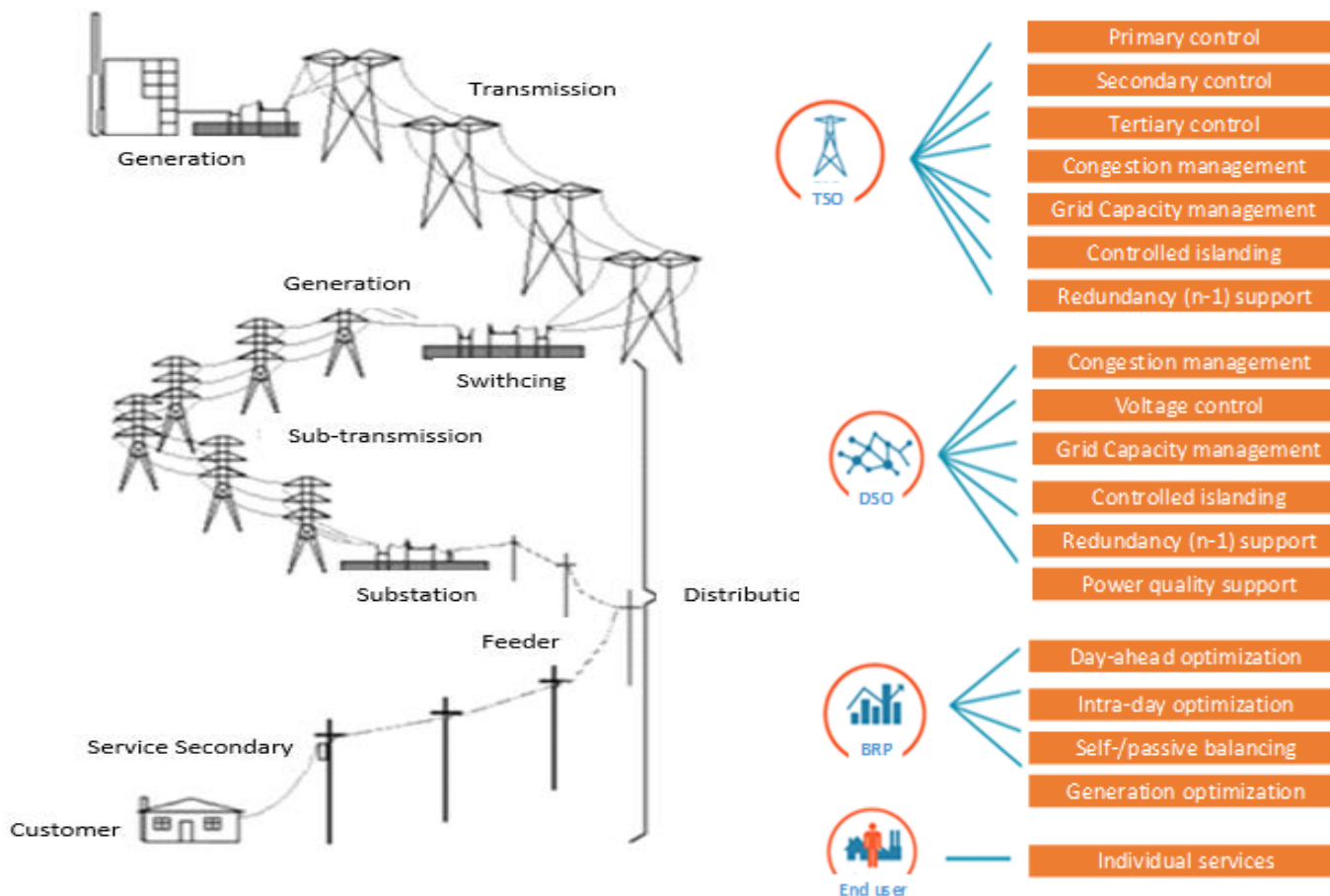


8 surveyed countries in 3 synchronous areas, i.e. Denmark, France, Germany, Netherlands, Norway, Spain, Switzerland and UK.

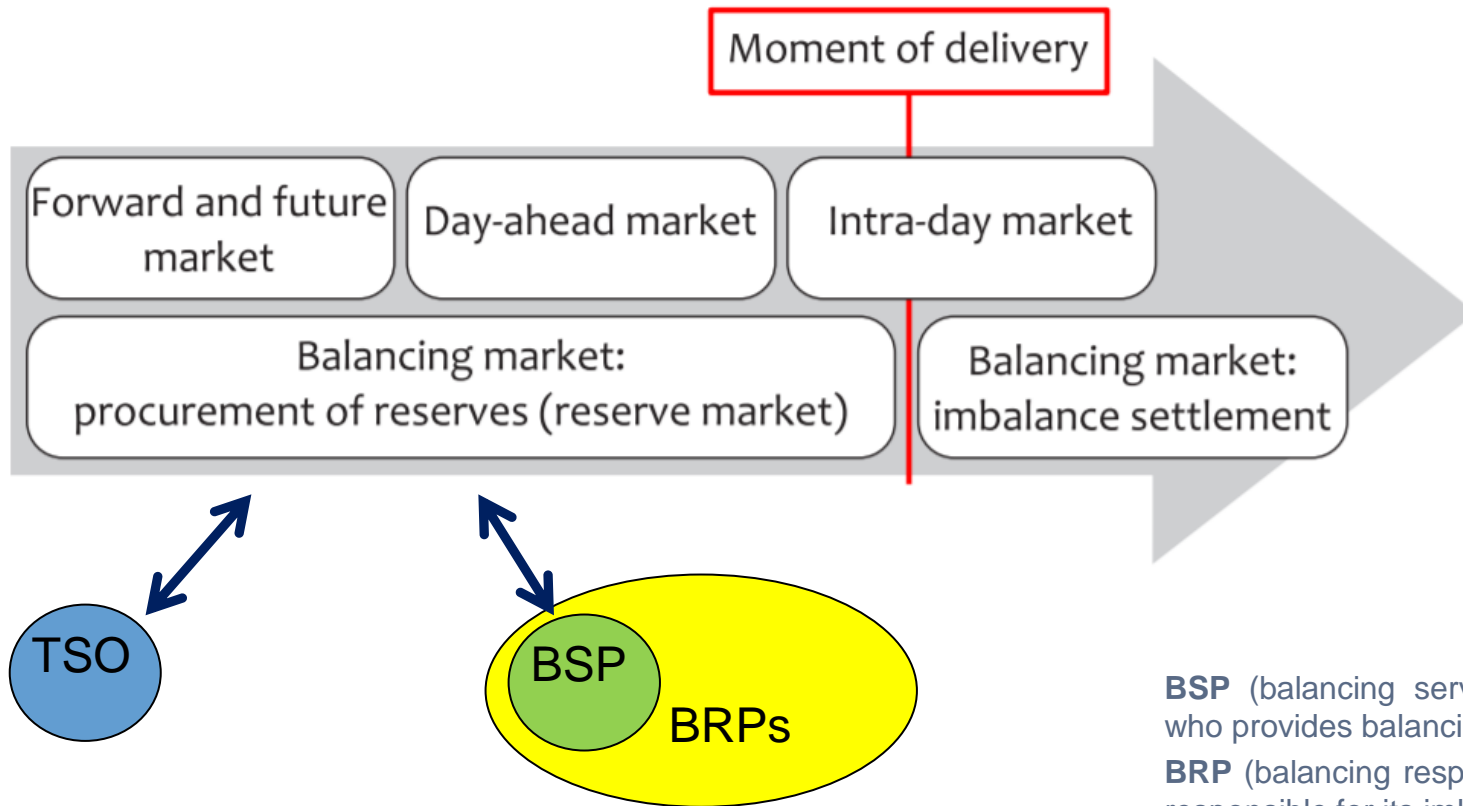
11 service categories  
**TSO** - FCR/ (a/m)FRR/ RR/ DSR/ CoM/ CaM/ VC  
**DSO** - CoM/ CaM/ VC/ PQ  
**P2P** - Self-balancing/ PO/ ET



# Electricity Grid Services in Europe



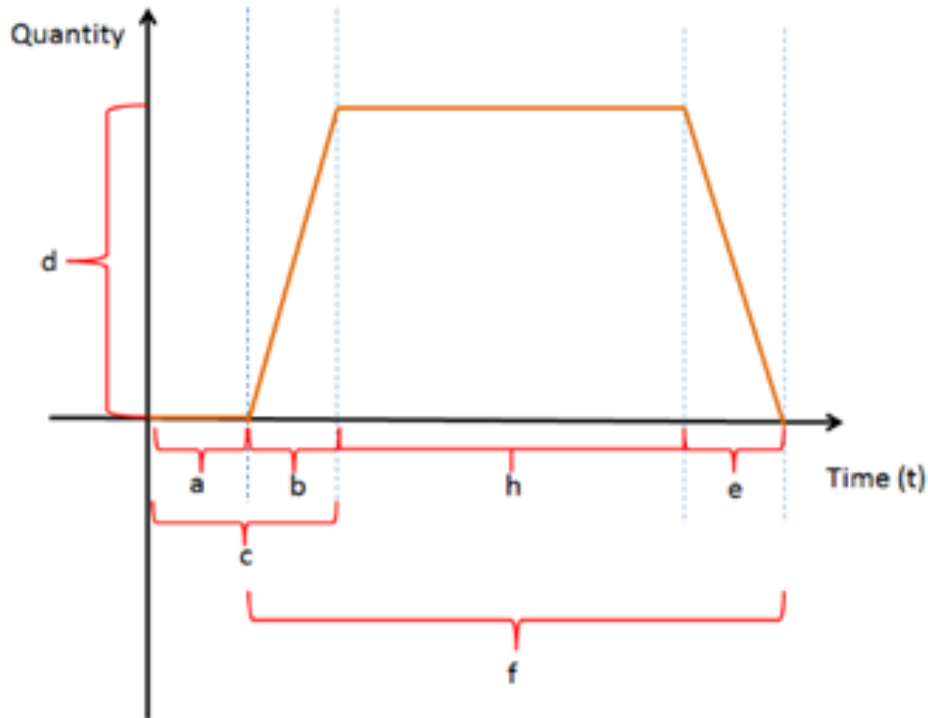
# Trading a Balancing Product in Electricity Market



**BSP** (balancing service provider): who provides balancing services

**BRP** (balancing responsible party): responsible for its imbalances

# Standard Description of A Balancing Product



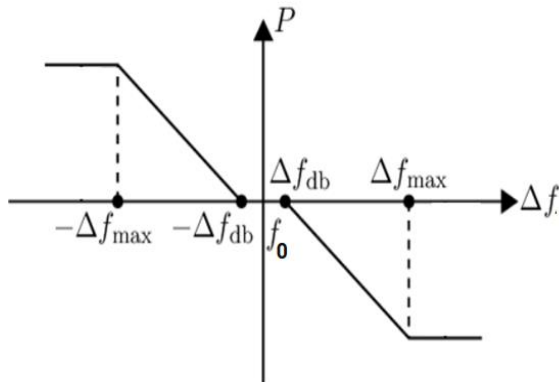
- (a) Preparation Period
- (b) Ramping Period
- (c) Full Activation Time
- (d) Min. & Max. quantity
- (e) Deactivation Period
- (f) Full Delivery Period
- (g) Validity Period: at least the Full Delivery Period, depending on validation rules applied.
- (h) Min. & Max. Duration of Delivery Period
- (i) Mode of Activation: Manual/ Automatic.

Standard description of any balancing product by *ENTSO-E*

# An example: Requirements for FCR in Denmark



Requirements for FCR for DK1



Performance requirements

$$\Delta f_{db} = 0.02\text{Hz} \quad \Delta f_{max} = 0.2\text{Hz}$$

$$TS_{50\%} \leq 15\text{s} \quad TS_{100\%} \leq 30\text{s} \quad (@\Delta f_{max})$$

$$TD \geq 15\text{min} \quad (\text{until FRR takes over})$$

$$TR = 15\text{min}$$

## Market rules

Day-ahead auction for up/down FCR with 6 equally sized time blocks  
minimum 0.3MW

## Accuracy of measurement

Accuracy of  $f$  measurement  $\geq 0.01\text{mHz}$

Sensitivity of  $f$  measurement  $\geq \pm 0.01\text{mHz}$

SCADA resolution  $\leq 1\text{s}$

Performance record at least one week

## Communication

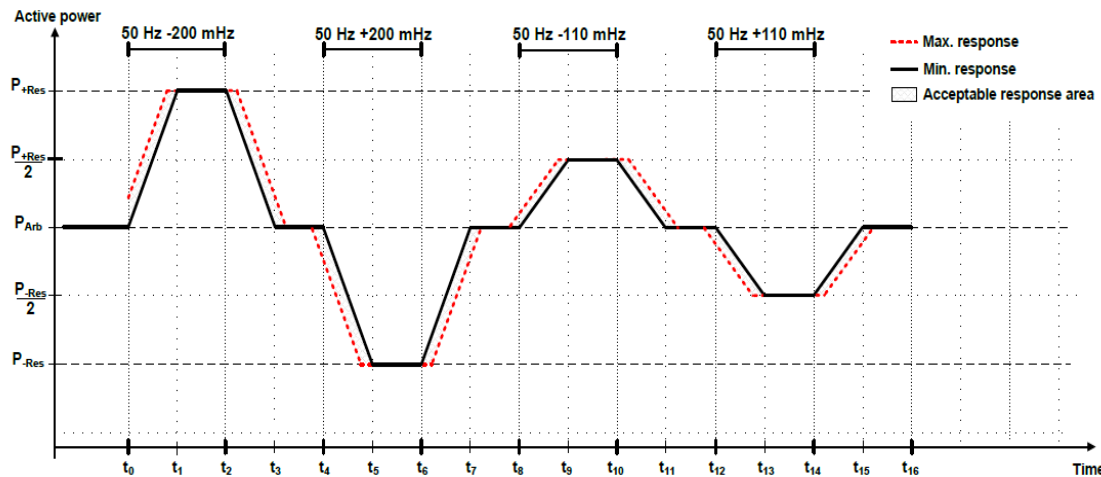
Online controllability from the TSO Control Centre

## Approval/Pre-qualification test

Conducted at least 3 weeks prior to the date of delivery. Testing details provided by the TSO.



# An example: Requirements for FCR in Denmark



Time parameters	Time
$t_0 - t_1$	As specified in Figure 3
$t_1 - t_2$	15 min
$t_2 - t_3$	As specified in Figure 3
$t_3 - t_4$	1 min
$t_4 - t_5$	As specified in Figure 3
$t_5 - t_6$	15 min
$t_6 - t_7$	As specified in Figure 3
$t_7 - t_8$	1 min
$t_8 - t_9$	As specified in Figure 3
$t_9 - t_{10}$	5 min
$t_{10} - t_{11}$	As specified in Figure 3
$t_{11} - t_{12}$	1 min
$t_{12} - t_{13}$	As specified in Figure 3
$t_{13} - t_{14}$	5 min
$t_{14} - t_{15}$	As specified in Figure 3
$t_{15} - t_{16}$	1 min

Prequalification tests of minimum requirements for FCR response

# Electrolysers for Grid Services



	PEM (Hydrogenics)	PEM-HGas1000 (ITM)	HPAWE (IHT)
Nominal power ( $P_{norm}$ )	Average 1075 kW	1030 kW	4MW
H <sub>2</sub> production under $P_{norm}$	213 ± 4.5 Nm <sup>3</sup> /h H <sub>2</sub>	432 kg/24h	800 Nm <sup>3</sup> /h
Efficiency under $P_{norm}$	-	up to 74%	4,5-4,7 kWh/Nm <sup>3</sup> at stack level
Load range	282 ~ 1540 kW	10% - 100% $P_{norm}$	0.6 ~ 6MW
Fluctuation	±8kW, occasionally up to 220kW, can last several min.	-	-
H <sub>2</sub> production under $P_{max}$	292 ±9 Nm <sup>3</sup> /h	-	1200 Nm <sup>3</sup> /h
Power consumption at Warm stand-by	Relatively high.	<5% $P_{norm}$ for stand-by durations less than 1 h.	Negligible for stand- by durations shorter than 8 h.
Start-up time from warm state to $P_{norm}$	-	<30 sec	<2 sec
Start-up time from cold state to $P_{norm}$	> 25 min	5 min due to safety checks	10-20 min
Efficiency considerations during start-up	-	<10 min from cold start mode to reach maximum efficiency.	-
Power ramp-up	2~17 sec between signal and target load	<1 sec response between min. and max. available power	2 sec between signal and target load
Power ramp-down	As fast as or faster than power steps up	-	1~2 sec between signal and target load

- 18+ relevant European activities have been reviewed
- Several WEs have already providing balancing services (often within a portfolio)
- The demand/interest for intermittent renewable based WE applications (wind-electrolyser, solar-electrolyser) is growing.

# Concluding Remarks



- The grid services and technical requirements are different between grid operators, but getting more and more harmonized.
- Distribution grid services and P2P services are emerging but not available yet as market-based services.
- Details of pre-qualification requirements among countries are not given at the same level.
- Requirements and services evolve over time, e.g. FFR (activation time less than 1s, duration 5-30s).
- WEs are in principle able to meet the technical requirements of most grid services, especially balancing services, although this can be significantly influenced by local conditions, system design and the business feasibility, etc.

More details are available in **D1.1-Electrical Grid Service Catalogue for Water Electrolysers**  
<https://www.qualygrids.eu/publications/>

# Thank you

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**QualyGridS**

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