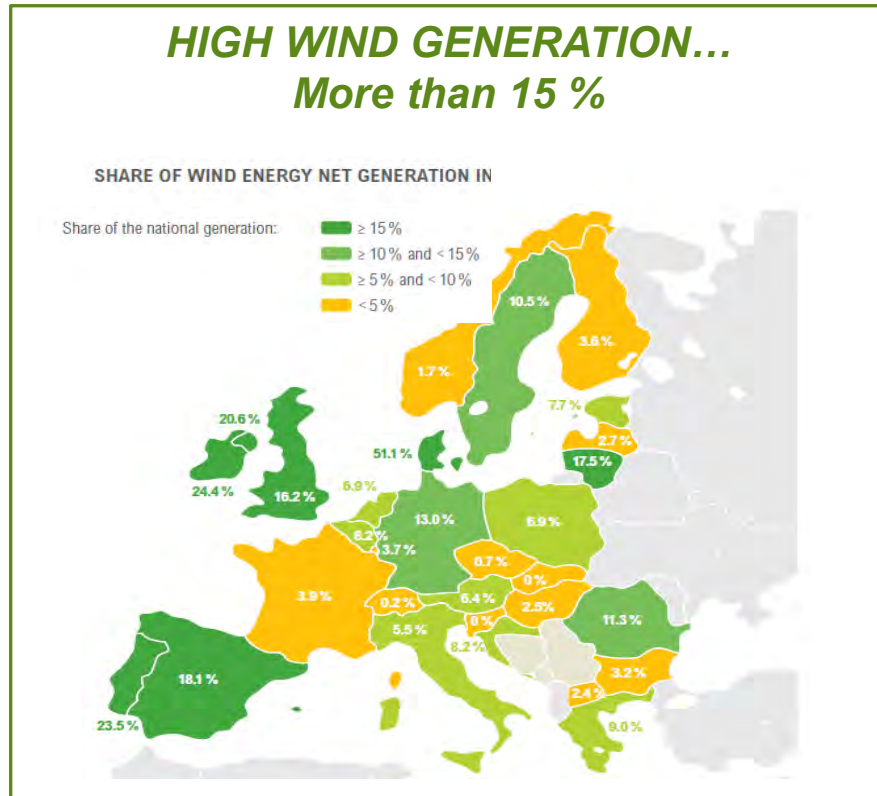


Wind power integration on Spanish System

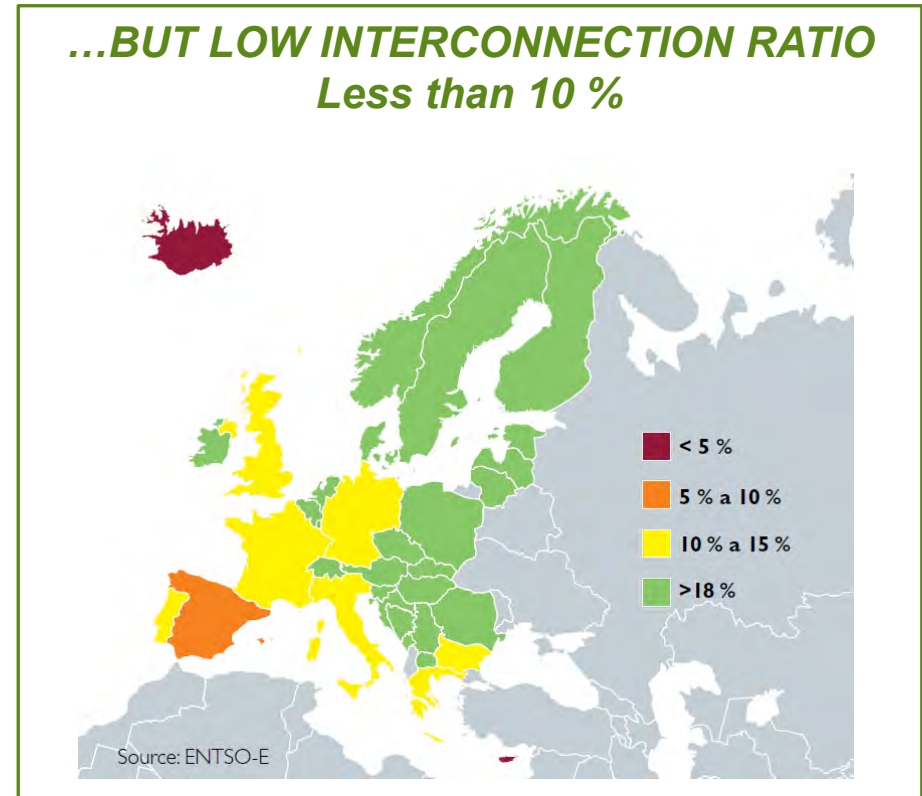
Spain: A “non highly interconnected” system

Currently Spain has more than 23 GW of wind power installed...

HIGH WIND GENERATION...
More than 15 %



...BUT LOW INTERCONNECTION RATIO
Less than 10 %



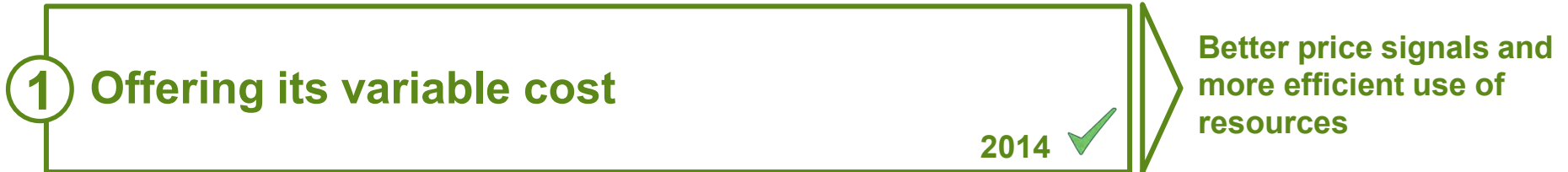
Due to the generation portfolio Iberdrola is well positioned on the Spanish electricity system in order to enable the integration of its own wind generation and other's capturing new market opportunities

Wind integration on Spanish system

The *Clean Energy Package* includes wind integration on organised markets as a main goal for 2020-2030

Spain and Iberdrola have been pioneers considering wind energy as any other technology taking advantage of the new European regulation

Renewables: End of dispatch priority



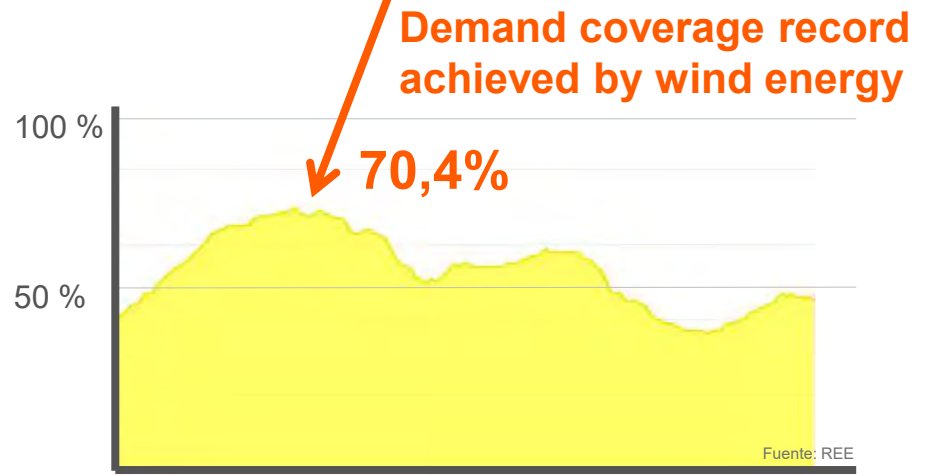
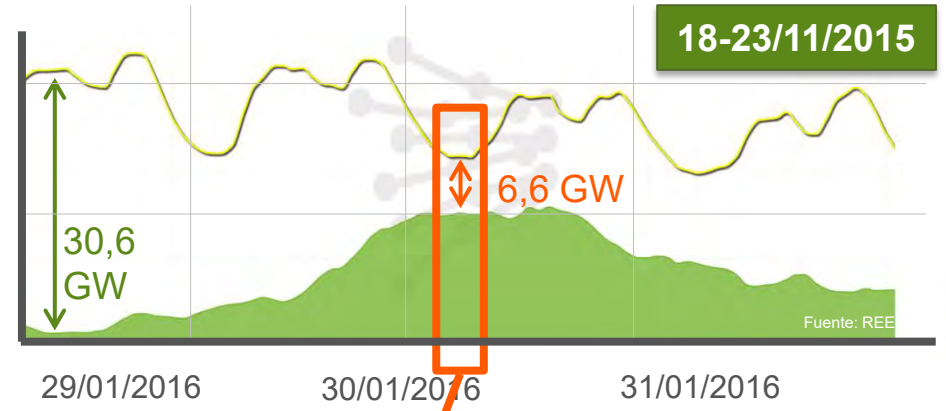
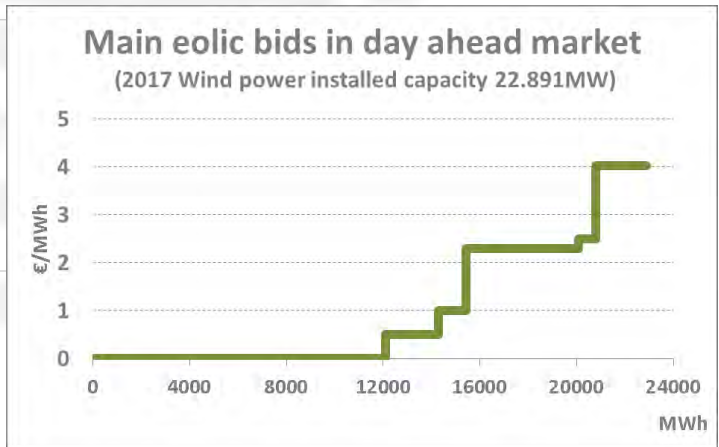
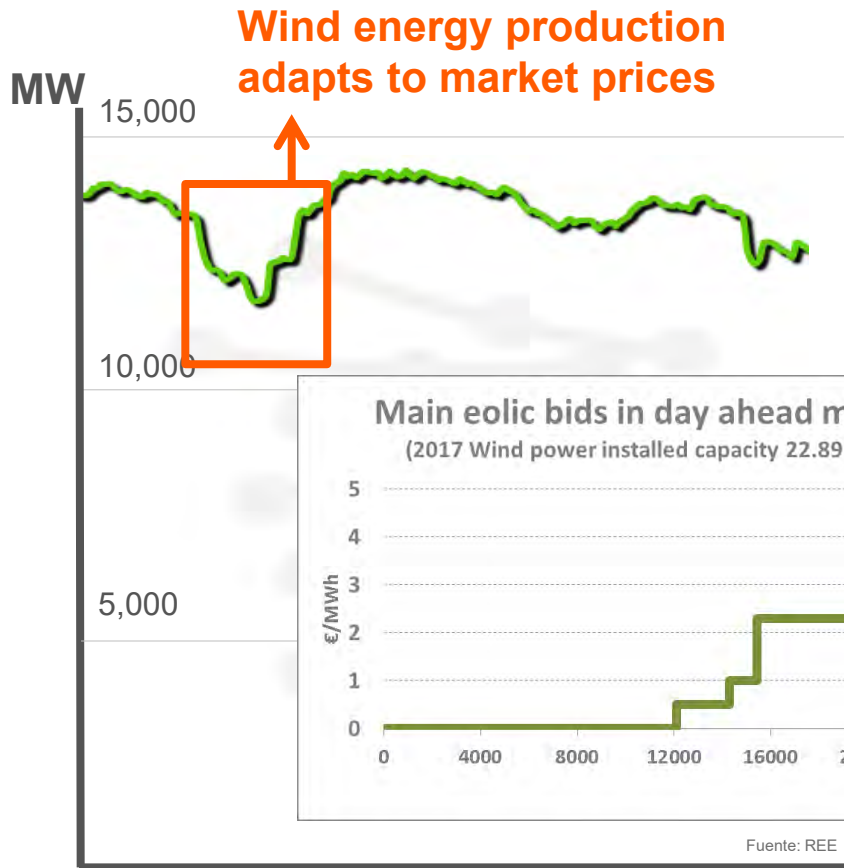
Renewables: Balance responsibility



① Wind energy shows its costs

Since 2014, after the new regulation framework, wind energy is offering its variable costs on the day-ahead market

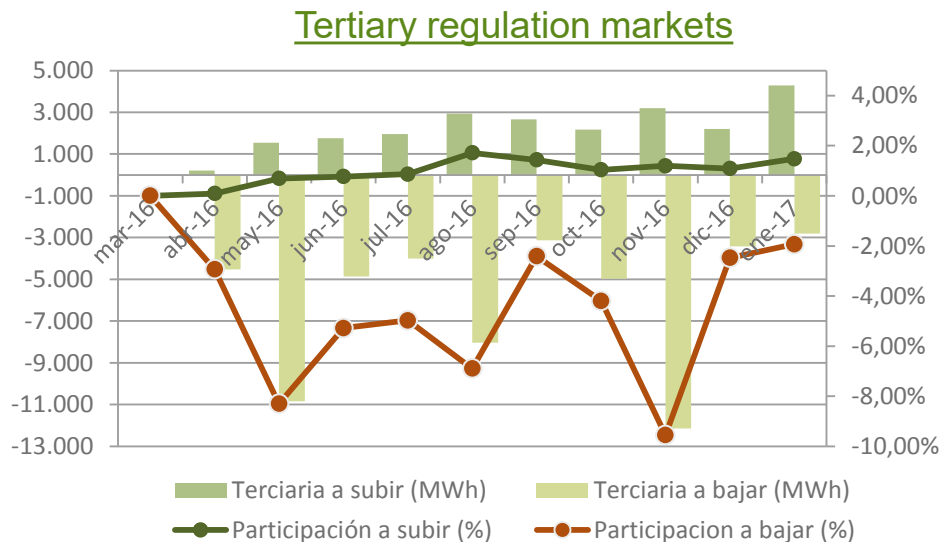
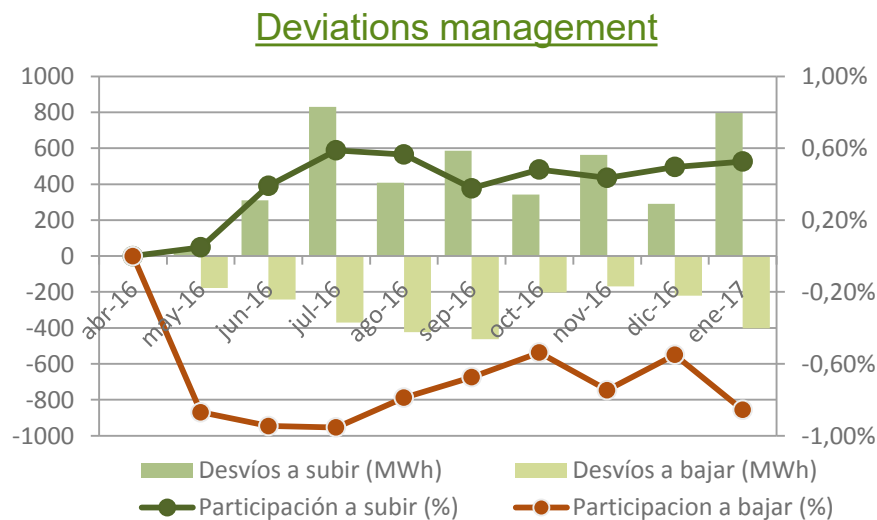
Signals to the markets are stronger and more reliable, providing a more efficient management of wind surplus



② Participation of wind energy on Ancillary Services

Since February 2016, wind energy can participate on Ancillary services, providing balancing with closer negotiations to delivery time allowing wind energy management optimisation:

1. Reducing deviations as a result of having better forecasts
2. Extra earnings over the Day Ahead market price (however non-compliance is economically penalized)



Wind energy participation requires passing TSO's qualifying tests
Iberdrola's qualified wind assets are 40% of the total 5700 MW already qualified in the Spanish system

③ Integration of wind power in the control zone of Iberdrola

On January 27th Iberdrola became the first company to integrate its wind power generation within its Control Zone

Integration of wind generation represents an opportunity for the company

Enables **direct savings of imbalance costs** of Iberdrola through consolidation of portfolio

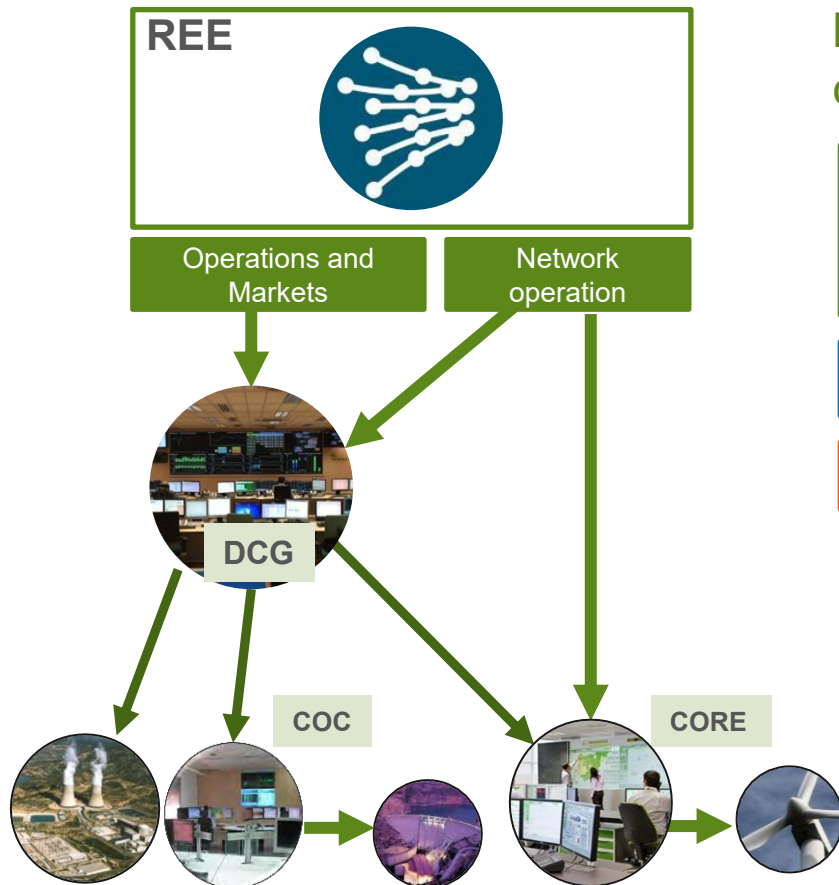
Optimizes the participation of wind power in Ancillary services (tertiary and deviation markets) by reducing/eliminating penalties

Allows **savings by using Iberdrola's hydro assets flexibility** to reduce imbalance costs of wind power production

The added value is possible thanks to the **operational capacity**, supported by the flexible **balancing assets** of Iberdrola

Changes in the Operational Scheme

On January 27 Iberdrola became the first company to integrate its wind power generation within its Control Zone



Integration of Renewables in control zone was challenge that required mayor changes :

1. Changes on Real Time communications between Renewable control Center (CORE) – TSO (REE) – Integrated Central Control (DCG)

2. Integration of the Renewable assets in the AGC system

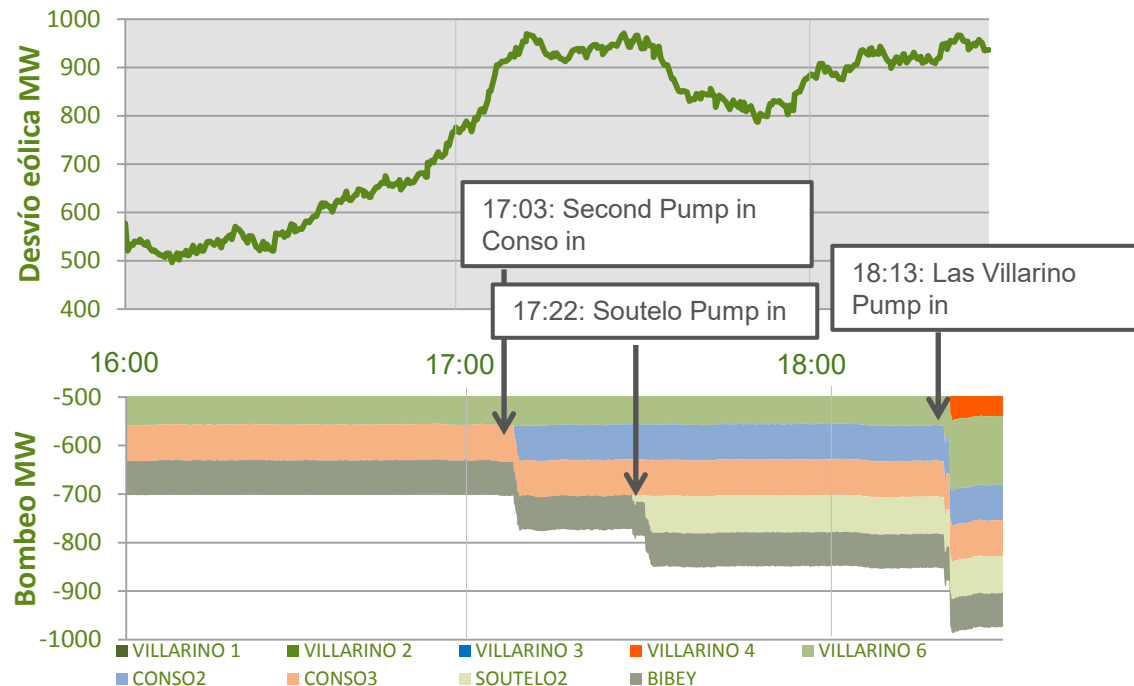
3. Integration and optimization of power metering

	MW	Power Plants	Signals
Before (traditional generation)	20.422	112	9.639
Δ Renewables in control zone	+5.645	+194%	+6.517
	+28%	+173%	+68%
Current total	26.017	306	16.156

Case study: Highlighting the management capability (1/2)

On February 7th, some events took place at the same time (increase on the Spanish wind production above the forecast and deviation in the interconnection with France) highlighting the optimised wind management of Iberdrola after the integration

- Iberdrola's wind production much higher than forecasted
- After 17:00 the maximum deviation above the program was reached (~1000 MW)



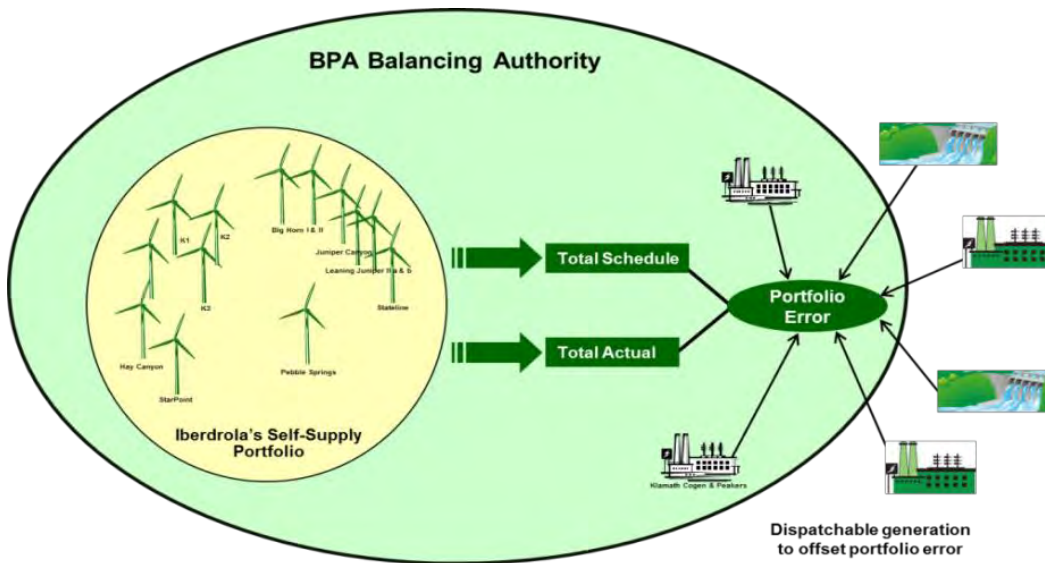
Wind integration
con Control Zone
allows “storing”
wind surplus

“Pumping Wind”

- Next step would have been to assume a deviation in the system

Balancing authority in the US

Iberdrola has **1,300 MW of wind** and **636 MW of thermal** operating in the **Pacific Northwest**. These facilities are interconnected into Bonneville Power Administration's (BPA) system and went into commercial operation between 2001 and 2010. Between 2005 & 2009 BPA had a wind energy "boom" by interconnecting more than 4,000 MW of wind on its system. The combination of these actions created **punitive charges and penalties of ~\$12/MWh** (Impact to IBE: \$32M/year)



Utilizing a **combination of owned and contracted dispatchable generation**, IBE has **successfully balanced our Northwest wind fleet on BPA's system** since 2010.

- Wind Assets
- Klamath & Peakers
- Hydro Slice (Grant)

Benefits

Considerable cost savings

Additional operational flexibility beyond even self-supply

Increased independence from BPA

Option to participate in evolving market structures such as energy imbalance markets (EIM)

Platform for increased growth

Being a BA (responsible to maintain in real time the balance of electricity resources with electricity demand) will deliver a lot of **benefits**

Conclusions

Iberdrola has the largest integrated regulation zone in Spain after integrating wind assets

Iberdrola and Spain have been pioneers integrating wind energy as any other technology taking advantage of new European regulation. Other utilities will do the same in the future

Renewables integration in regulation zone brings direct benefits due to portfolio effect, but we must further optimize the real time operations and the remote metering quality

Systems are key the guarantee progress:

- **New SCADA and AGC systems, with state-of-art technology, flexible for future challenges and more integrated with economical operation of electric market**

What's next?... customer integration in regulation zones? New regulation to be developed.....



Ángel Chiarri
June 2017

Thank you for your attention