



Integration of renewable energy into the electricity Market – New requirements for Power Control Centers

**11th International Workshop on
Electric Power Control Centers**

May 22-25 2011 Altea, Spain



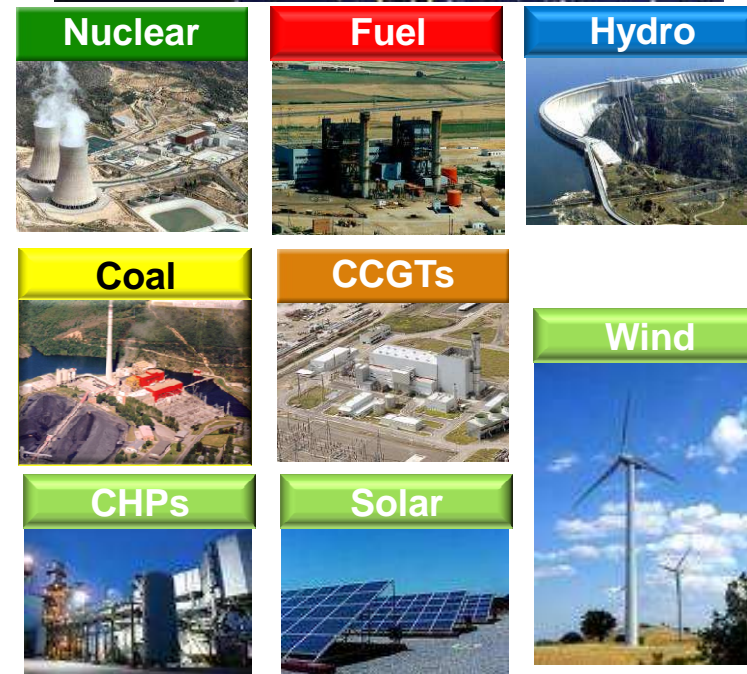
IBERDROLA

Agenda

**Data of Spanish
Generation Mix**

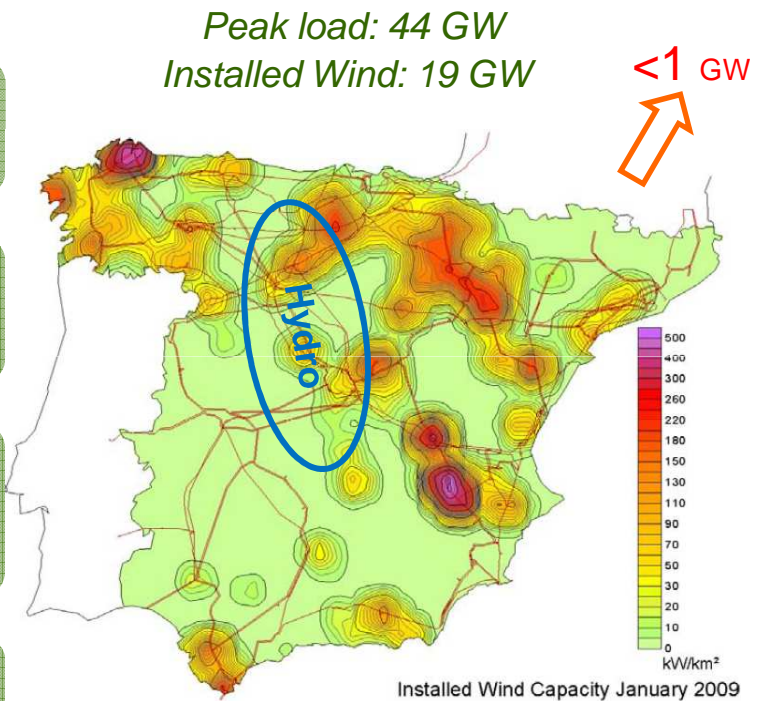
**2010 year experience:
Unexpected Stress Test**

**Open Discussion on new
requirements**



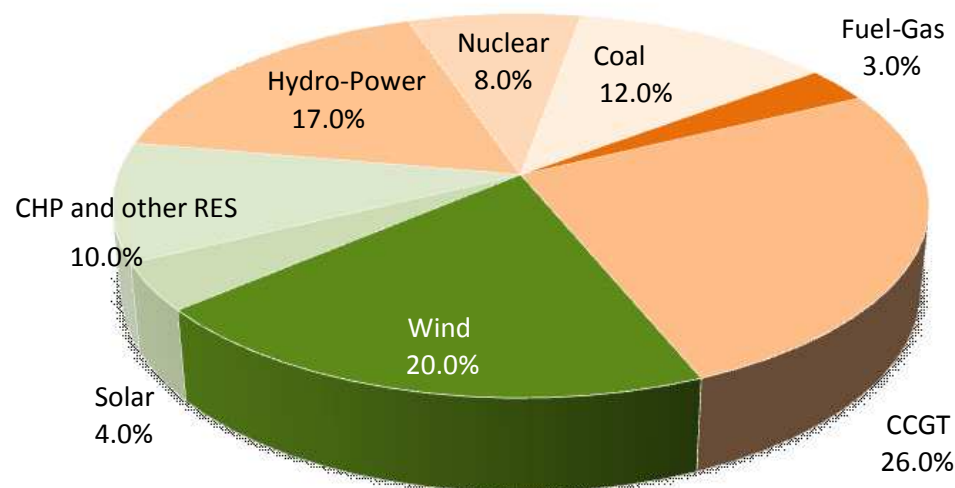
Spain is a favorable landscape to renewables


✓	Reserve margins	25 GW CCGT (2001-2009) 75% of coal fit scrubbers SO ₂
✓	Grid	Reinforcements in last decade Dispersed wind
✓	Flexibility, storage...	~52 CCGTs Units 17 GW hydro (~5 GW pumping)
✗	Interconnections (France)	Export capacity < 1 GW



Source: REE

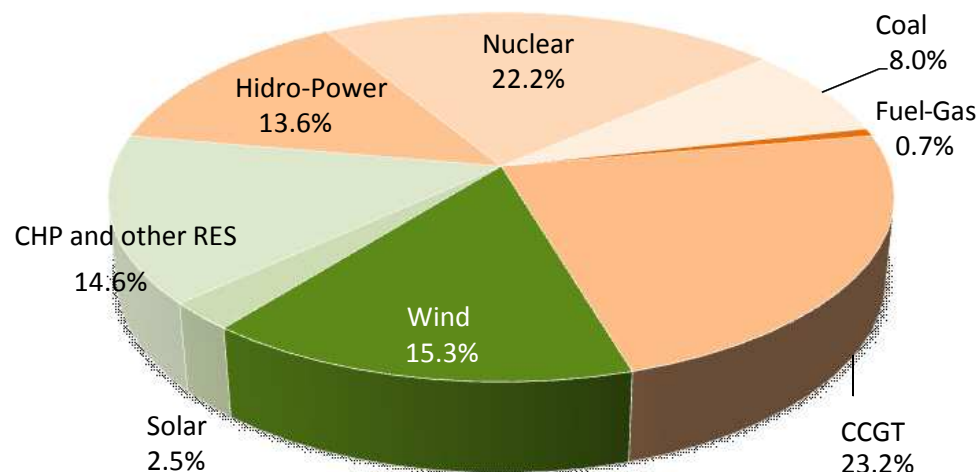
Generation Mix in Spain end of 2010




Tecnology	SEP MW	%		%
Hydro-Power	16 657	17	8 847	35
Nuclear	7 716	8	3 379	13
Coal	11 380	12	1 253	5
Fuel-Gas	2 860	3	157	1
Combined Cycles	25 220	26	5 893	23
Total (conventional)	63 833	66	19 529	77
Wind Power	19 813	20	5 199	21
Solar Power	4 018	4	50	0.2
CHP and other RES	9 783	10	543	2
Total (RES and CHP)	33 614	34	5 792	23
Total 97 447 MW		25 321 MW		

Installed Wind Power equivalent to 19 nuclear Plants

Energy Production in Spain 2010



Tecnología	GWh	%		%
Hydro-power	38 001	14	9 633	15
Nuclear	61 944	22	22 830	36
Coal	22 372	8	2 059	3
Fuel-Gas	1 847	1	34	0
Combined Cycle	64 913	23	18 122	29
Total (conventional)	189 076	68	52 678	84
Wind Power	42 656	15	9 628	15
Solar	6 910	2	21	0
CHP and other RES	40 896	15	576	1
Total (RES and CHP)	90 462	32	10225	16

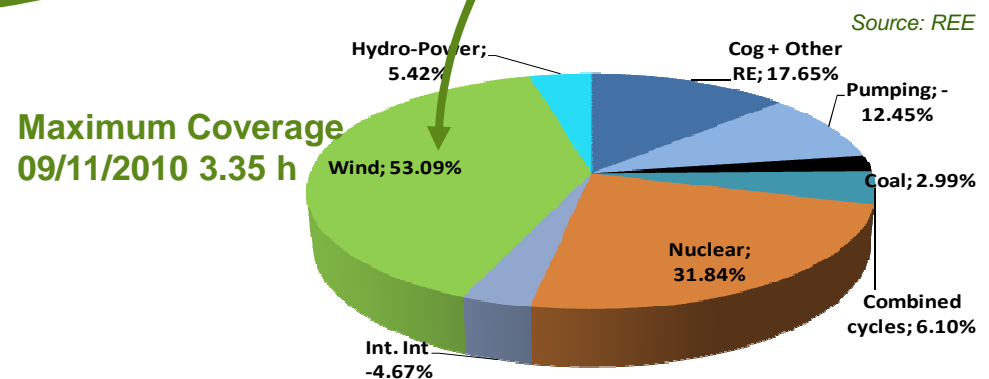
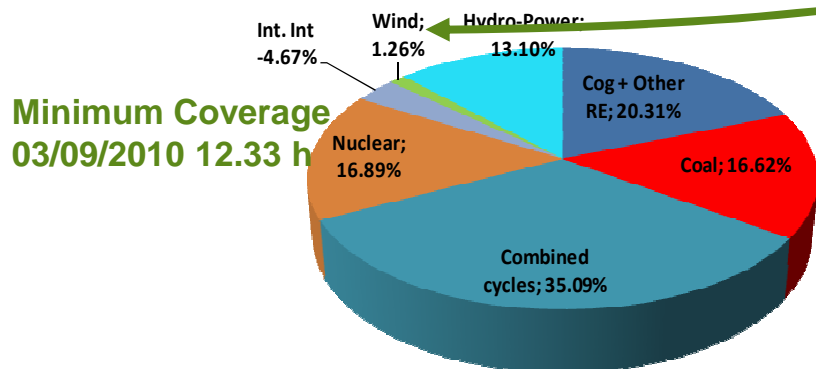
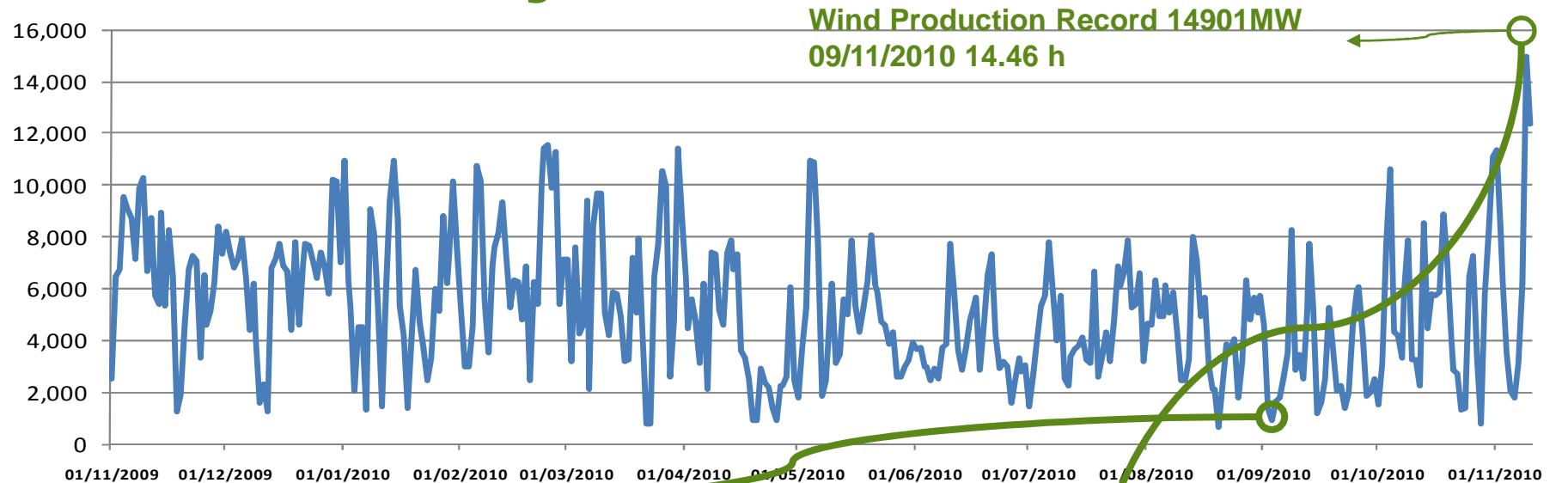
Total 272 868 GWh 62 903 GWh

La energía eólica se coloca por primera vez en marzo como principal fuente de generación eléctrica

Los aerogeneradores cubren un 21% de la demanda con un récord de generación

EL PAÍS - Madrid - 31/03/2011

Wind variability



Source: REE

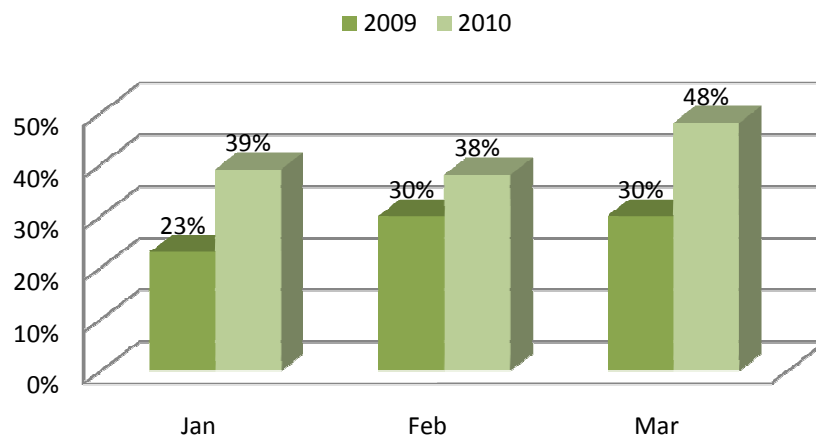
Demand and Generation equilibrium must be compensated by manageable Generation

Experience from 2010 operation

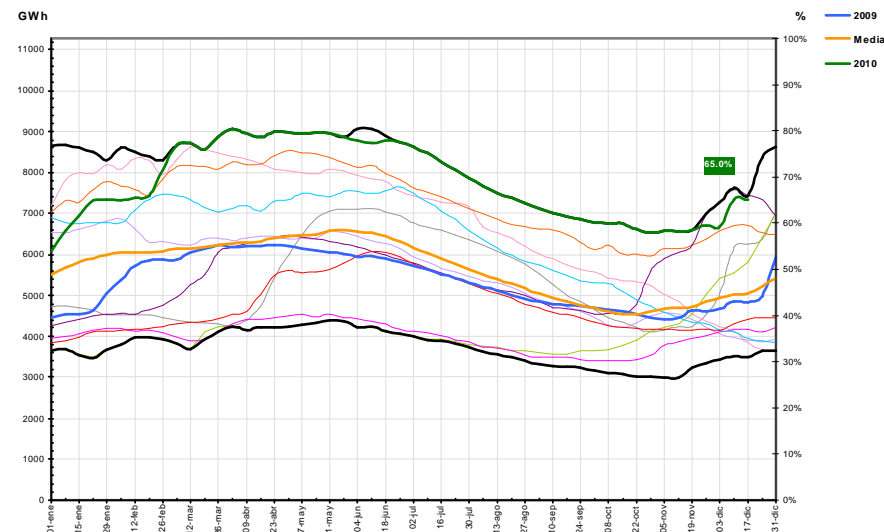
- Slow down in the demand evolution. 2006/2007 level
- Low flexibility in load reduction of nuclear and CHP
- High wind generation (18% increase from 2009).
- Extremely High Hydro inflows.
 - Increase in run of river hydro production.
 - Decrease in upward power reserves.



Large contribution of renewables

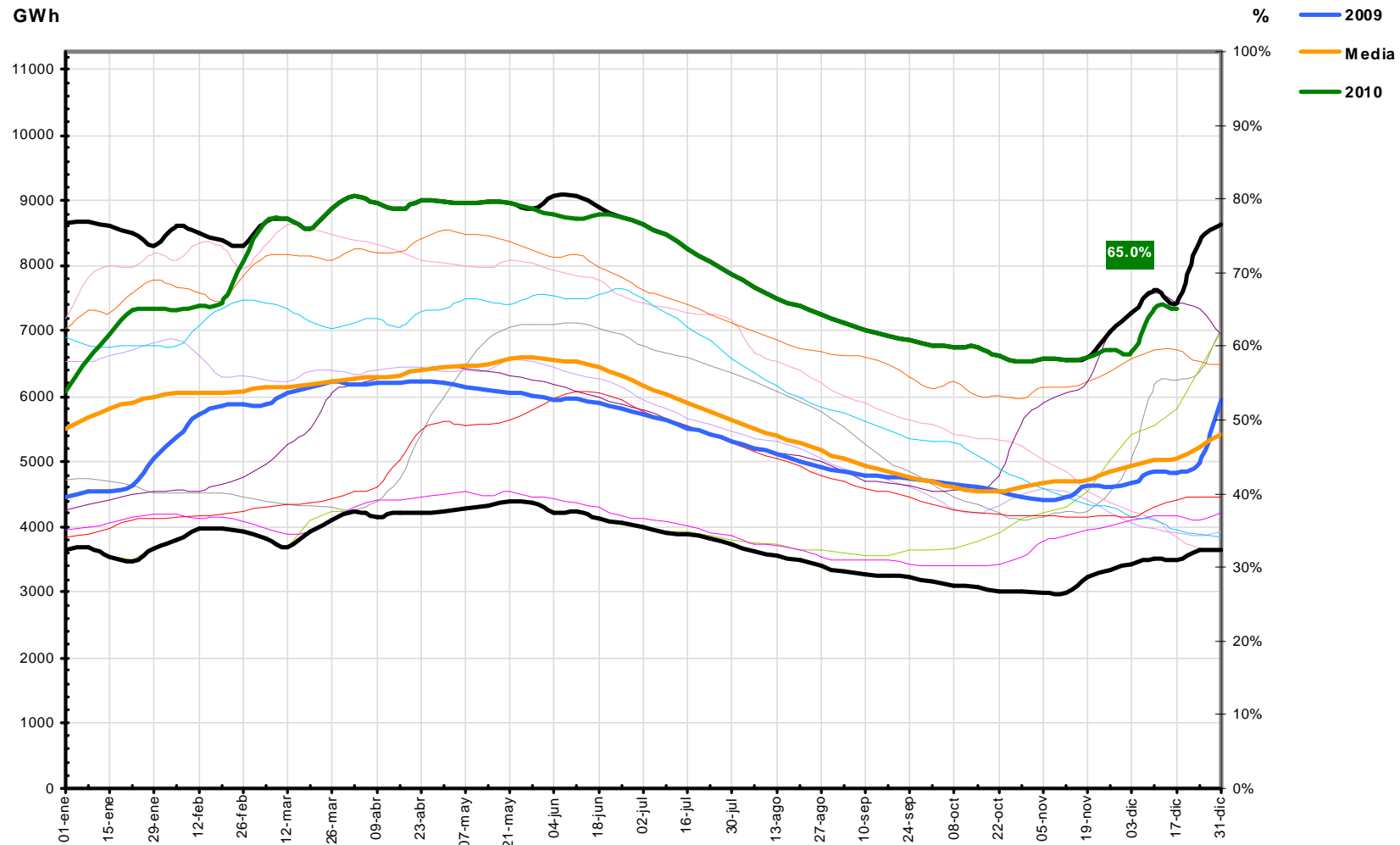


Iberdrola stored energy in hidro reservoirs



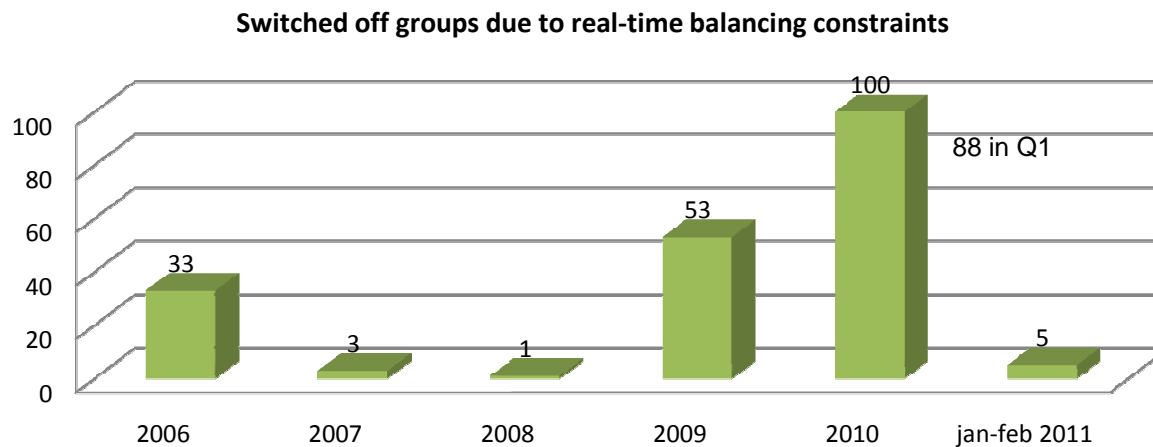
Experience from 2010 operation

Iberdrola stored energy in hidro reservoirs



Flexibility to the system from Conventional Technologies

- **Combined cycle gas-fired units**
 - High availability in spite of daily switch off operation
 - Lower number of hours running than expected



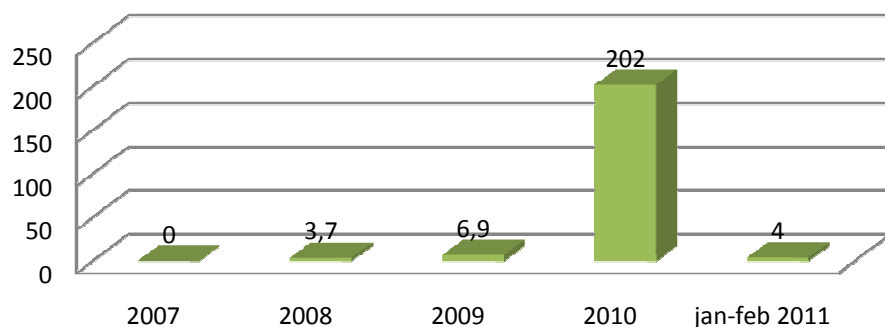
- **Hydro pumping units**
 - High availability, but limited storage in the upper basin leads to rapid exhaustion of the storage capacity

Wind Power control

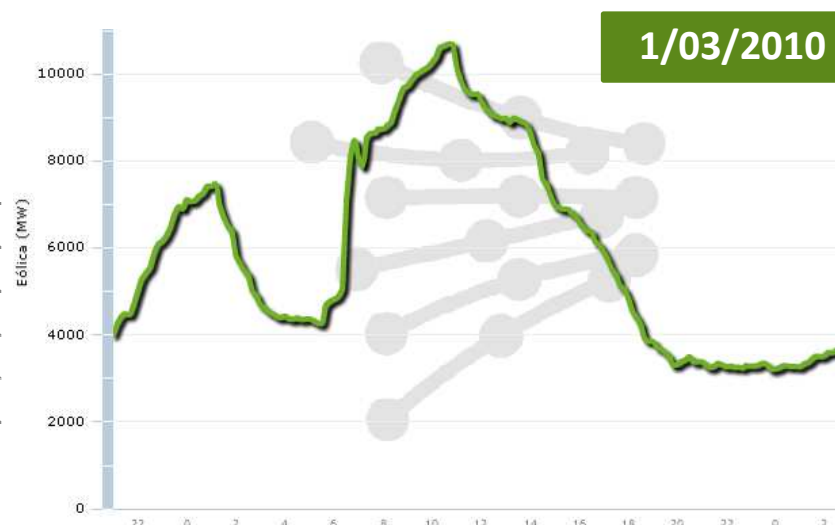
The TSO may reduce the wind generation to restore downward reserves

- As a last resort
- Thanks to the control center structure
- Conventional generation still needed:
 - To supply peak demand
 - For ancillary services (LFC, ...)

Wind reduction due to power balance feasibility (GWh)

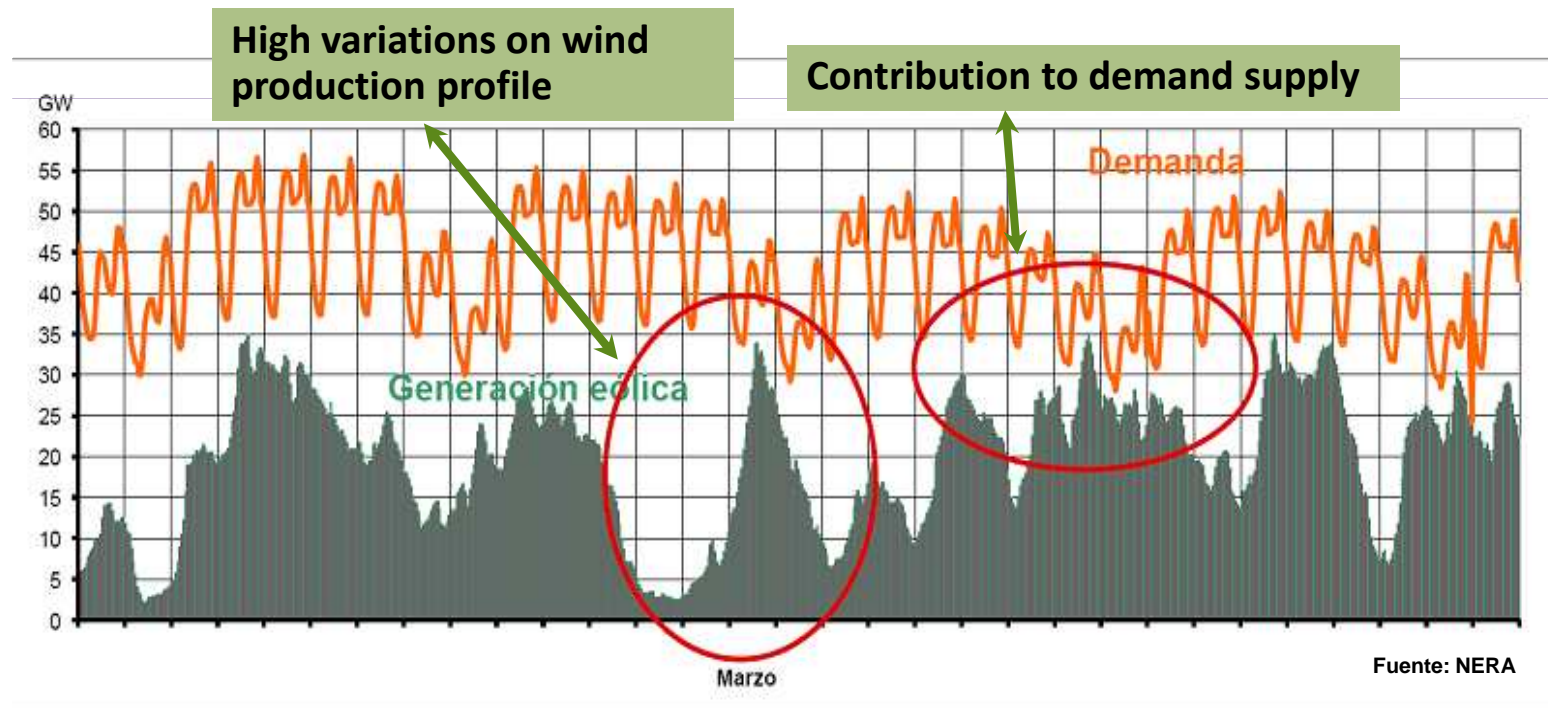


0,019% 0,5% potential energy



Electric System management will be more difficult

- March 2020 estimation based on what happened on 2008
- Year 2010 was a Good Stress Test for integration of renewable energy



Discussion for new requirements

Conventional Generators

Flexible operation on daily switch off

- CCGTs designed for: >5000 hours/year and <20 startups
- Currently 2000-3000 hours and >100 startups

Investment in flexible generation

- Pumping storage
- Peaker turbines

Reduce minimum load level of existing units

...



Discussion for new requirements

Renewable energy Producers

Better response to TSO set points

- Does the mechanism need to be improved?

Participation in Ancillary Services:

- Active/Reactive/Voltage Regulation
- Can it threaten the security of supply?

Estimation of Generation tripping due to over-speed protection

- It will anticipate needs for reserve power

...



Discussion for new requirements

Electricity Market

New markets for:

- Reserve capacity
- Groups switched off
- Negative pricing mechanism

Demand side management

- Electric vehicle influence

More intra-day markets





IBERDROLA



Thank you

Gestión de la Energía - Explotación
Luis Aguiló
luis.aguilo@iberdrola.es