



Les services réseau en Europe dans un futur proche : besoins et technologies

Focus Hydro

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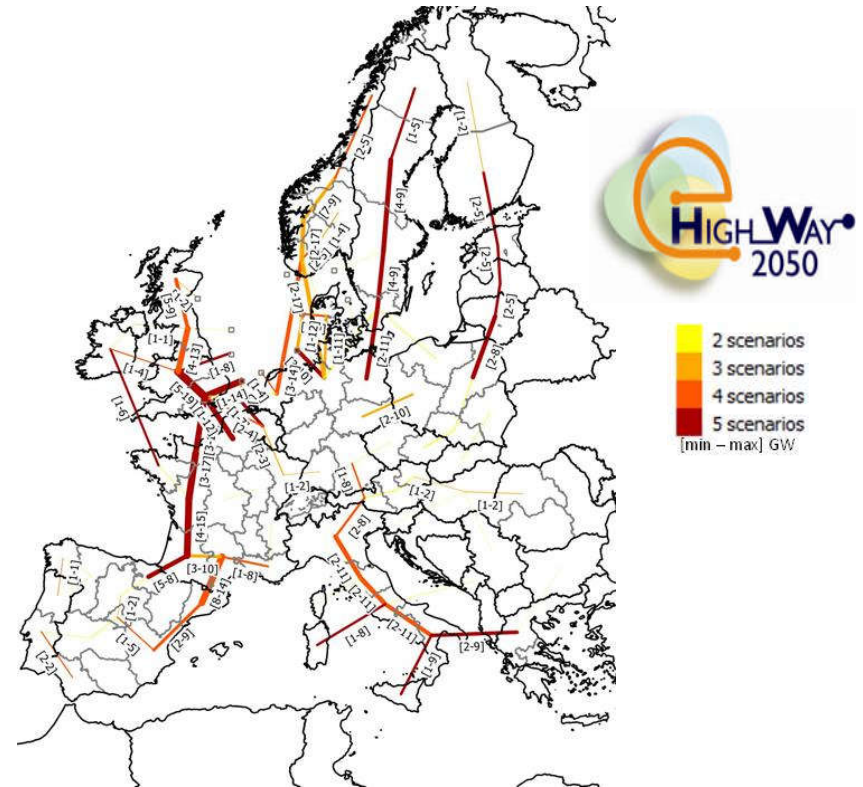


ENERGY TRANSITION

Major changes to the energy sector



**Energy
Transition**



**Compelling need to reinforce electricity
transmission system at European scale**

SUPERGRID INSTITUTE, a European leader in the field of supergrids

Key figures

- 01 | Date of creation: 2014
- 02 | Staff of **200+ persons**, 28 nationalities
More than 250 cumulative years of HVDC expertise
- 03 | Over **55 patent** applications
- 04 | Over 115 international publications
- 05 | **10 high tech test platforms** available for our clients
- 06 | Active member of major scientific leadership groups
CIGRE, IEC, IEEE...



SuperGrid Institute's test platforms



SUPERGRID INSTITUTE

Our domains of application

Future T&D grids



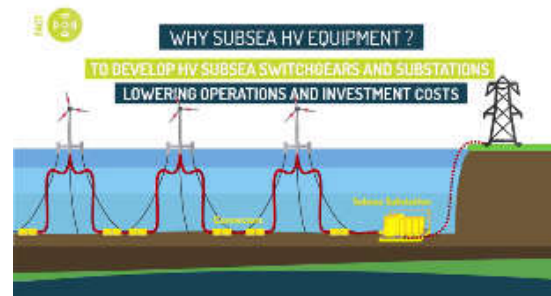
Offshore Wind Farm grid connections



Rail



Subsea HV equipment



Hydro & Storage



Research Program : Power Storage & Balancing

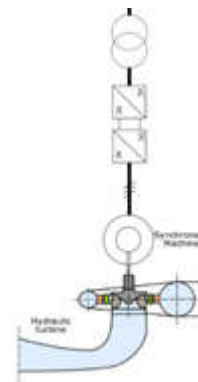
An expertise on ancillary services



Hydraulic Technologies



Ancillary Services



Energy Markets



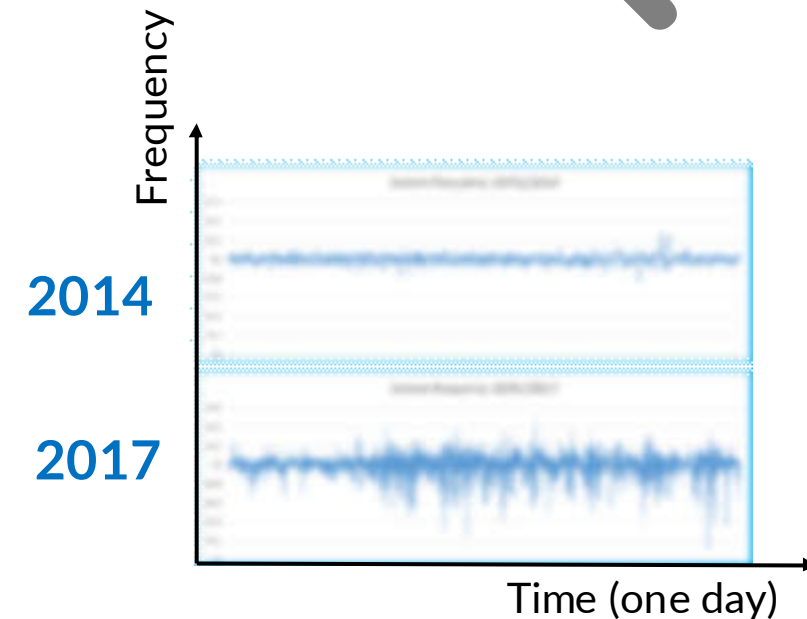
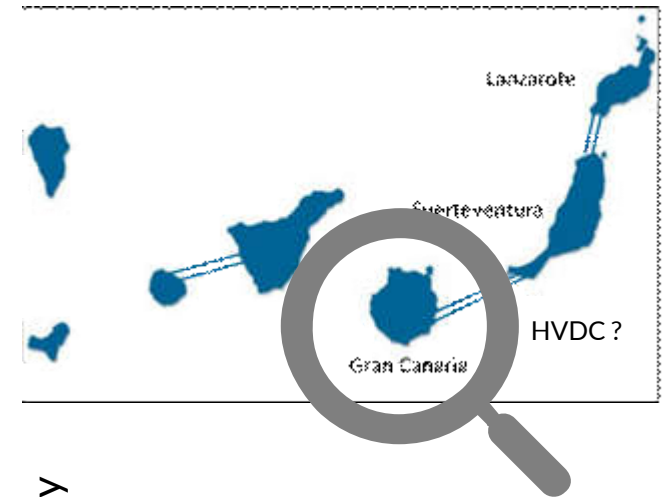
What is an ancillary service ?

Example of the Canaries island

- Small and isolated network
- Increasing penetration of renewable energy (wind) for a decade
- Frequency become unstable (low inertia)
- Project of a STEP to regulate the frequency



Soria-Chira project : PSP 6 x 33MW



Source: Grid2030 RITSE Project

www.ree.es/es/sostenibilidad/anticipacion-y-accion-para-el-cambio/programa-grid2030

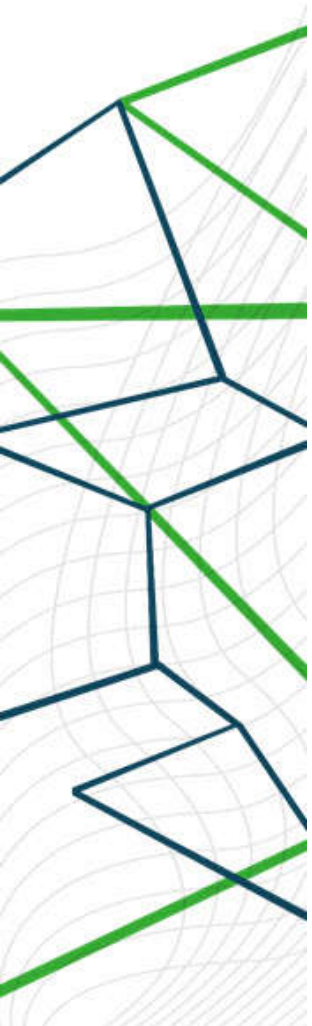
What is an ancillary service ?

Oscillations in Continental Europe : 1st December 2016

A major grid incident :

- Spain exported 2250 MW to the EU (maximum capacity)
- 11h18: The line 400 kV line Argia-Cantegrit tripped





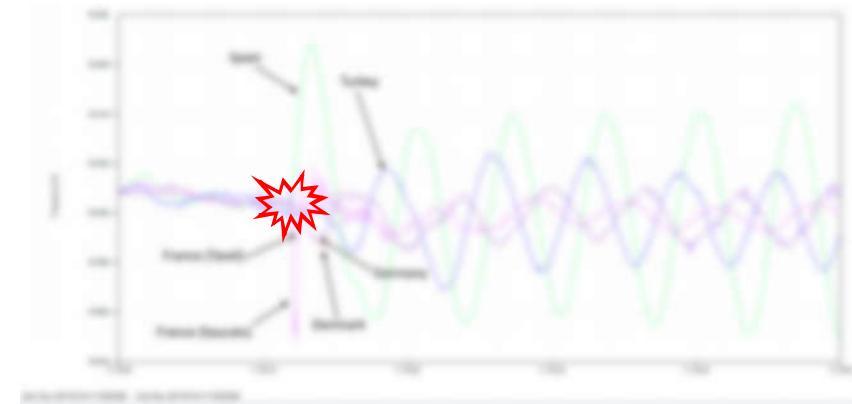
What is an ancillary service ?

Oscillations in Continental Europe : 1st December 2016

A major grid incident :

- Spain exported 2250 MW to the EU (maximum capacity)
- 11h18: The line 400 kV line Argia-Cantegrit tripped
- Undamped oscillations at 0.15 Hz appeared across Europe
- After few minutes, exchange between Spain and France have been reduced to 1000MW
- 11h21: Oscillations start to be damped.

Investigated in RITSE Grid2030 project with REE

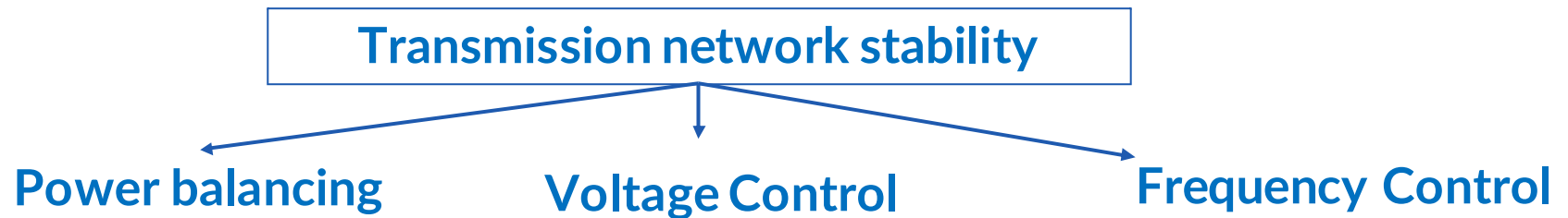


Source: Grid2030 RITSE Project

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What is an ancillary service ?

Global mechanisms, local implementations



- Network congestion
- Production vs consumption

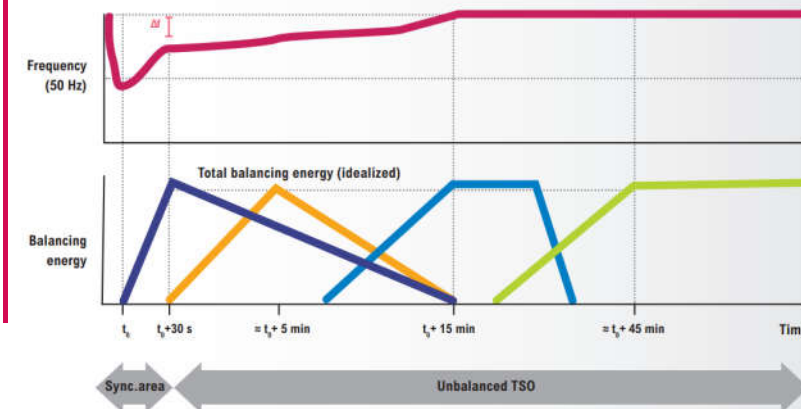


- Nodal management
- Reactive power



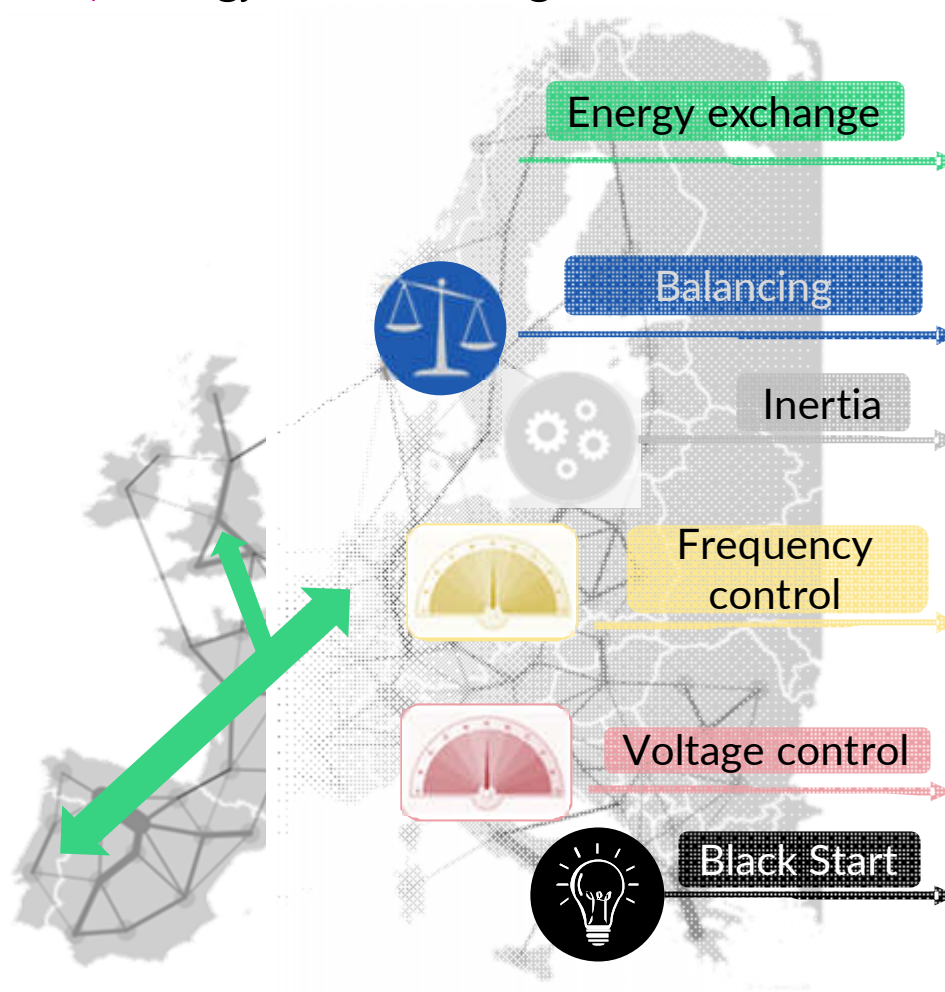
entsoe

FCR	aFRR	mFRR	RR
• Automatic activation • Max 30 s	• Automatic activation • 30 s to 15 min	• Semi-automatic or manual activation • Max 15 min	• Semi-automatic or manual activation • Min 15 min



How compensation mechanisms meet technical needs ?

Energy market design



Compensation mechanisms

Power exchange markets:

- Forward (Peer to peer )
- Day ahead (Open market SDAC coupling )
- Intraday (Open market SIDC coupling )

RR market TERRE 

None

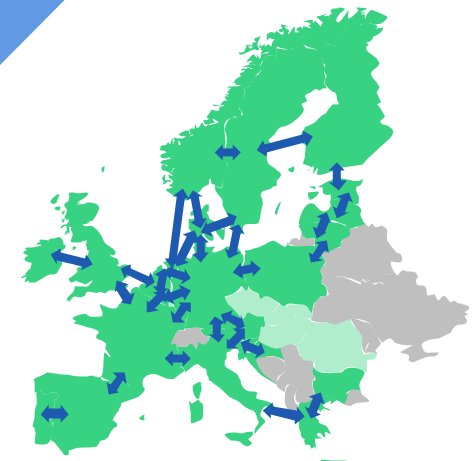
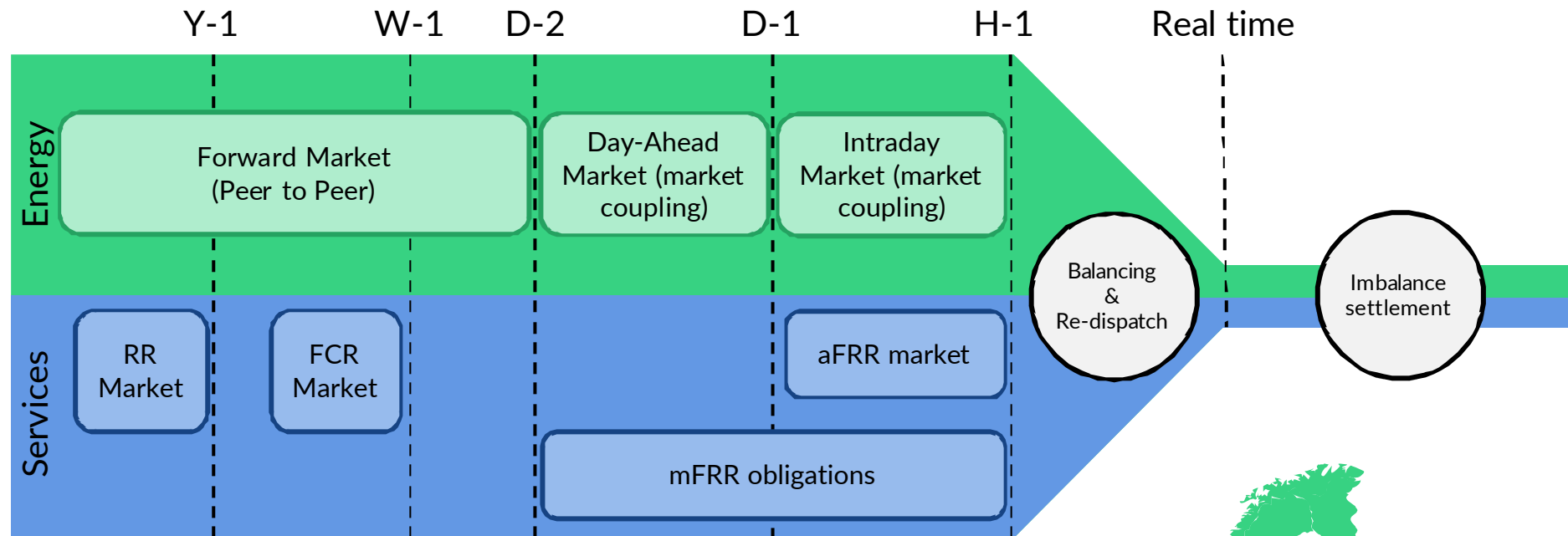
- FCR cooperation market 
- aFRR market PICASSO  and IGCC 
- mFRR obligation (future platform MARI )
- RR market TERRE 

Contracting (SSY remuneration )

Emergency and Restoration Code. Local practices.

How compensation mechanisms meet technical needs ?

Market timing

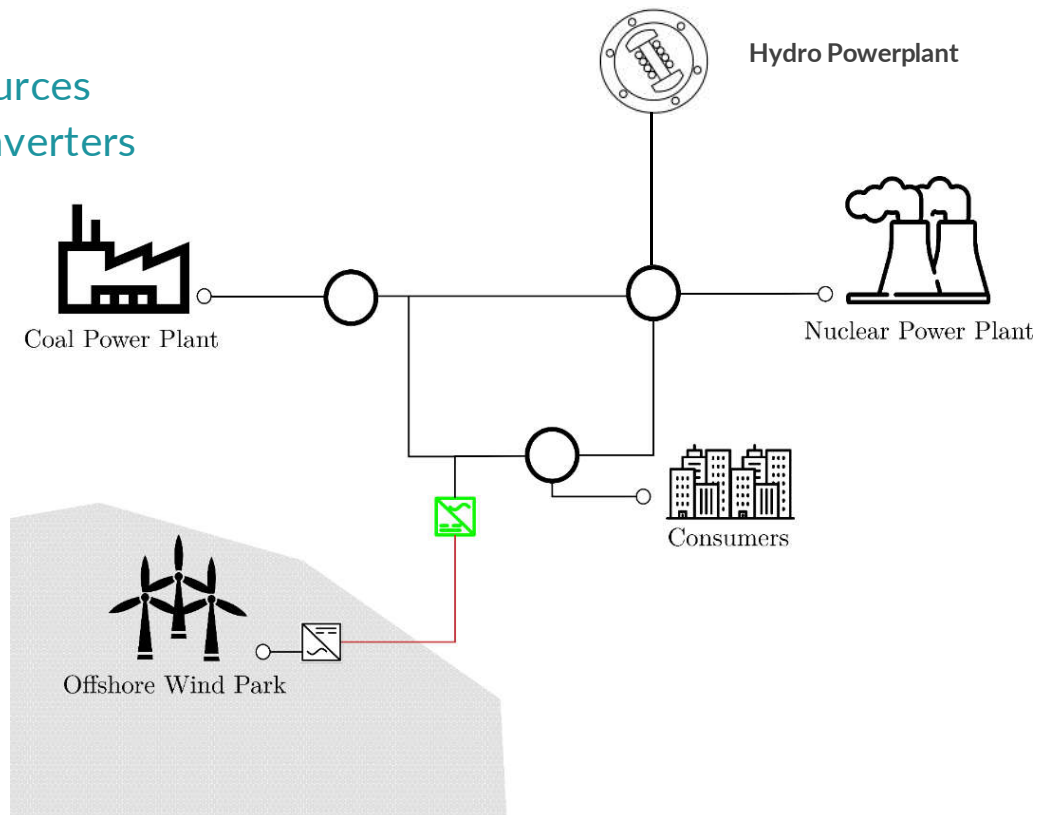


The power system in the next decades

A deep change in the system control will be necessary

Large penetration of renewable sources :

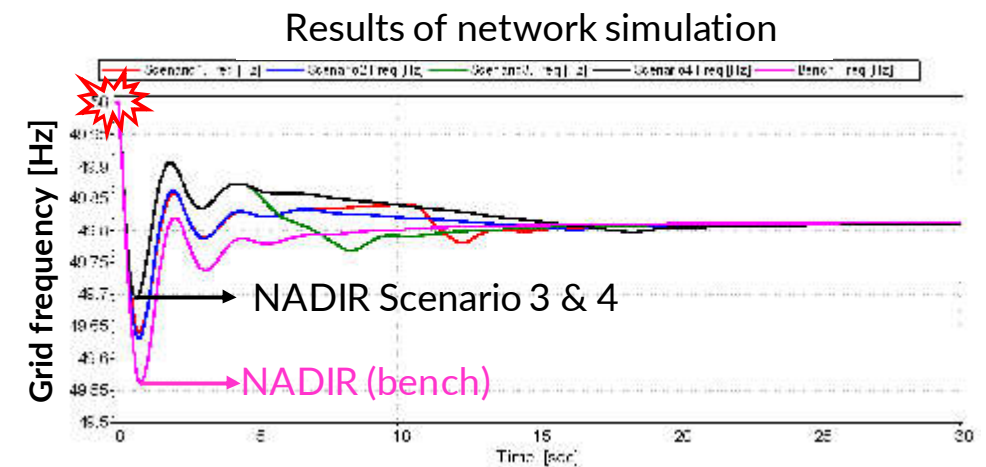
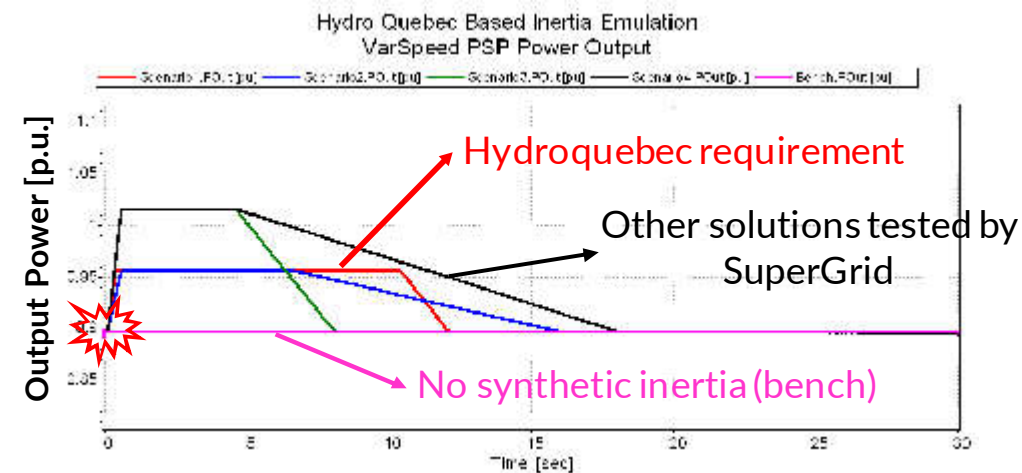
- Less synchronous machines
- Less dispatchable power sources
- More power electronics converters

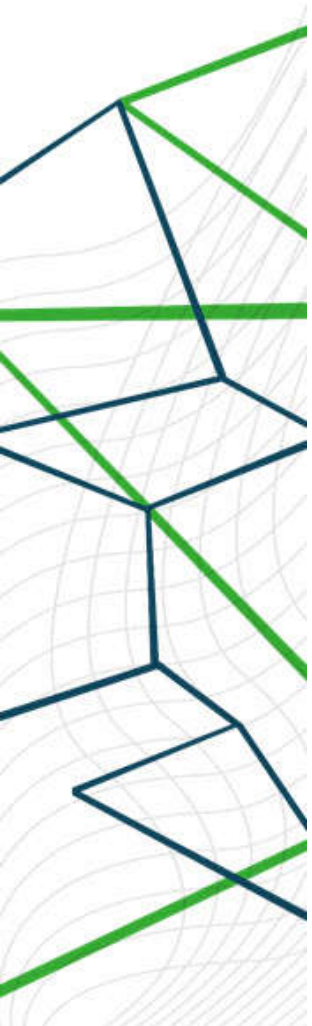


The power system in the next decades

An example of new ancillary service : the synthetic inertia

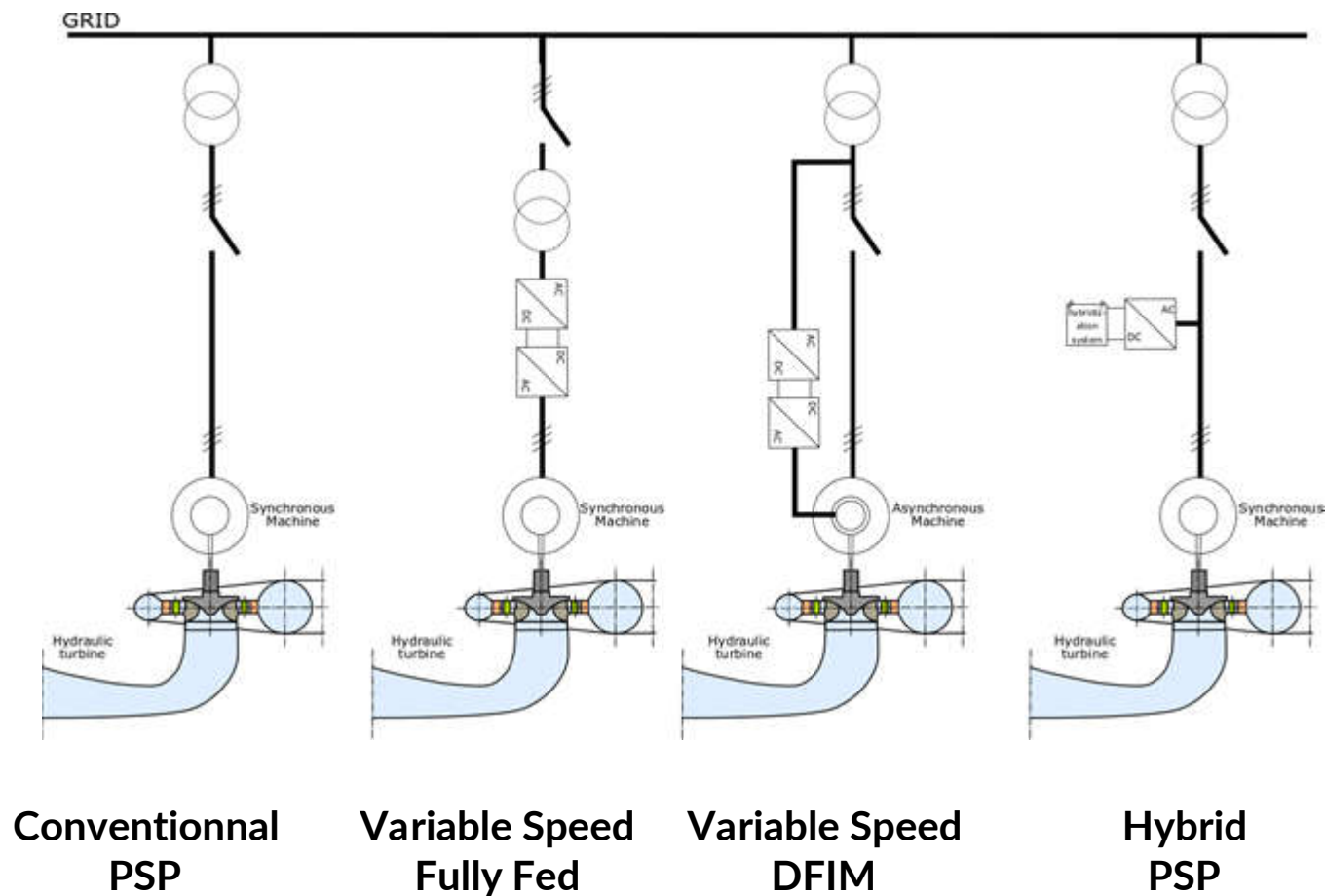
- Synthetic inertia : an automatic power response to a frequency droop
- Synthetic inertia contribute to frequency stability
- Varspeed hydro and Wind can provide synthetic inertia
- Hydro only can provide sustained power





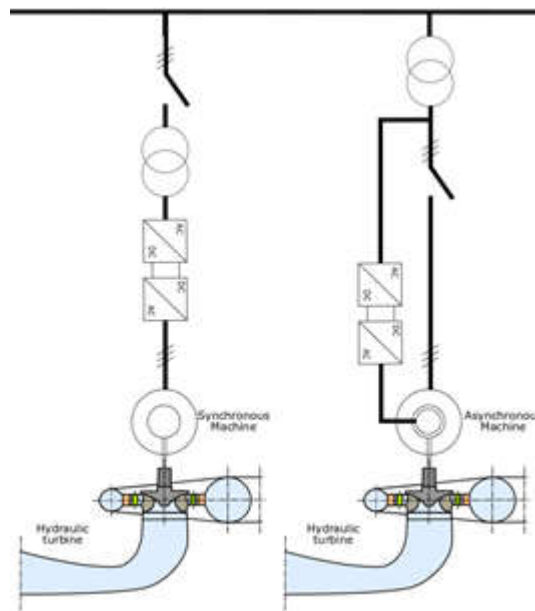
Contribution of the Hydro Power Plant to Ancillary services

4 Hydro technologies dedicated to Ancillary Services



Contribution of the Hydro Power Plant to Ancillary services

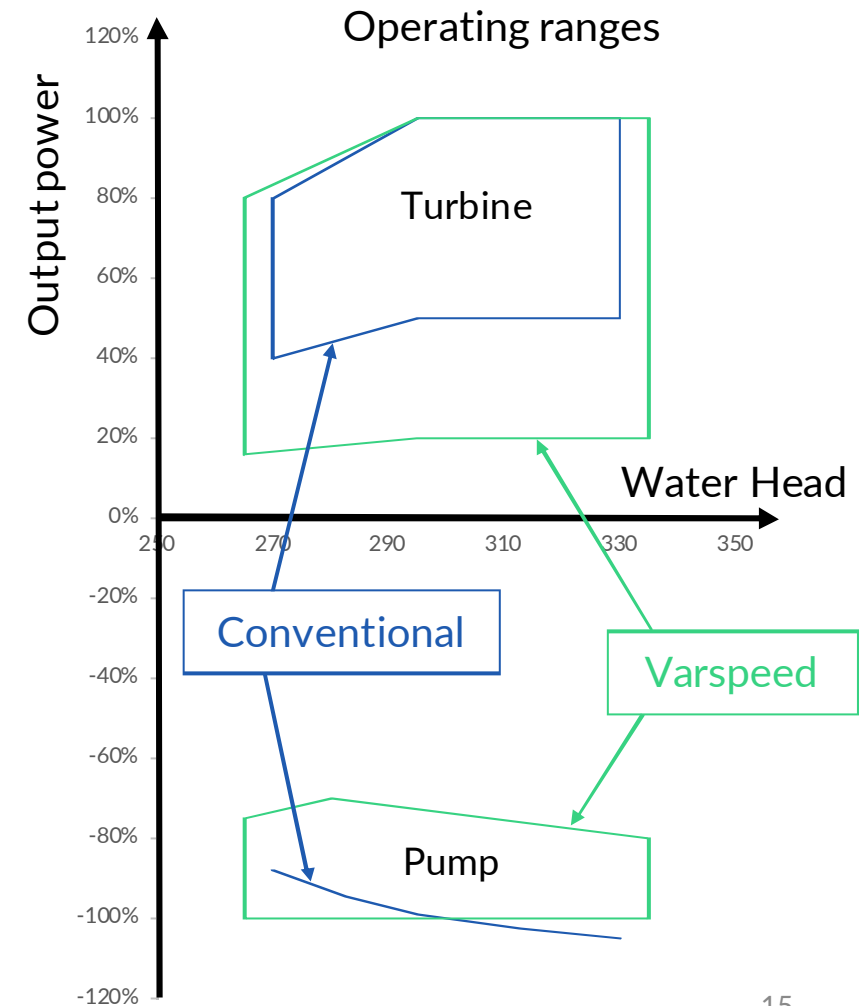
Variable speed units



**Variable Speed
Fully Fed**

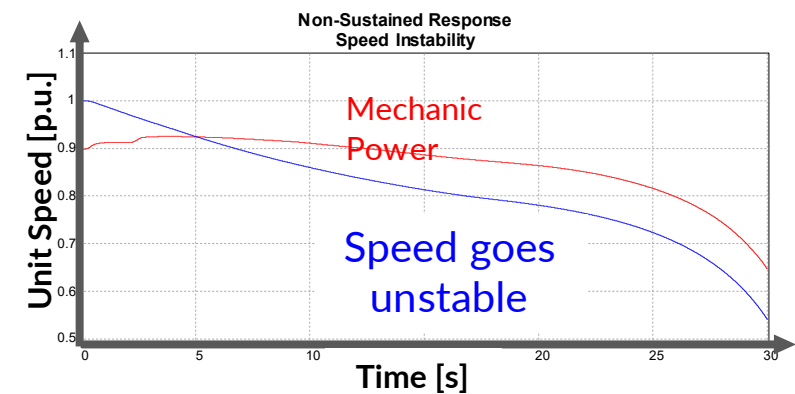
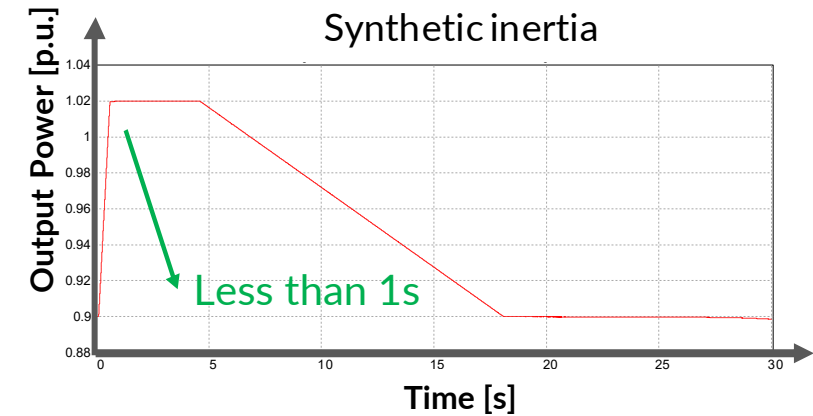
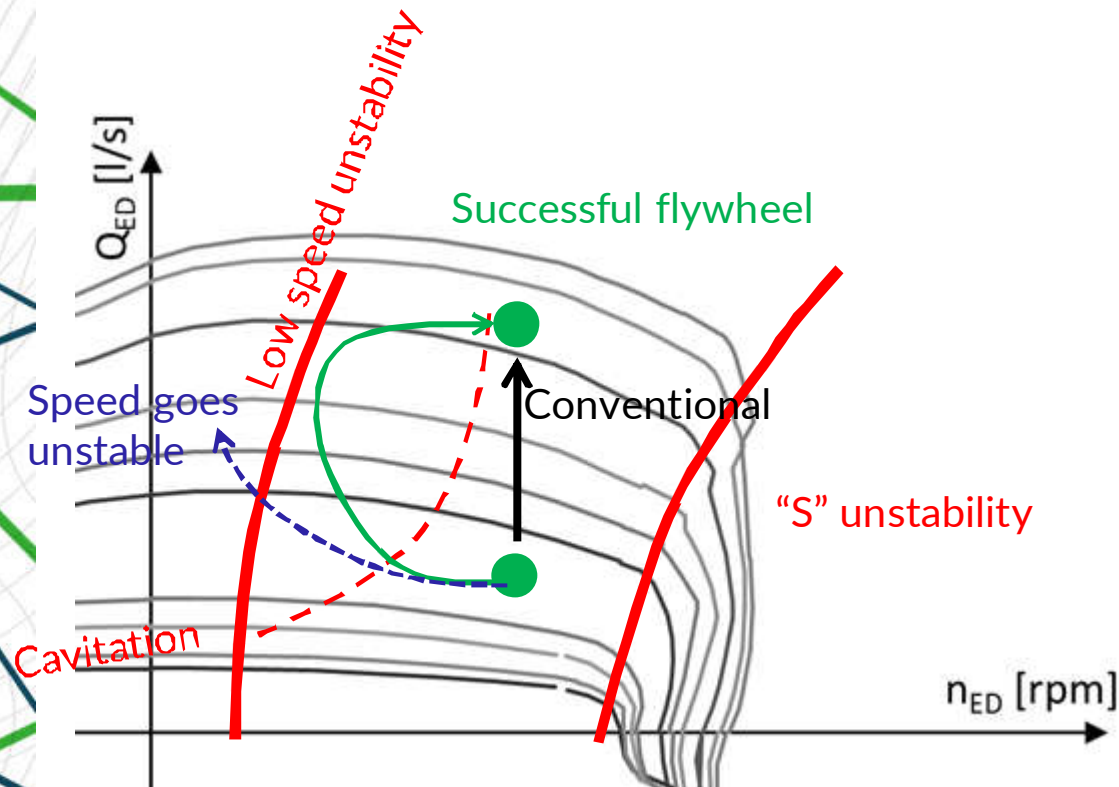
**Variable Speed
DFIM**

Active power regulation in pump mode



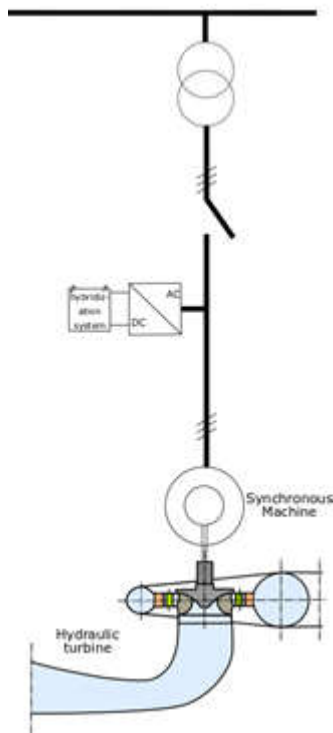
Contribution of the Hydro Power Plant to Ancillary services

Variable speed units– Flywheel effect

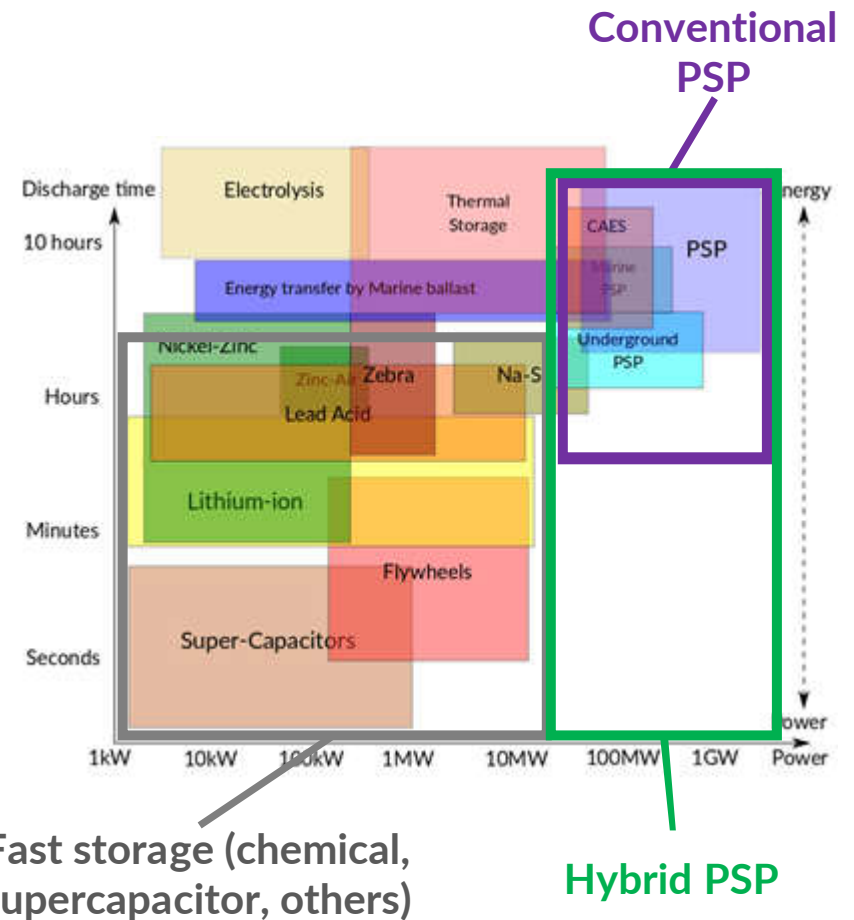


Contribution of the Hydro Power Plant to Ancillary services

Hybrid Hydro Powerplant



- New technology development (today TRL3)**
- Concept : coupling a conventional HPP unit to an Energy Storage System (ESS)**
- Objective : improve the performance of the PSP for Ancillary Services.**

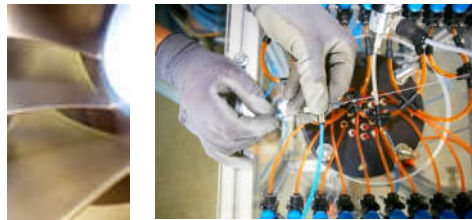


SuperGrid Institute

Two test platforms for hydro technologies

TM1 IEC-60193 test rig

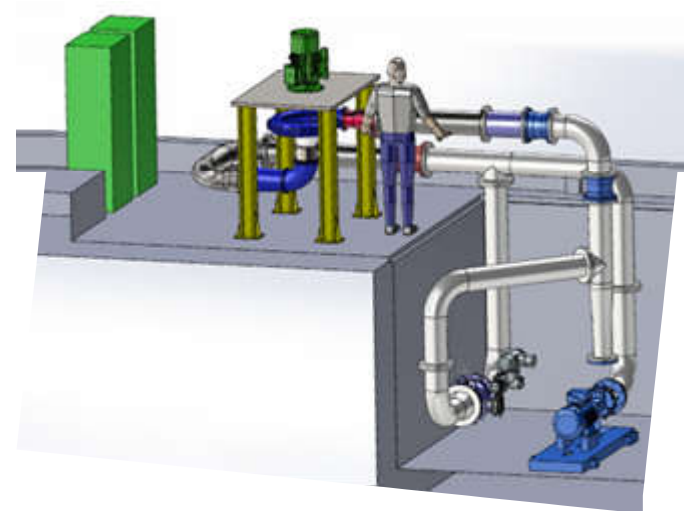
- Output/Inut power : 330 kW
- Scale of the turbine : $\sim 1/10$ to $1/5$
- Testing Head: 100 mWC
- Efficiency accuracy: better than 0,3 %



HydroPHIL A future real time platform

- Output/Input Power : 10-15kW
- Turbine & Motor/Generator
- Scale : $\sim 1/25$ to $1/8$

➔ Commissioning 2020



Conclusion

- We will have to adapt our electricity network to allow the energy transition
- New technologies will be needed to increase the share of renewables in the mix
- Compensation mechanisms for producers will have to be adapted to new technical needs
- The SuperGrid Institute was created to ensure that France and Europe remain leaders in these areas

Thank you for your kind attention

