Are grid codes and forecasting requirements a barrier or a sign of commitment to VRE?

- ✓ **Lessons learned**
- ✓ **Grid Integration**

IBERDROLA

Renewables: one size does not fit all

More mature markets (EU or North America)

- Low energy demand growth/overcapacity
- Large penetration of var-res
- Sustainability of premiums under fire
- Market design questioned. Key issue: value of electricity
- Challenges: interconnections, price signals: energy, balancing and capacity markets, emissions

Emerging markets

- High energy demand growth
- Medium/Low penetration of var-res
- High sensitivity to premiums costs
- Institutional design incomplete/limited
- Grid upgrades required
- Sensitive to mature markets *(under)* performance

Potential markets

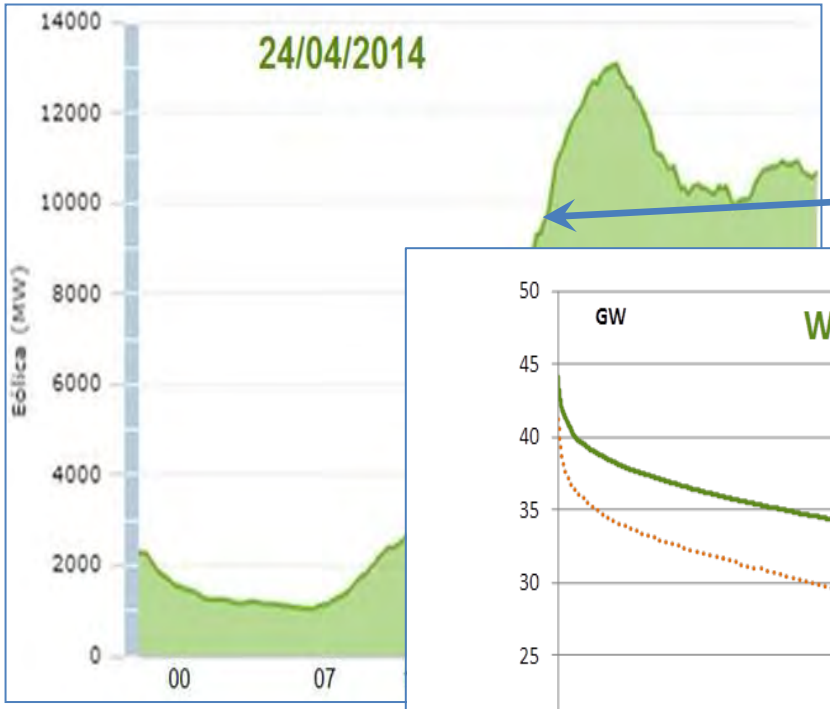
- Higher energy demand growth
- Low penetration of var-res/vast resources
- High sensitivity to premiums costs
- Weak institutional /market design
- Legal certainty needed
- Weak grids and interconnections

Lessons learned

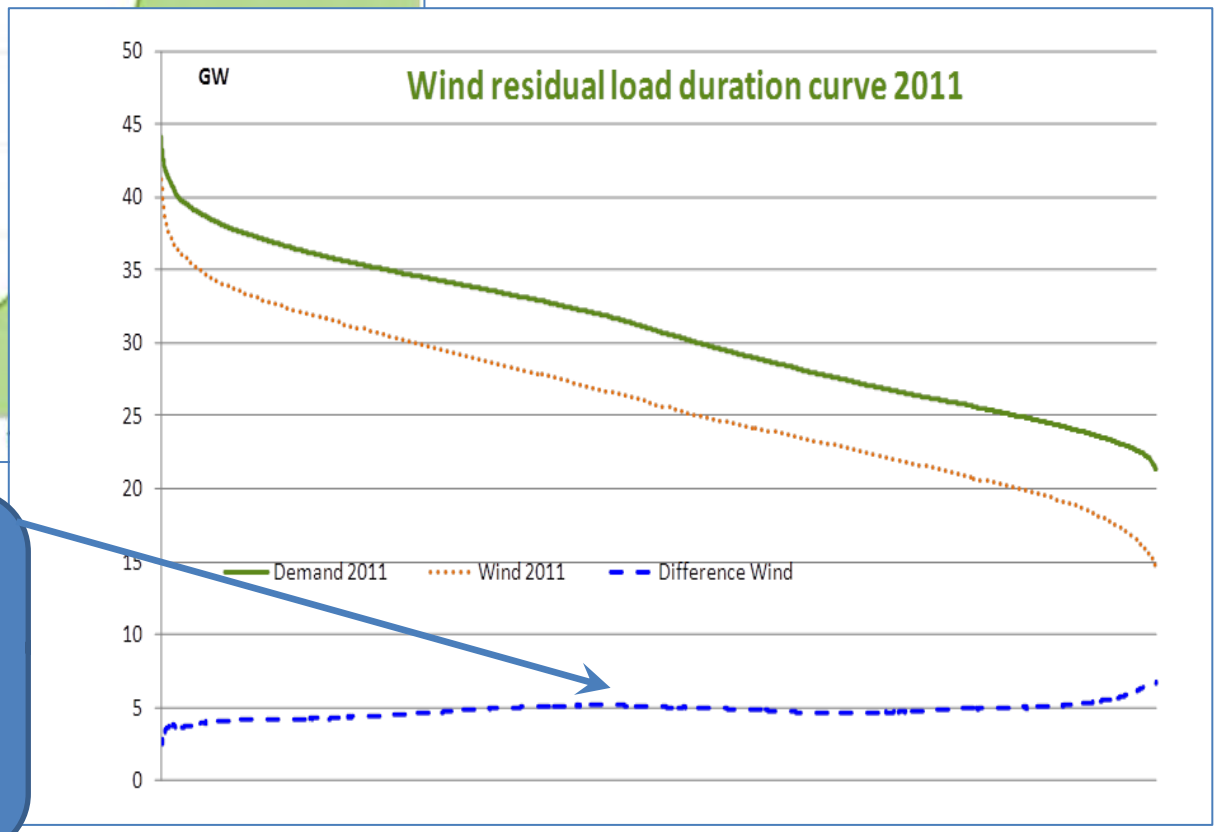
Lessons learned

IBERDROLA

Wind is variable, its energy stable



Even if predictable, wind is variable…



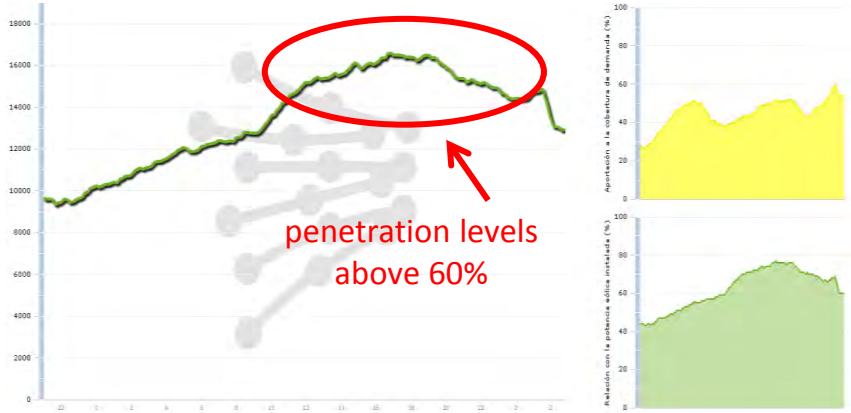
…but its annual energy contribution is very stable

4

Lessons learned

Impact of high renewable penetration level on the power system and the wholesale market

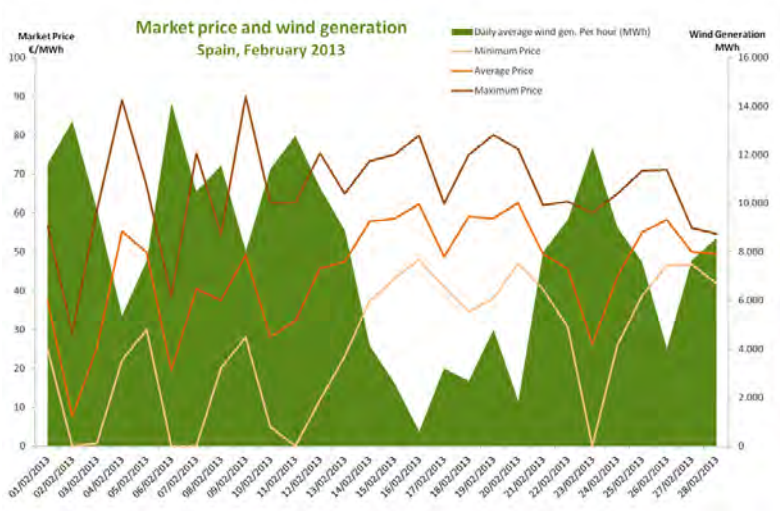
✓ **Spain: November 2012, wind penetration**



Large renewable penetration achieved in many markets:

- ✓ Advanced forecast methods
- ✓ Control centers capable of real time wind management
- ✓ Improved operational and technical performance of RES generators

✓ **Spain: February 2013 market prices**



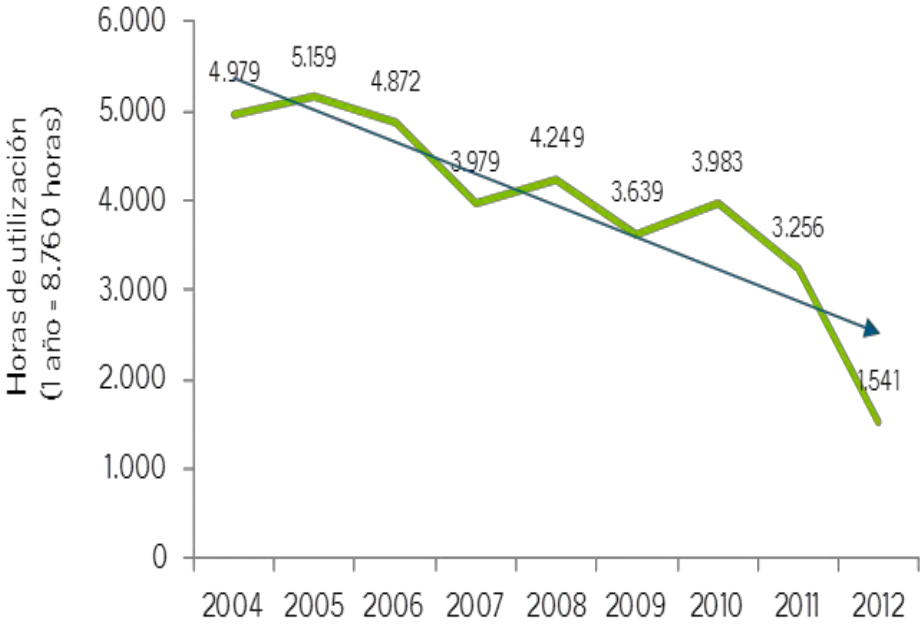
- ✓ Recurrent low and zero wholesale prices
- ✓ Is the current energy market design (marginal-cost alone) still valid?

✓ **Favorable framework, successful integration & market consequences**

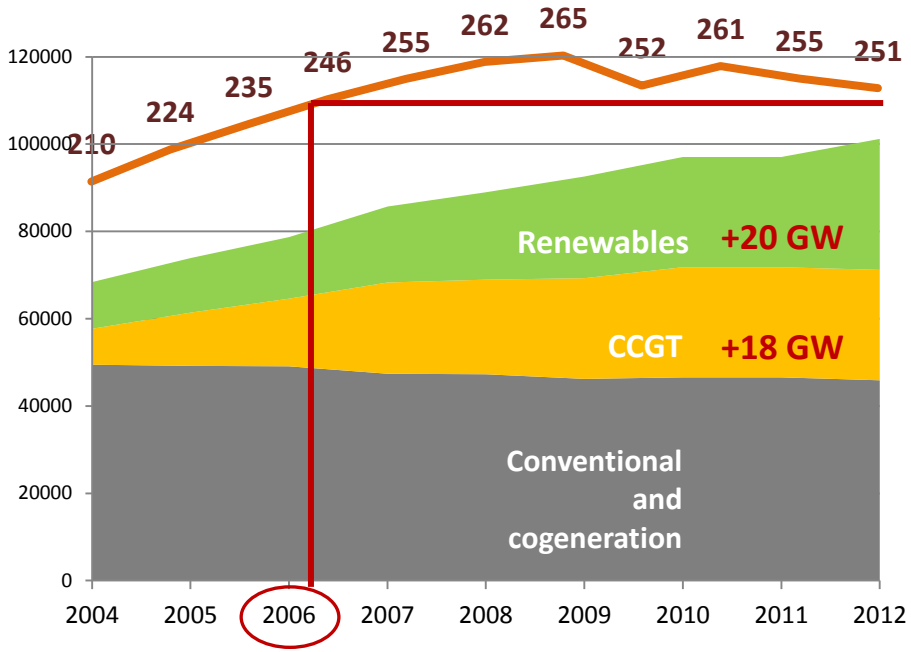
Lessons learned

High RES penetration affects conventional generation

CCGT load factors in Spain



Installed Capacity (GW) And power demand (TWh)



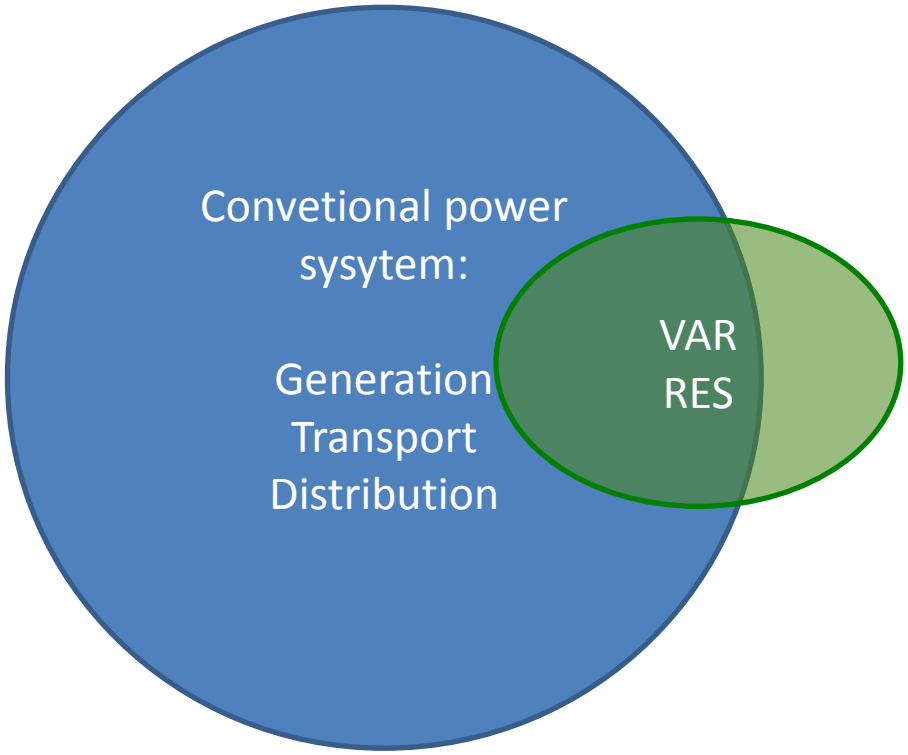
in an environment of weak demand, high penetration of RES tend to affect CCGT load factors

Source: REE, AEE, Energía y sociedad

Grid Integration

VAR RES in the power system: classic approach

VAR RES as an adittion to the system



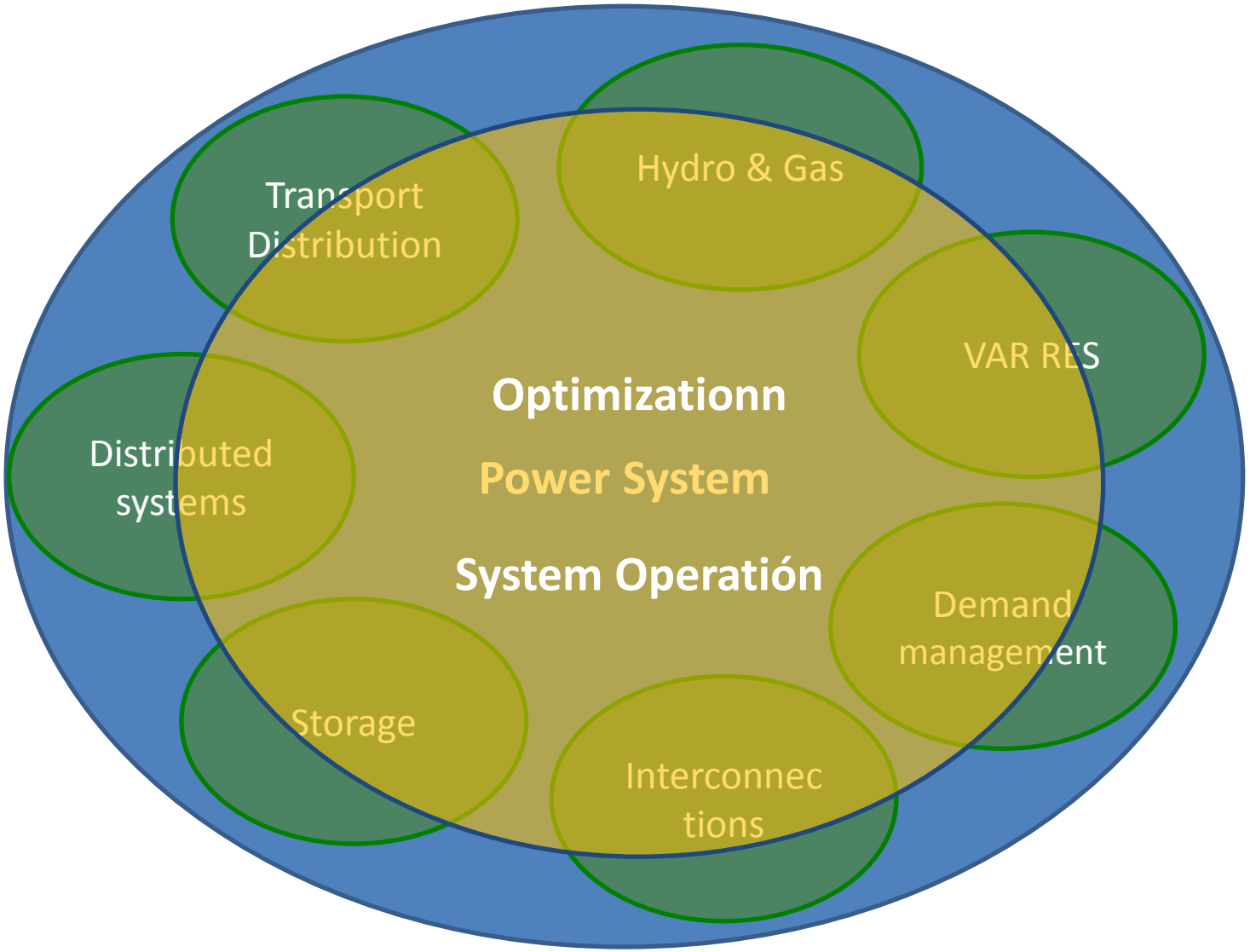
Diagnostic:

- ✓ VAR RES as the problem
- ✓ Conventional Generationn as *the* solution

Outcome:

- ✓ Sub-optimized system
- ✓ All agents penalized
- ✓ Client is desoriented

VAR RES in the system: integration and optimizations is the key



Open menu for acommodating large (≥ 10%) penetration of renewables in the electric system

1. **Markets and regulation**: Flexibility & demand side economics
2. **Technical**: advanced forecast, grid codes, control centers
3. **Hardware**: flexible generation plants, grids, interconnectors

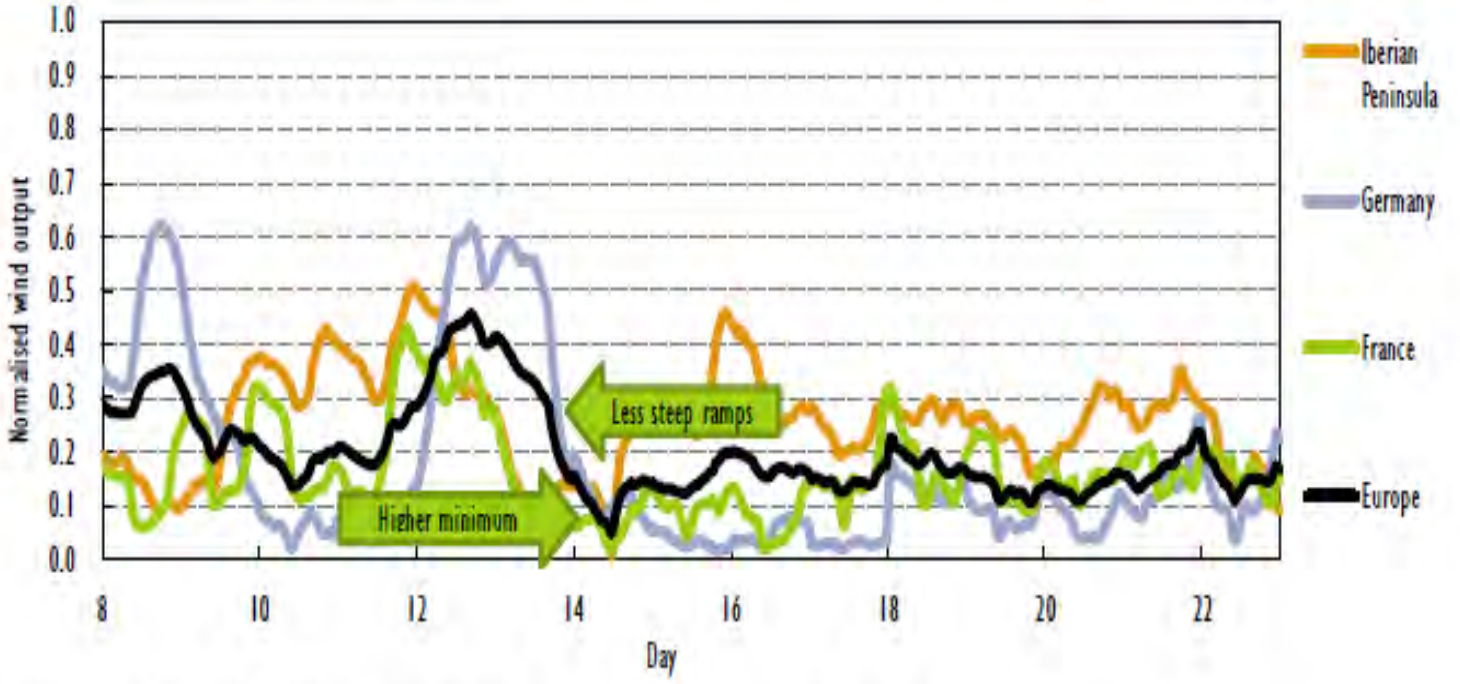
- ✓ Flexible generation units
- ✓ Storage (pumped storage, electric vehicles)
- ✓ Increase system size: interconnexions
- ✓ Demand side management
- ✓ Improved & smart grids. Transport & distribution
- ✓ Implement or improve var-res output forecast
- ✓ Ancilliary services: provide **network stability**
  - ➢ Real time dispatch, voltage dips, active & reactive power control

System Flexibility

Increase system size and geographical spread…

Large power system mitigate VAR RES Volatility

Figure 2.4 Sample weeks of aggregated wind and solar PV output for selected case study regions



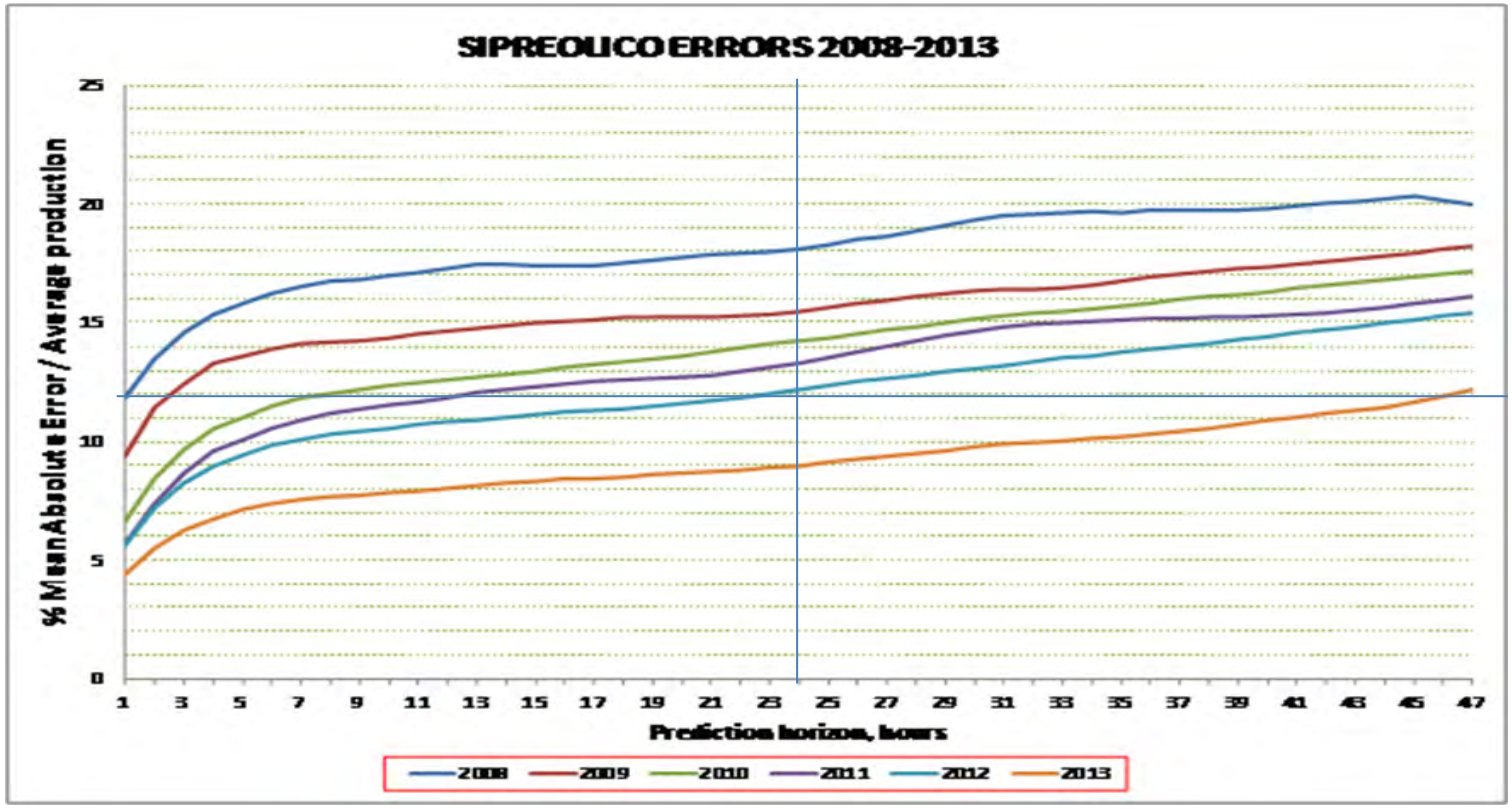
Notes: generation data for April 2011. Output has been normalised to installed capacity.

Source: unless otherwise indicated, all tables and figures in this chapter derive from IEA data and analysis.

Fuente: AIE

… in combination with advanced forecast systems

Continiously improving: today one hour accuracy >95%
and 48 hour > 88%

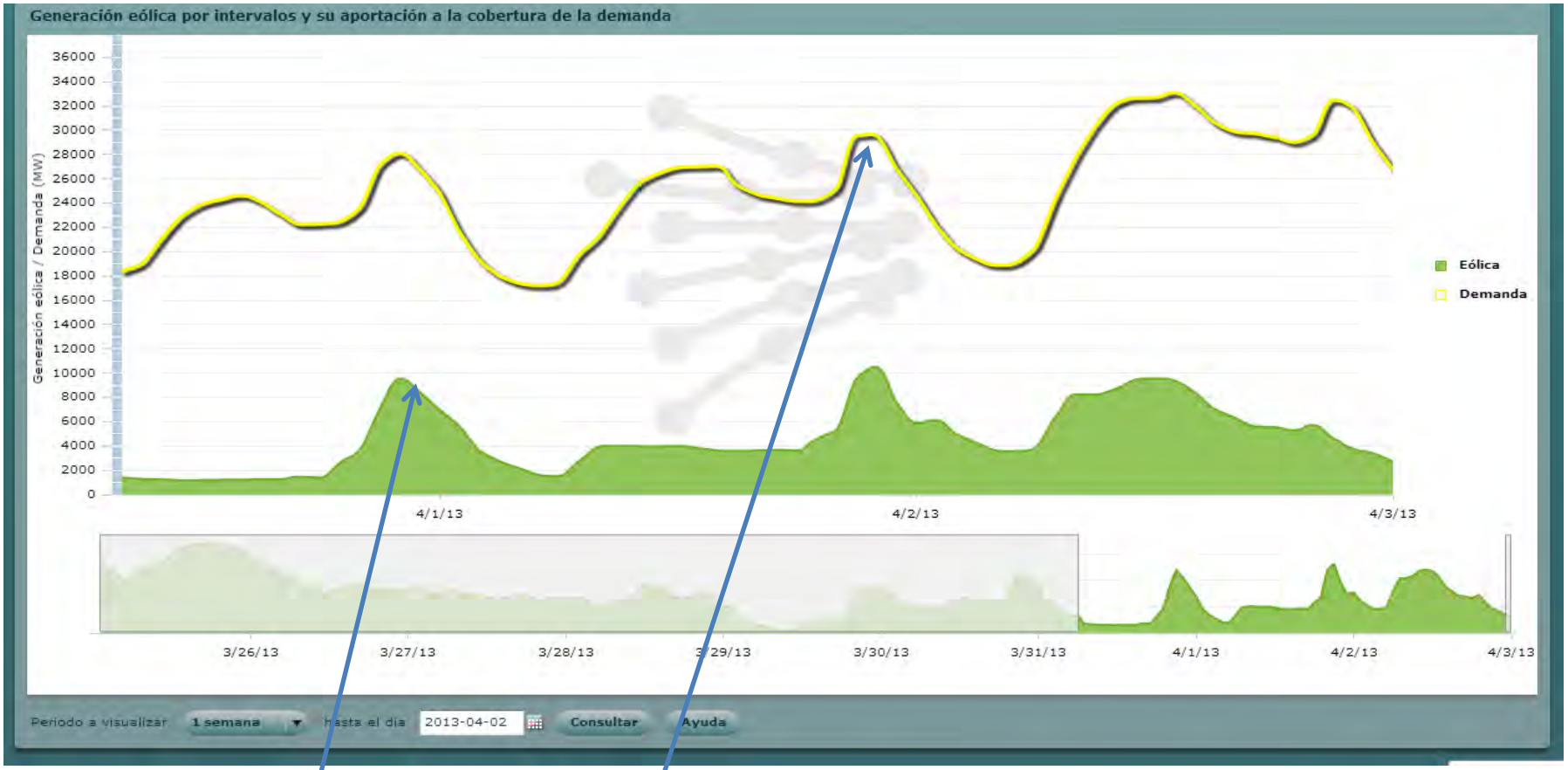


12

Control centres: active power control

IBERDROLA

Capable of attending TSO signals



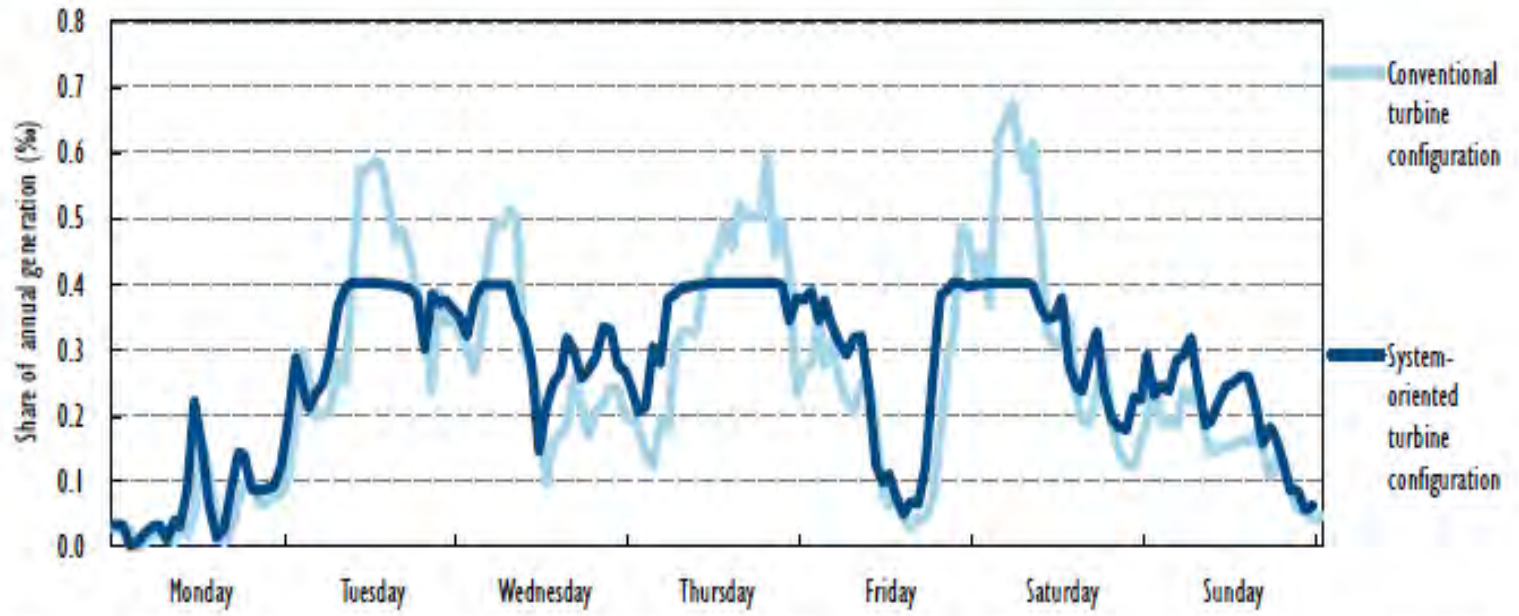
Source: REE

Easter 2013 – Spain. Low demand, high hydro output, rigid power mix.
Wind follows demand curve, according to TSO instrutions

Introduce efficient, system friendly turbines

Optimizing wind power output

Figure 5.4 Comparison of two different wind turbine designs and resulting variability



Notes: conventional turbine configuration: 2.5 MW, 90 meter height, 85 meter rotor diameter; system-oriented turbine configuration: 3 MW. 140 meter height, 115 meter rotor diameter.

Source: Agora, 2013.

Fuente: AIE

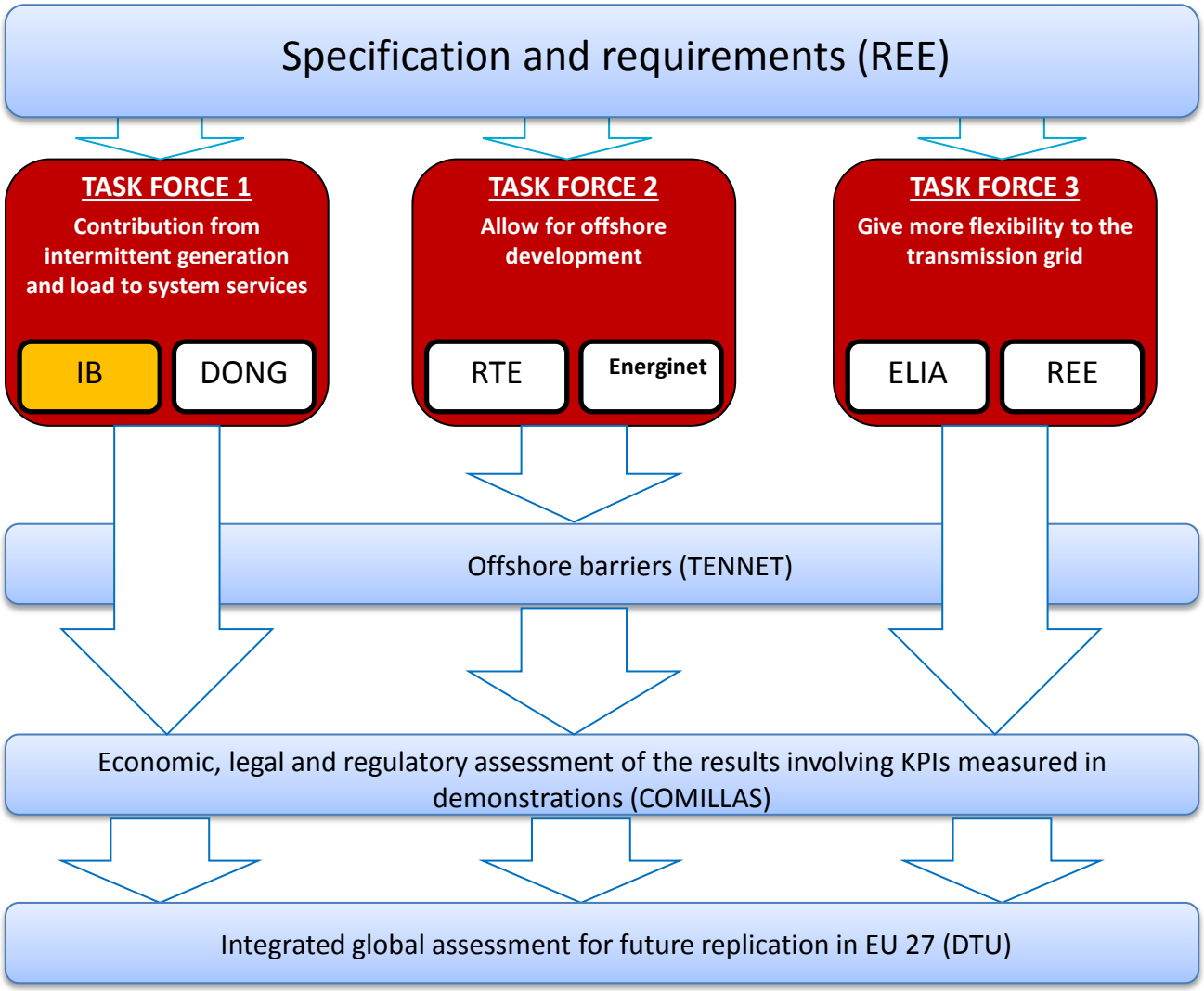

show *must* go on…

Annex: Project twenties

16

Project Twenties

Project Structure



Project Twenties

SYSERWIND: SYstem SERvices provided by WIND farms

Main objective: On-site test of new wind farms active and reactive power control services to the system, based on new operation strategies using improved systems, devices and tools,.

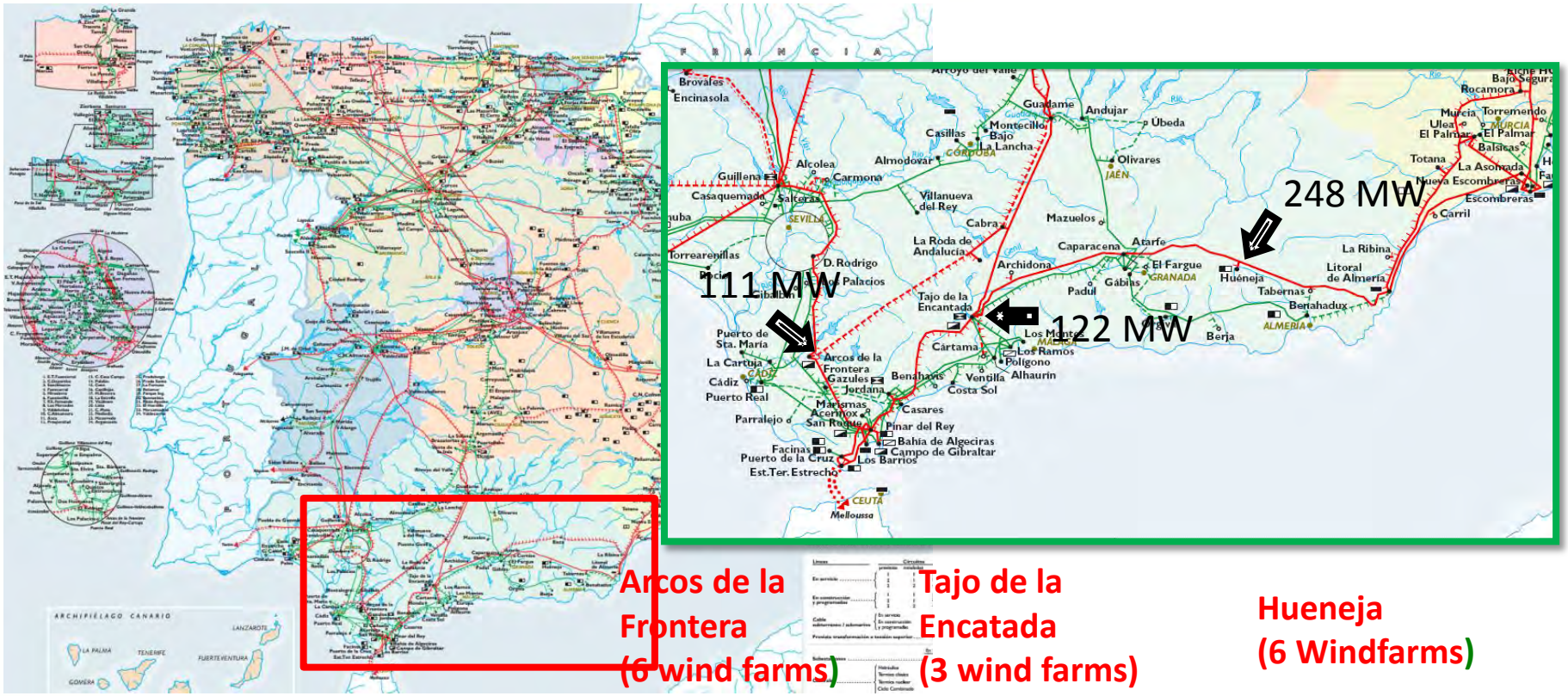
Demos:

1. Voltage Control/Reactive power regulation: with the objective to stabilize voltage in a region or zone of the TSO network, several wind farms will be aggregated to provide a voltage regulation.

2. Active power regulation: with the objective to perform secondary frequency control, several wind farms will be aggregated to provide secondary frequency regulation.

Expected impact: Preserving the stability and security of the energy transmission system, a higher controllability of the wind energy would be achieved, and the current barriers that prevent from a further development of wind power connected to the grid would be lowered.

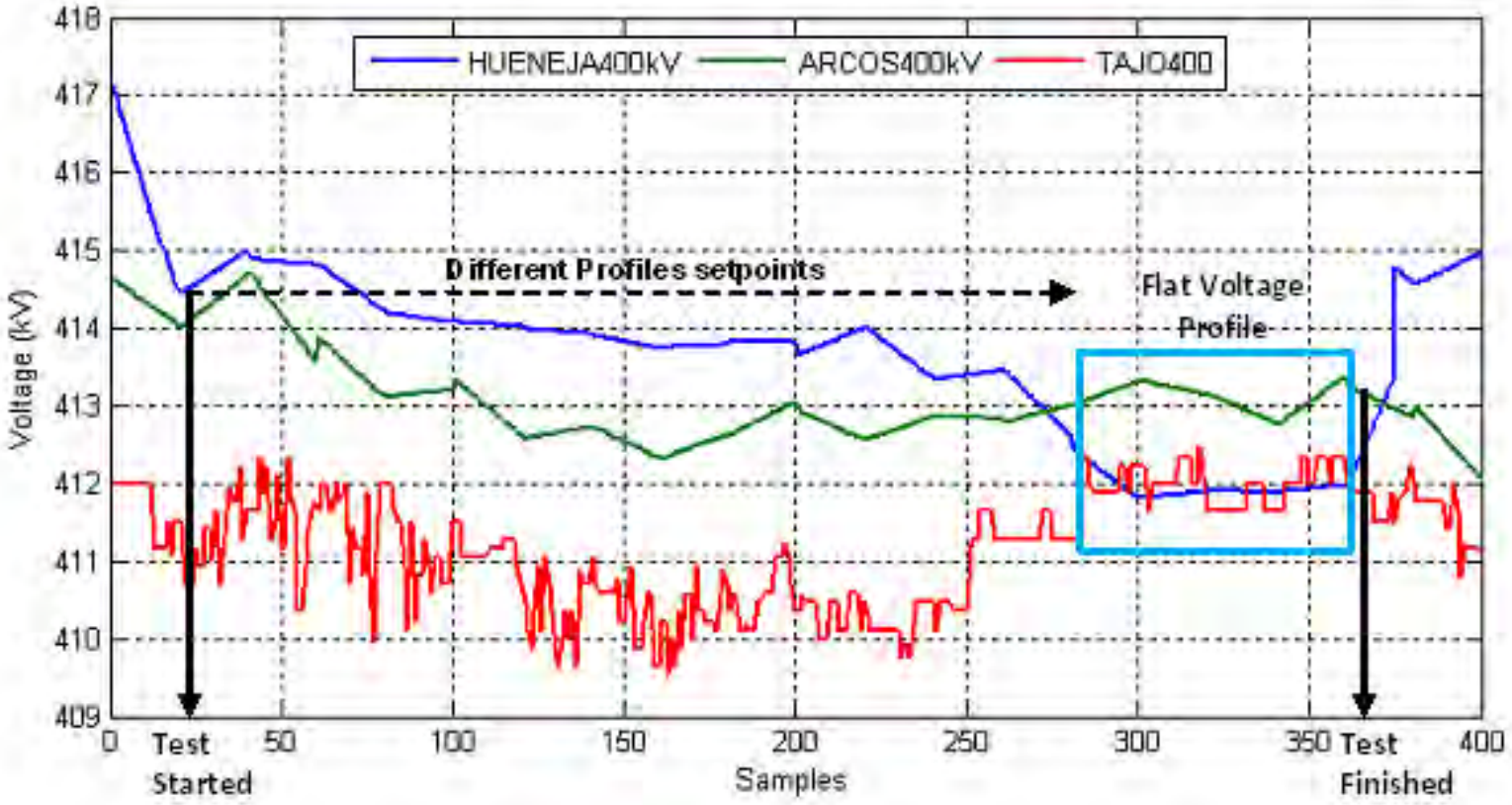
Project Twenties



	Arcos	Tajo	Hueneja
Parques Iberdrola Demo (MW)	111	122	248
Resto Generación Renovable (MW)	210	205	273
Total	321	327	521
% Parques Iberdrola en el nudo	35%	37%	48%

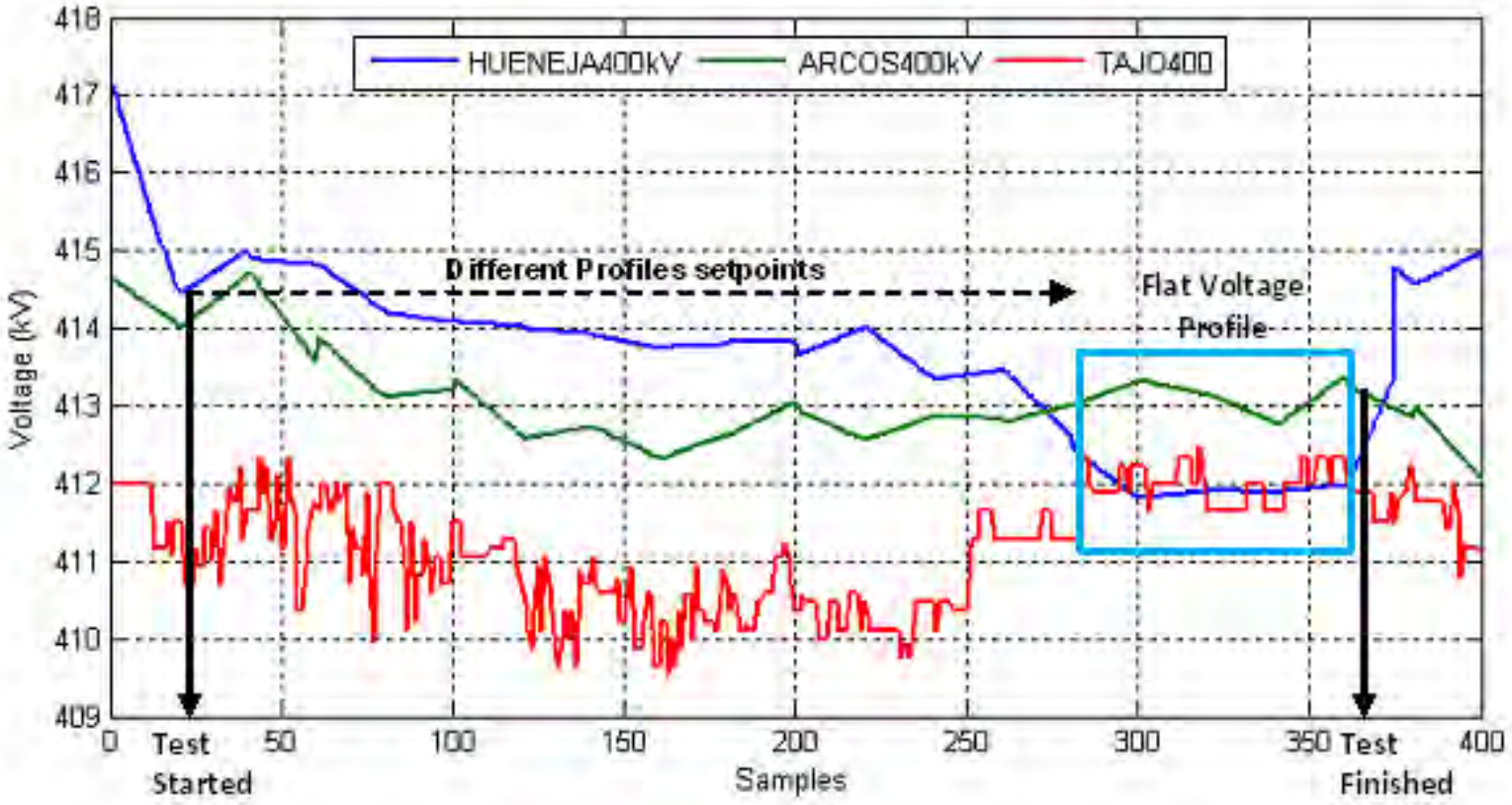
Project Twenties

Wide Aerea Response: **The Controller is able to move Voltage up to 3kV.**



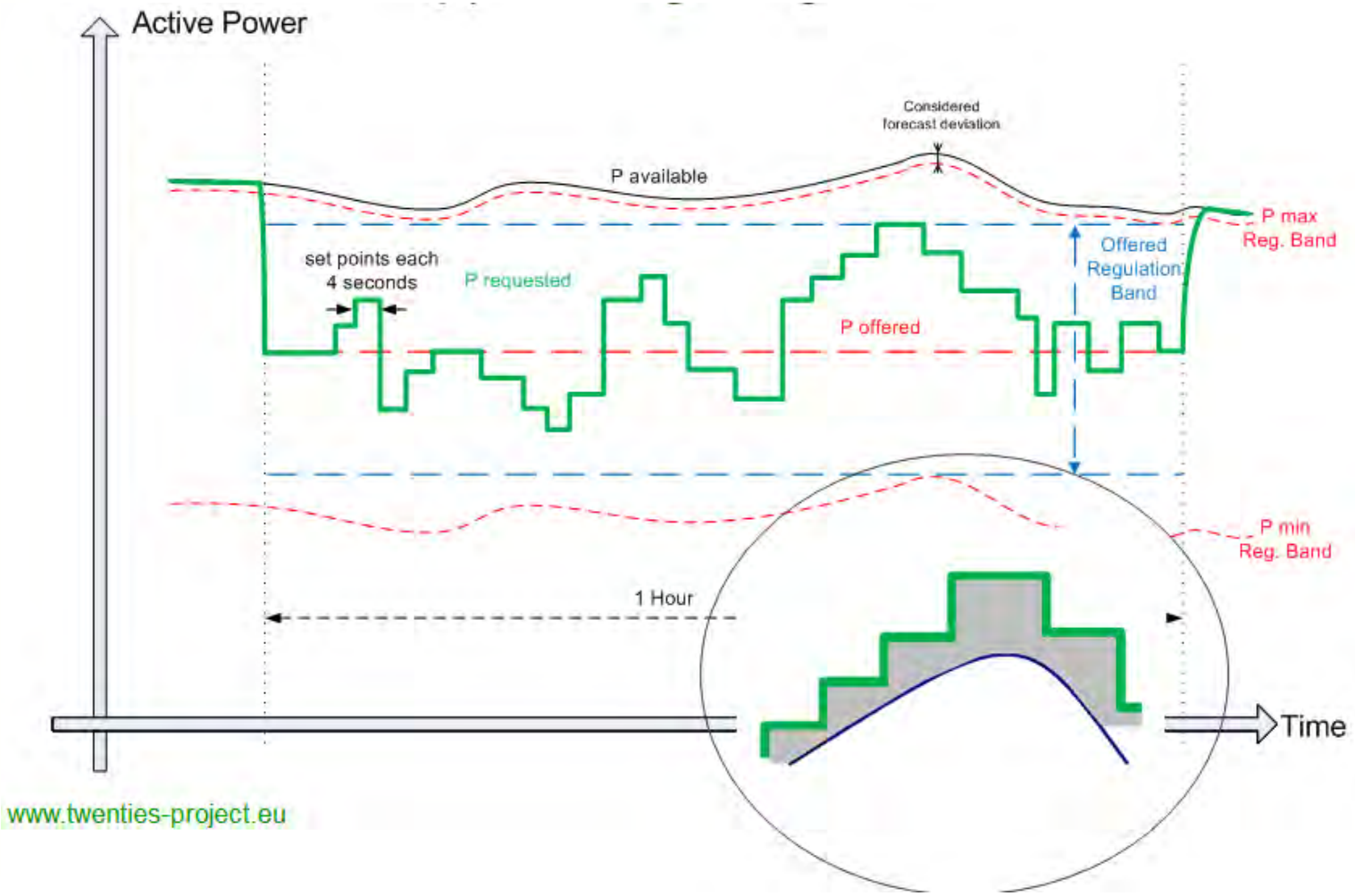
Project Twenties

Wide Aerea Response: **The Controller is able to move Voltage up to 3kV.**



Project Twenties

To follow the secondary reserve setpoint with a regulator constant time (τ) of 100 seg during at least 15 min.



Project Twenties

Wide Area Response: **Band : ± 20MW [120-80] of 480 MW installed.**