Experiences of REN in ensuring flexible on electric system

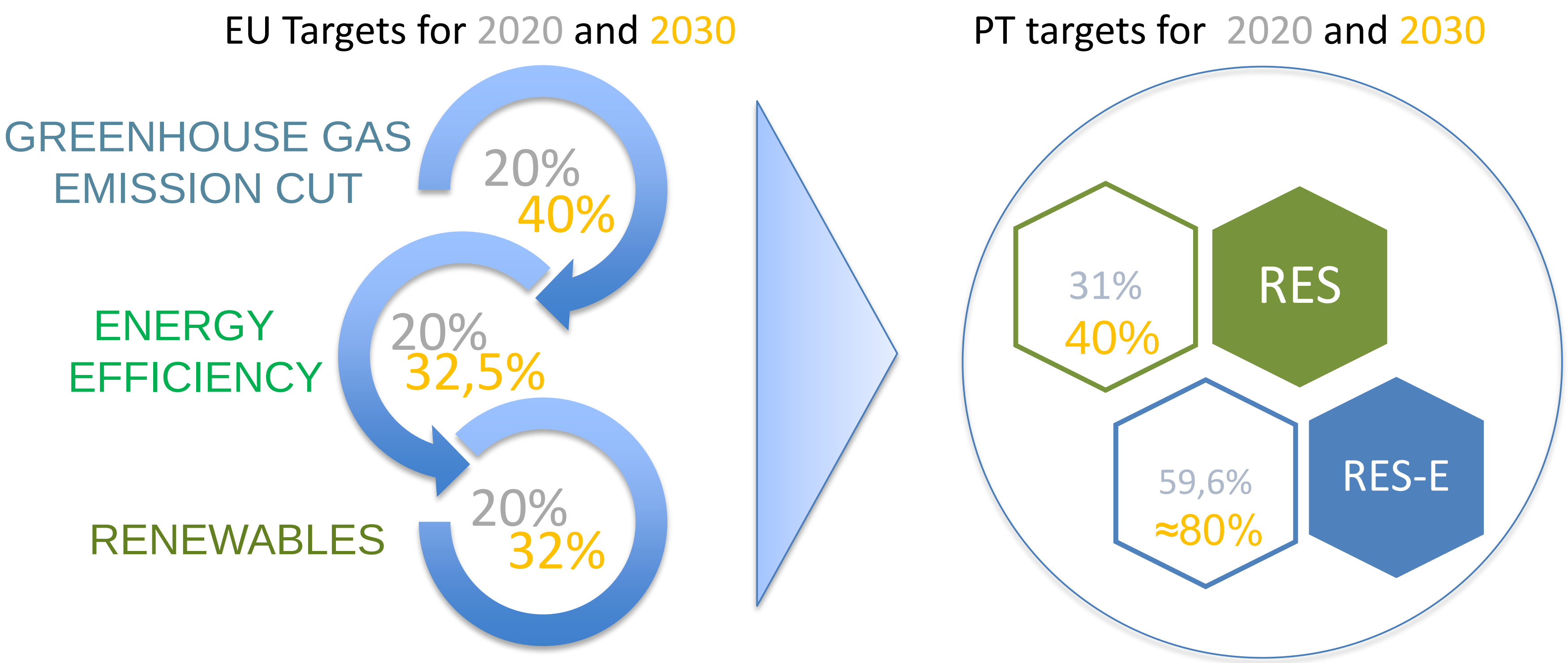
South East Europe Workshop on Grid Integration of Variable RES

Nuno Martins

Vienna, 7 November 2018

Energy policy (present & future)

Energy policy in EU and Portugal (2020 and 2030)

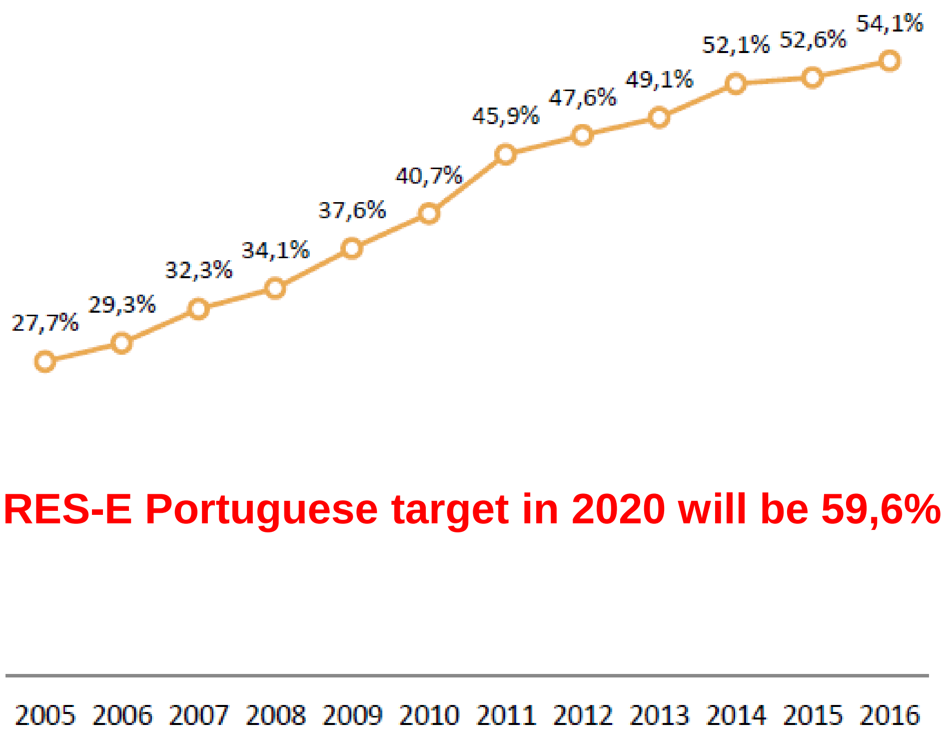


INTERCONNECTION CAPACITY / TOTAL INSTALLED CAPACITY
2020 ≥ 10% | 2030 ≥ 15%

Portuguese targets induces high penetration of renewable energy

Renewables on electricity sector (current situation)

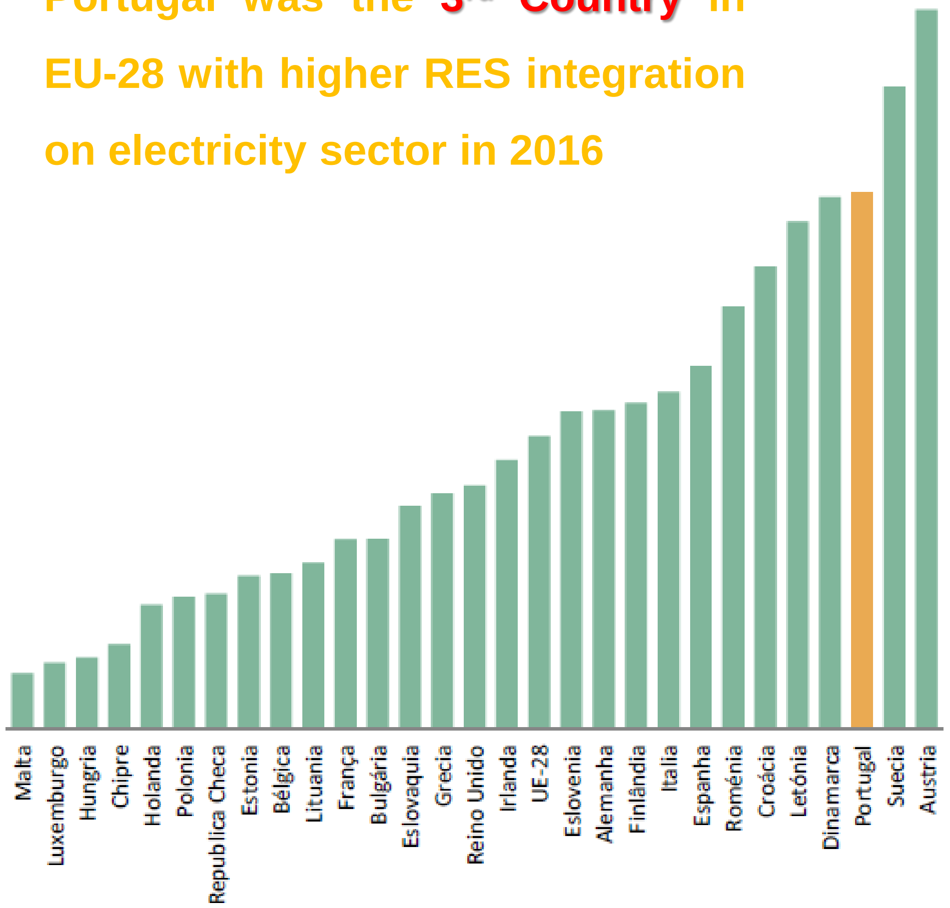
RES share[1] evolution on electricity sector until 2020 horizon



RES-E Portuguese target in 2020 will be 59,6%

Portugal position related with other EU-28 Member States in 2016

Portugal was the 3rd Country in EU-28 with higher RES integration on electricity sector in 2016



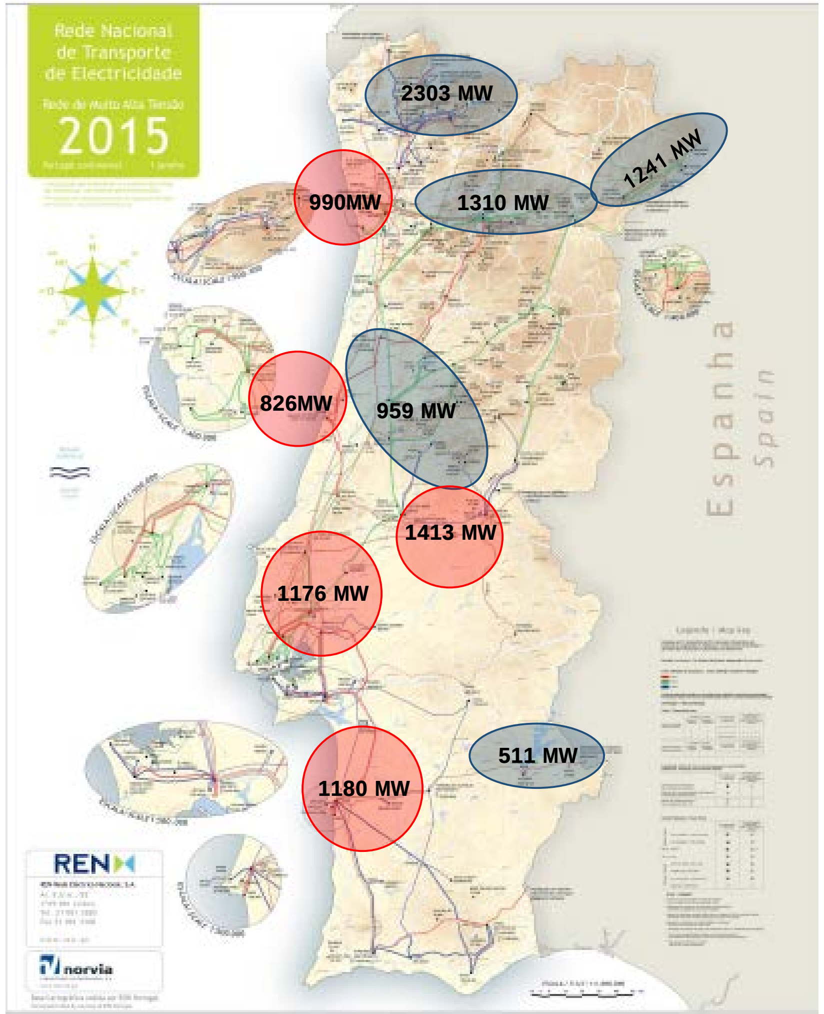
1: RES Share calculation according Eurostat methodology

Source: Eurostat, Direção Geral de Energia e Geologia (National Directorate of Energy and Geology)

Total installed generation capacity per technology

Total generation capacity (end of 2017)

		% of peak load (*)
▪ **Renewable**	**13 397 MW**	**153%**
▪ Hydro (Small hydro included)	7 193 MW	82%
▪ Wind	5 090 MW	58%
▪ Thermal (CHP included)	624 MW	7%
▪ Solar	490 MW	6%
▪ **Non-renewable**	**6 403 MW**	**73%**
▪ Natural Gas(CCGT)	3 829 MW	44%
▪ Coal	1 756 MW	20%
▪ CHP (Natural Gas)	778 MW	9%
▪ Other	40 MW	0%
▪ **Total**	**19 800 MW**	
▪ **Total installed pumped capacity**	**2 698 MW**	
▪ **Annual consumption in 2017**	**49,6 TWh**	



Source: REN

- Thermal (classic)
- Large Hydro

- **Dispatchable** 12 368 MW (62%)
  - Hydro
  - Natural Gas (CCGT)
  - Coal
- **Non-dispatchable** 7 432 MW (38%)
  - Wind
  - Solar
  - Small hydro
  - CHP
  - Other

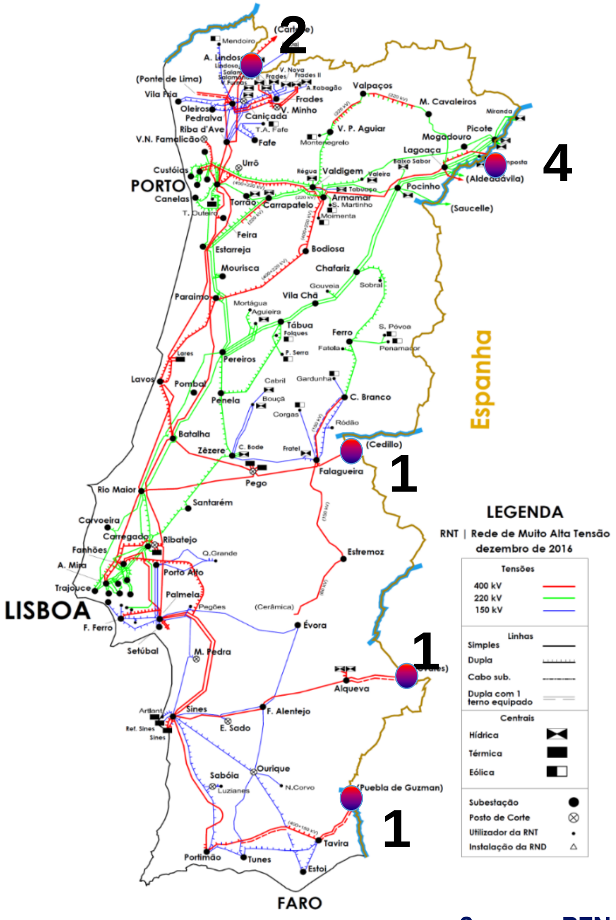
Source: REN

(*) Peak load - January 2017: 8 770 MW

Maximum generation - January 2017: 11 370 MW

Transmission network overview

Transmission network overview (end of 2017)

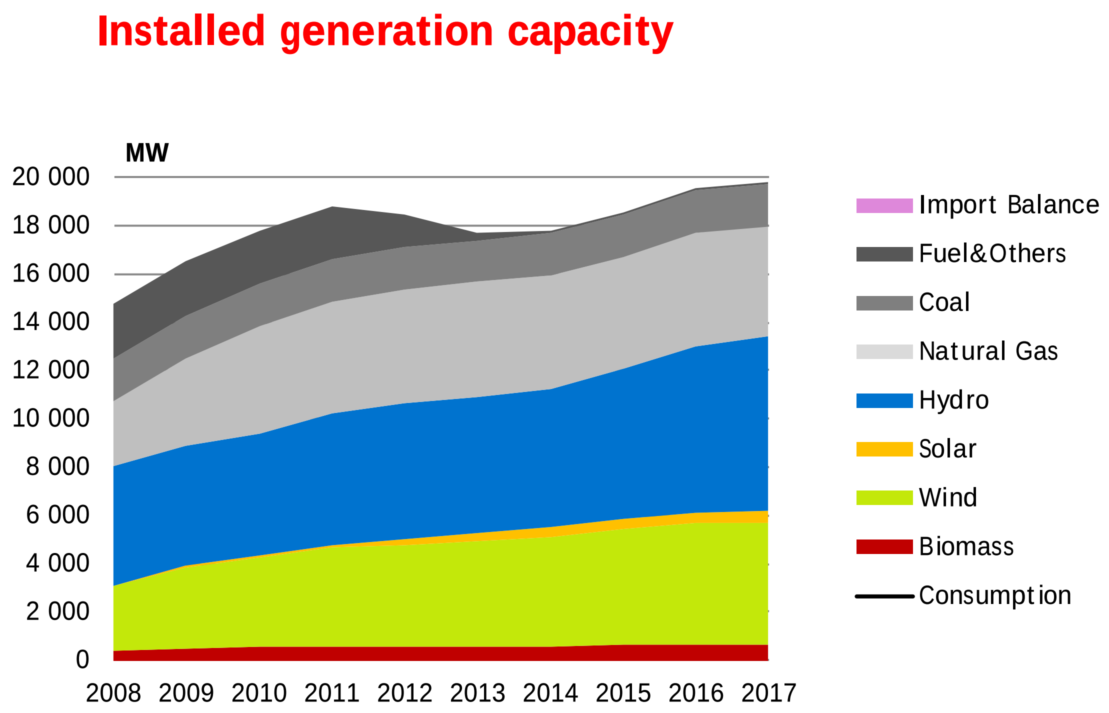


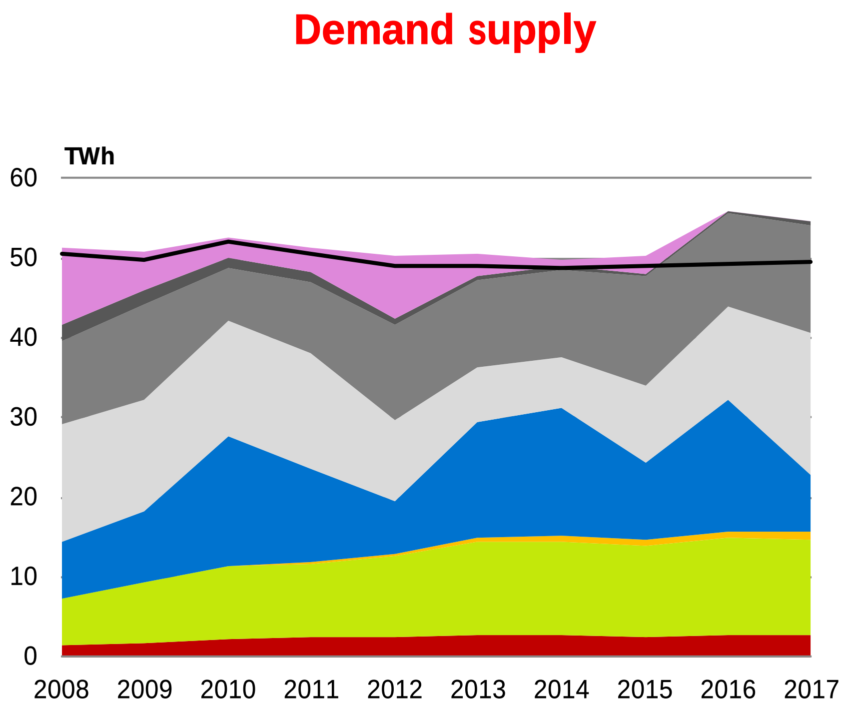
Source: REN

Circuits (km)	8 907
400 kV	2 714
220 kV	3 611
150 kV	2 582
Interconnections (#)	9
(6x 400 kV and 3x 220 kV)	
Transformer stations	68
Switching stations	14
Transformers	203
Shunt reactors	10

Evolution of power generation

Installed generation capacity and demand supply mix



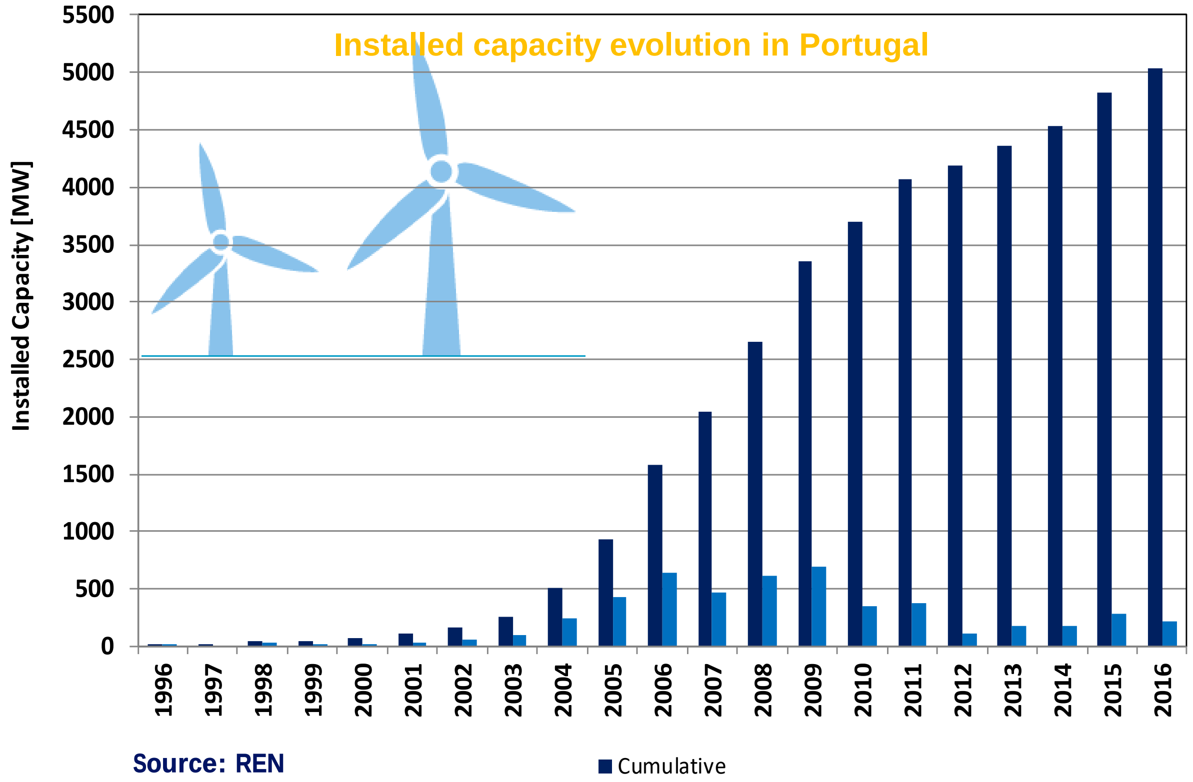


Source: REN

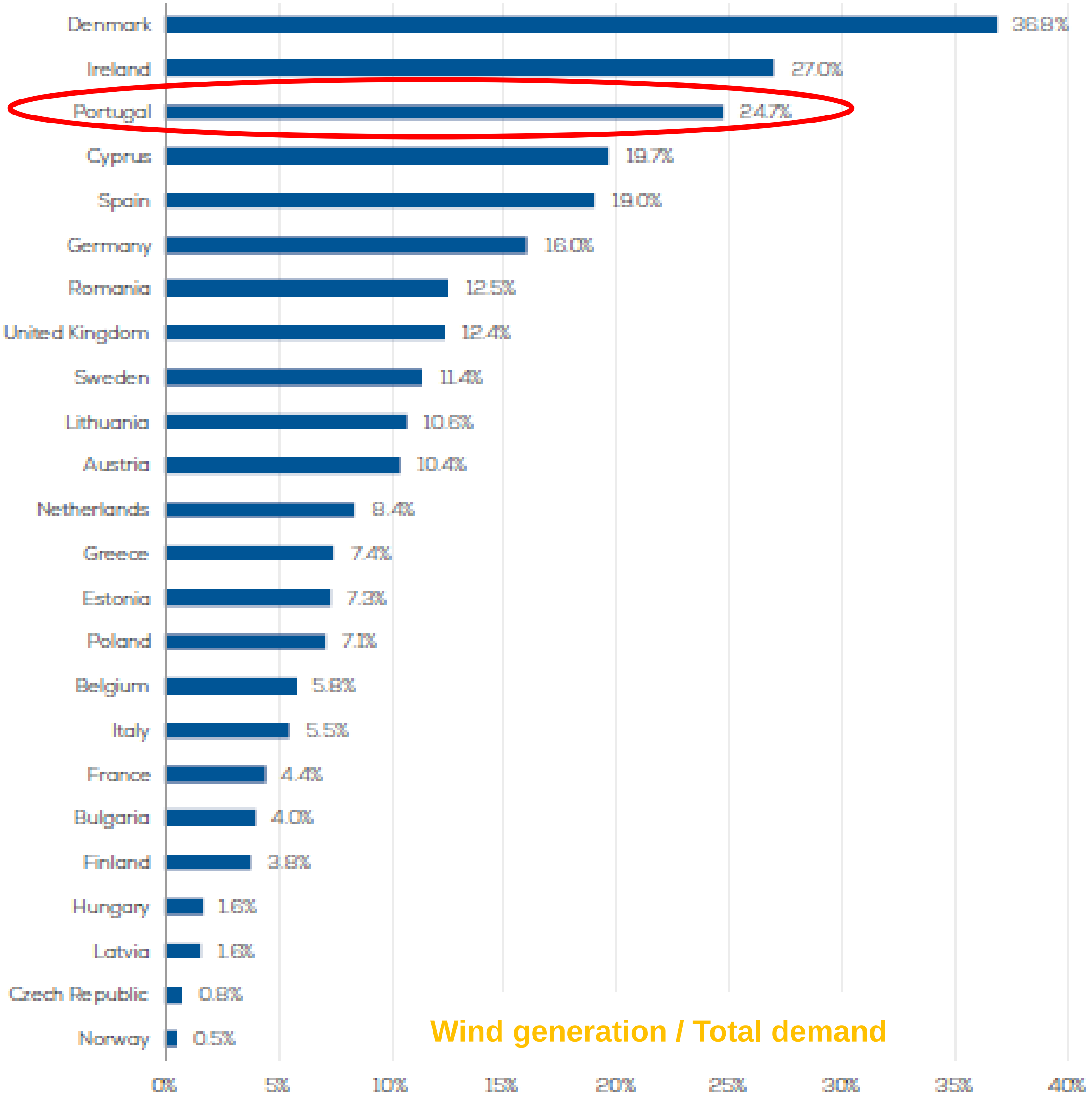
YEARLY ➔ **hydro** is highly dependent on wet/dry regime, whilst **wind** is more consistent

The changing of paradigm

Wind penetration rates and position related with European countries (2016)

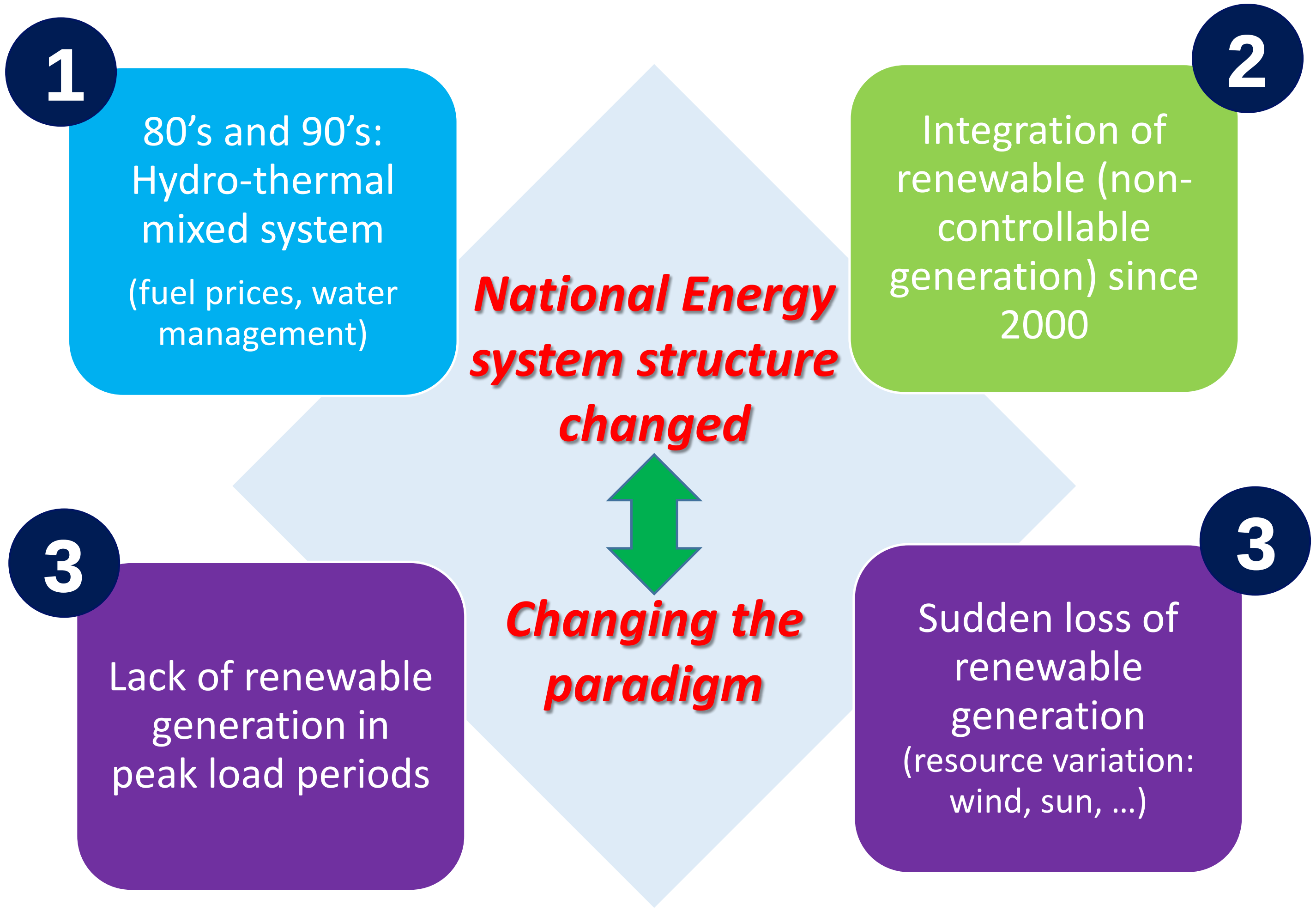


Source: REN



Source: WindEurope

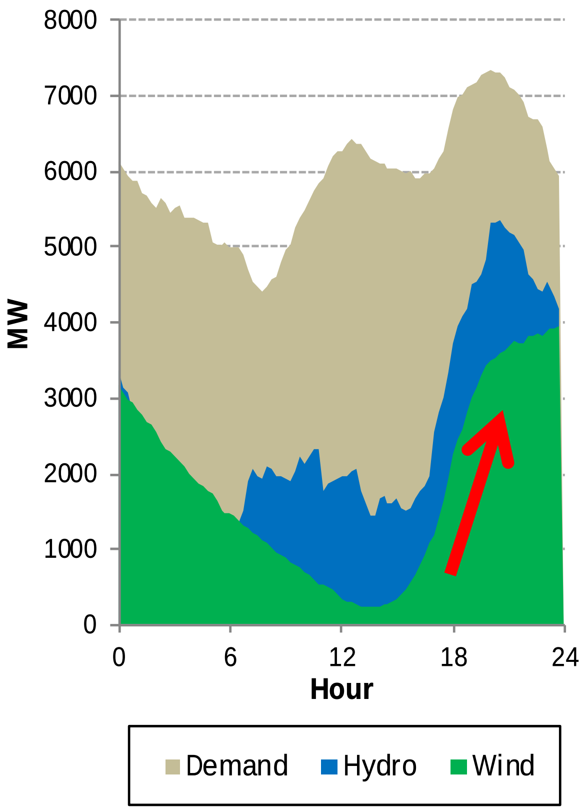
The changing of paradigm



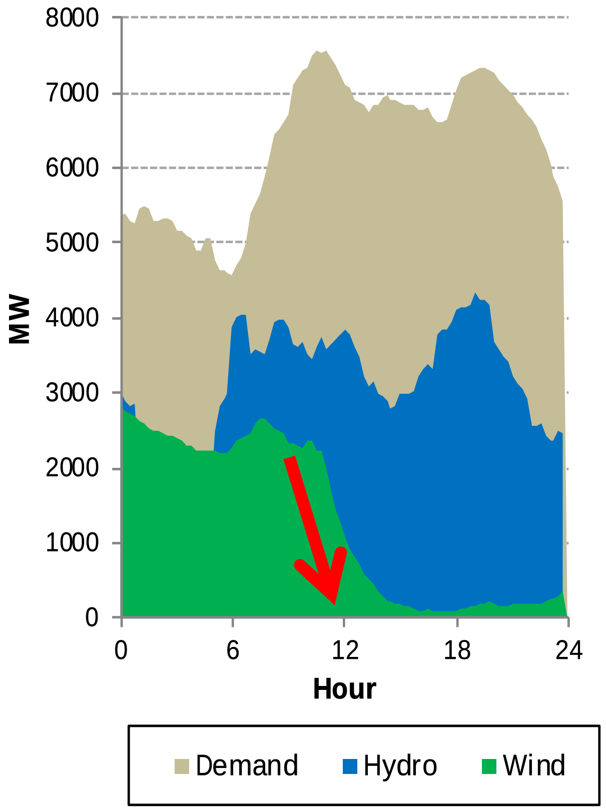
Wind generation volatility requires proper tools (planning and operation)

REN

Wind generation increase



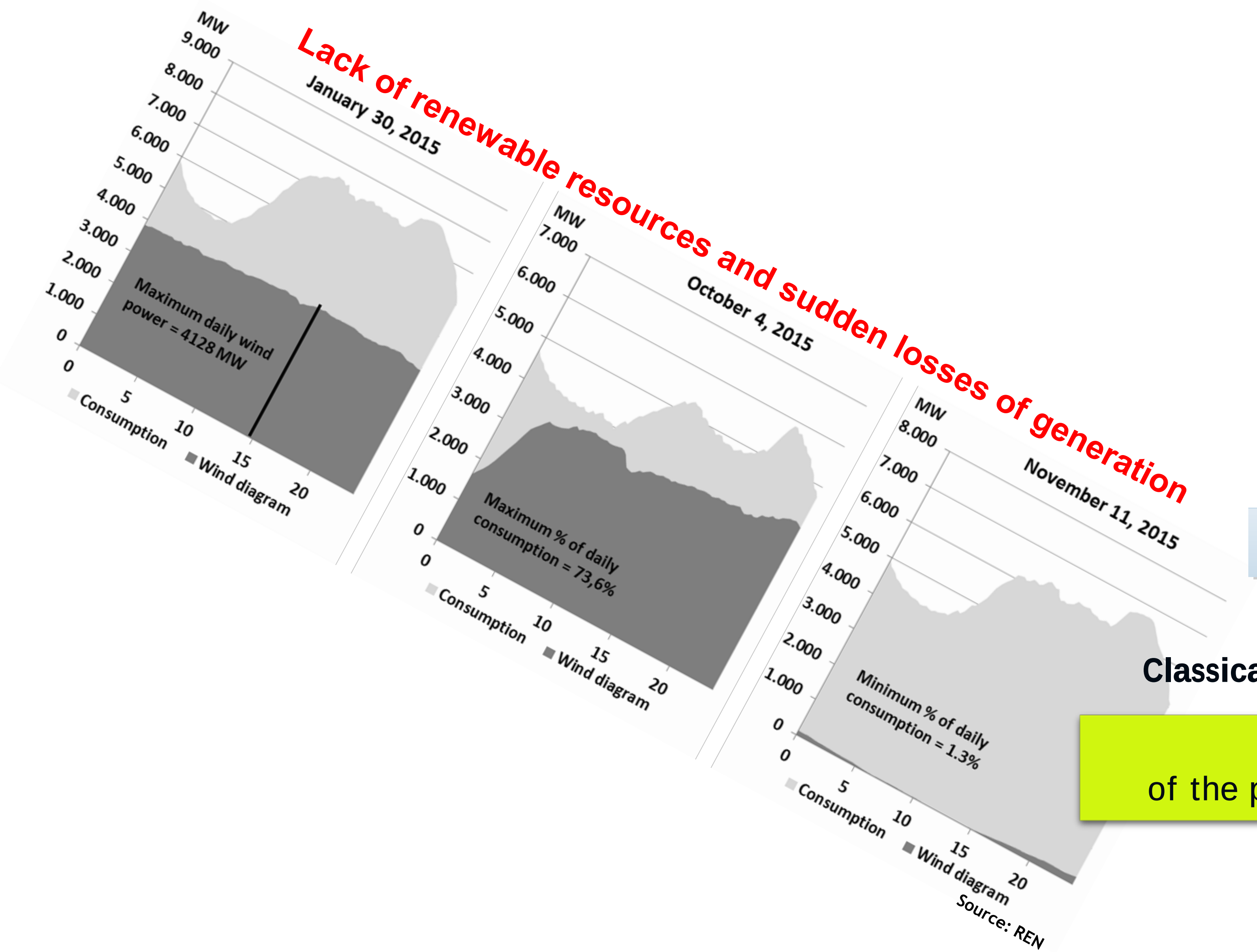
Wind generation decrease

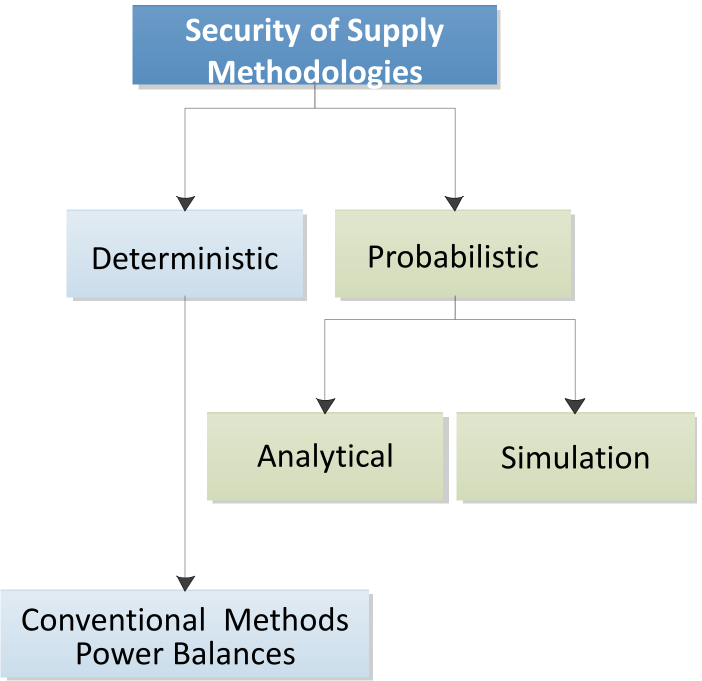


Source: REN

SHORT-TERM ➔ **hydro** (with reservoirs and pumping) is very flexible to cope with **wind** volatility

How to evaluate security of supply (planning methodologies)





Classical probabilistic models have limitations

Don't allow the evaluation
of the power system operational reserve needs

How to evaluate security of supply (planning methodologies)

Innovative methodologies (Mora® Model)

Integration of high levels of intermittent generation

Security of supply impact on adequacy

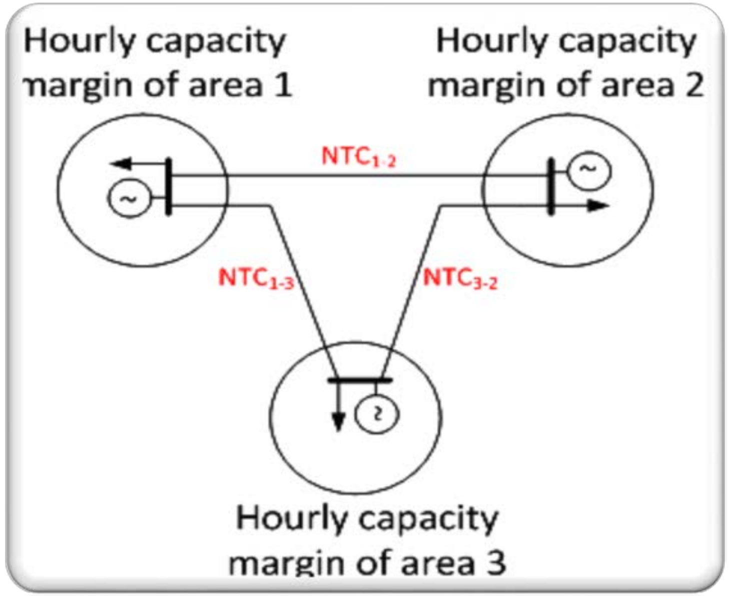
Operational reserve needs (security analysis)

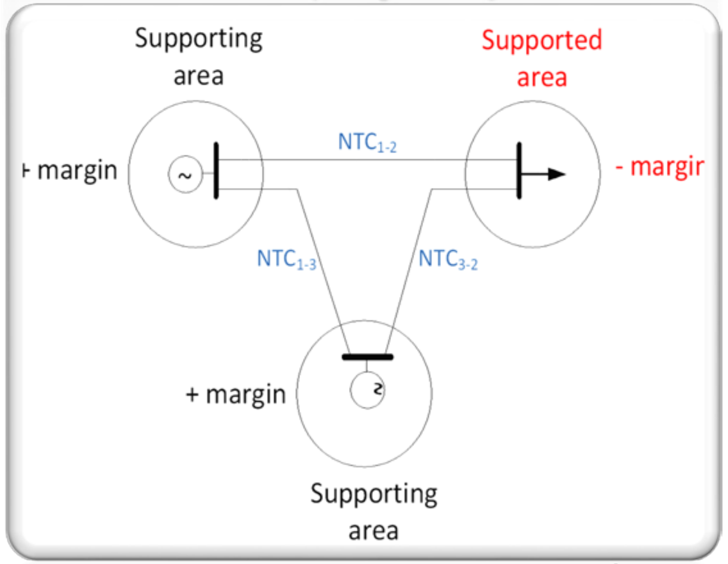
Deal with uncertainties:

- Load
- Wind
- Hydrology
- Generators unavailability
- Internal grid and interconnection

Results:

- Conventional probabilistic reliability indices, which represent the level of risk to the security of electricity supply
- Security of supply indices may include the effects of operating reserve (in)adequacy
- Probability distributions of each indices
- Renewable energy loss risk during base load periods

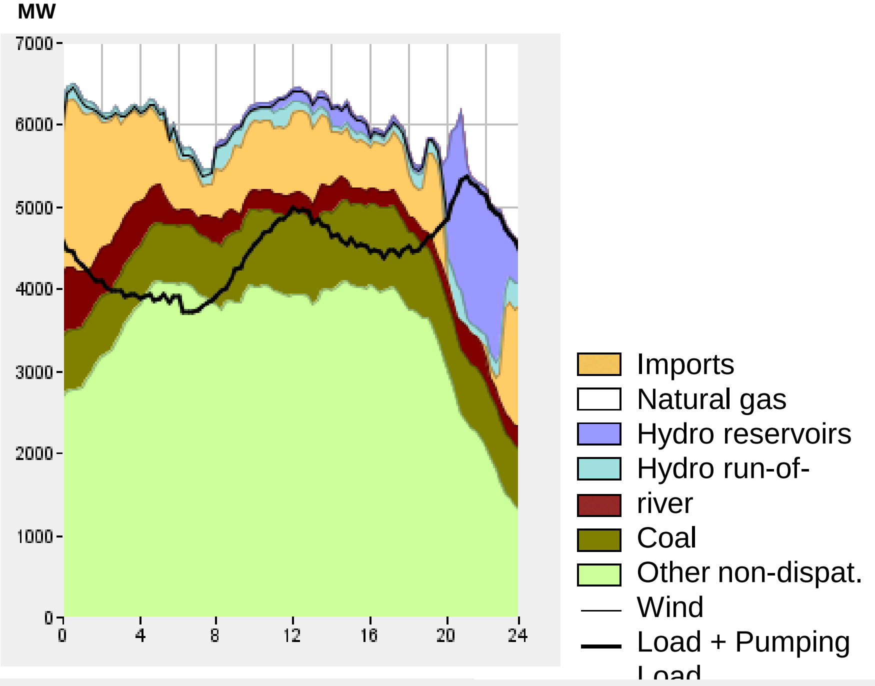


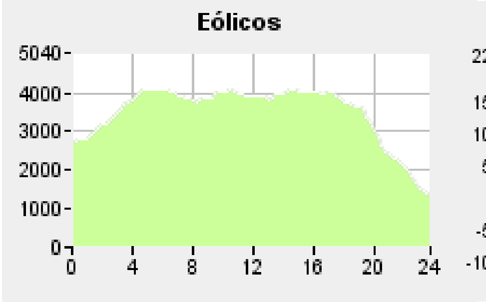


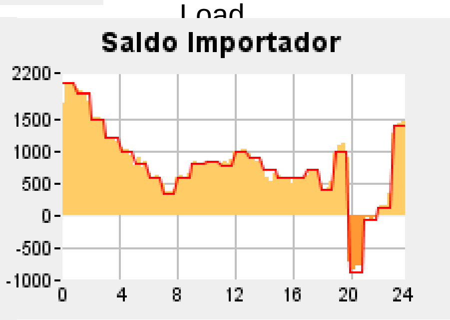
Note: MORA® is a registered trade mark of REN

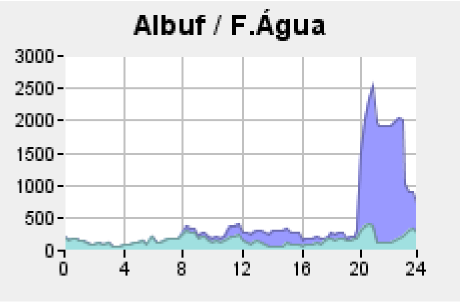
Role of hydro pumped-storage (system operation)

Load diagram 30th April 2017



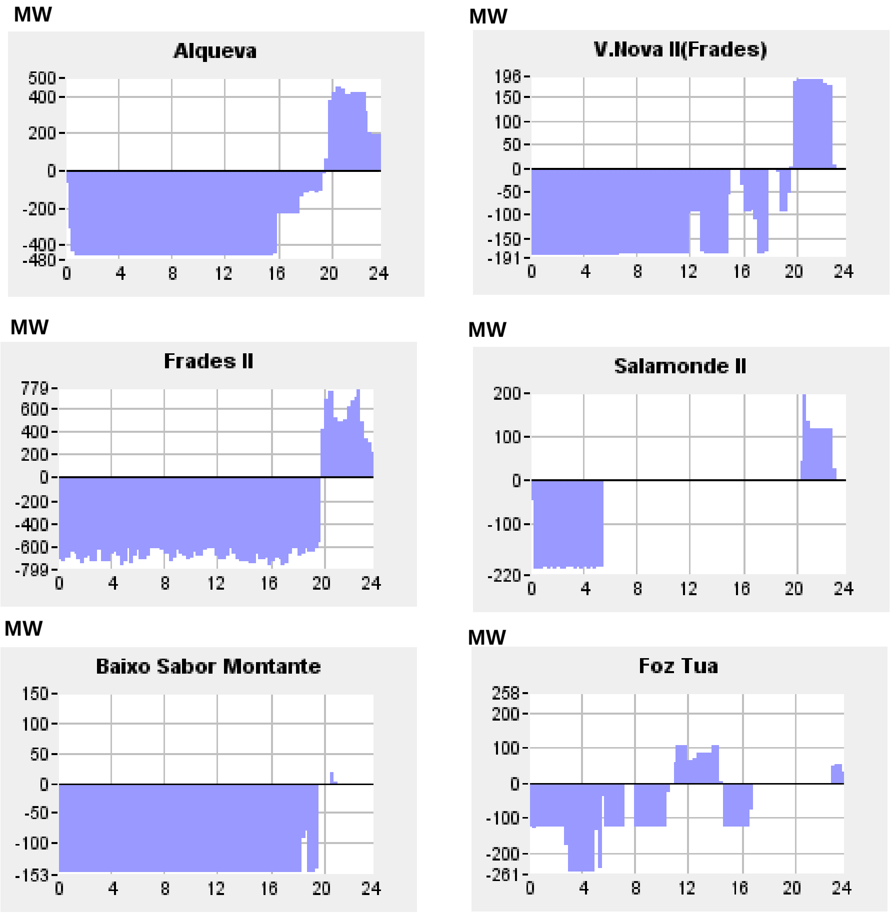






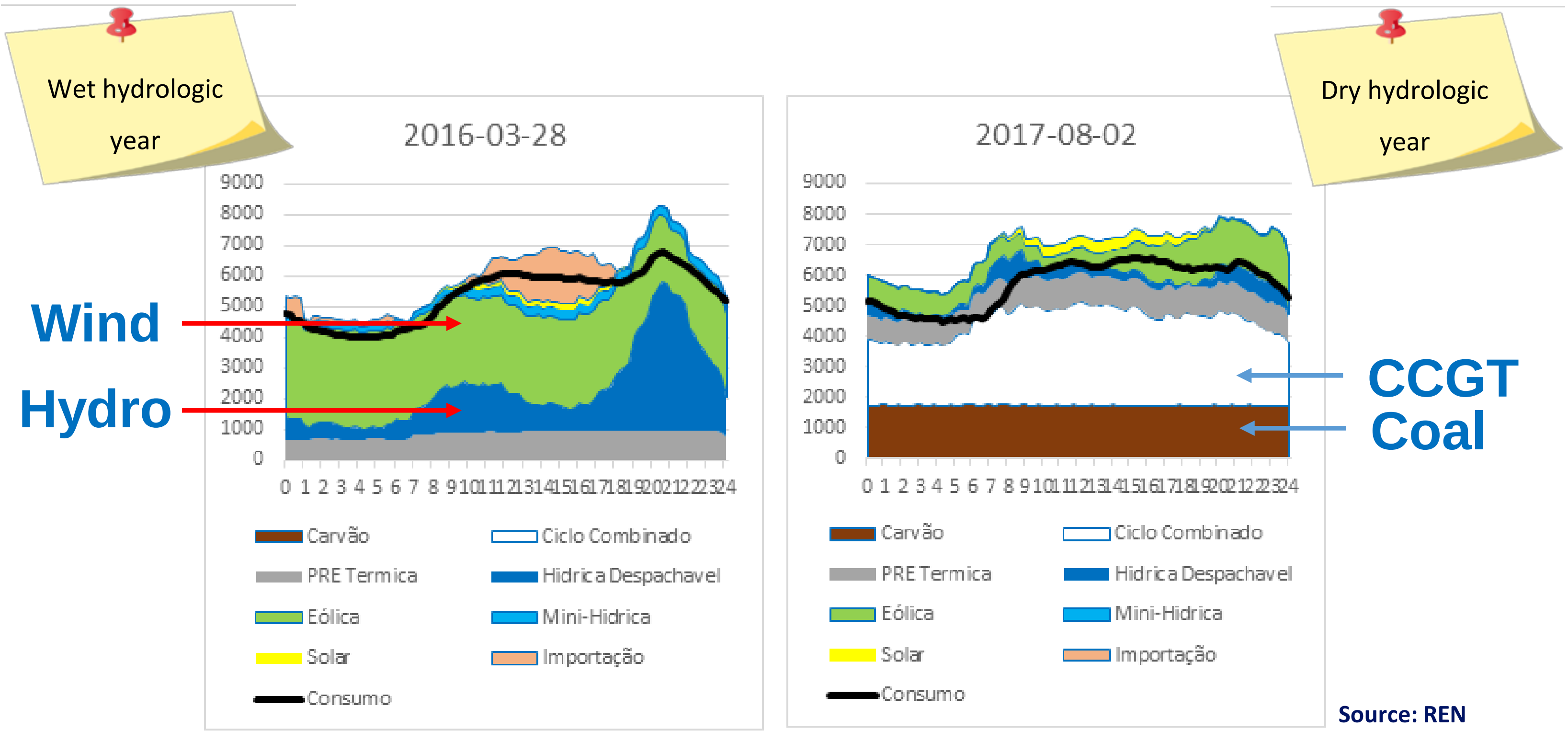
Source: REN

The role of Hydro Pumped-Storage



Currently renewables may supply more than 100% of Portuguese demand during some periods
Pumped-storage contribute to avoiding energy spillage

Role of backup technologies (system operation)



Source: REN

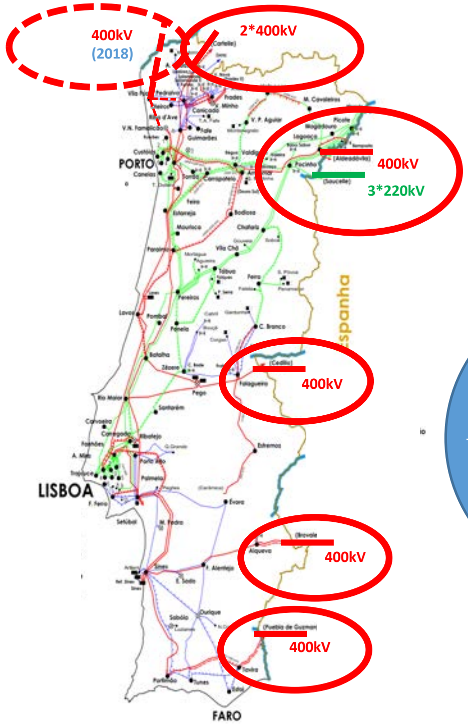
Utilization of CCGT and coal power plants as backup technologies depends on hydro production availability and market conditions

Role of transmission grid and interconnections (system operation)

Portuguese Transmission Grid

INTERCONNECTIONS

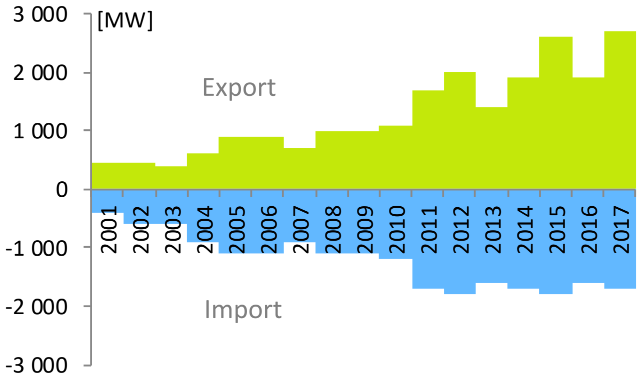
EXISTING	PLANNED (2021)
• 6x 400 kV AC OHL • 3x 220 kV AC OHL	• 1x 400 kV AC OHL



Creating value for the Market

TARGET
NTC (2021)
3 000 MW
(>10% of Generation)

Portugal–Spain | Net Transfer Capacity[1]



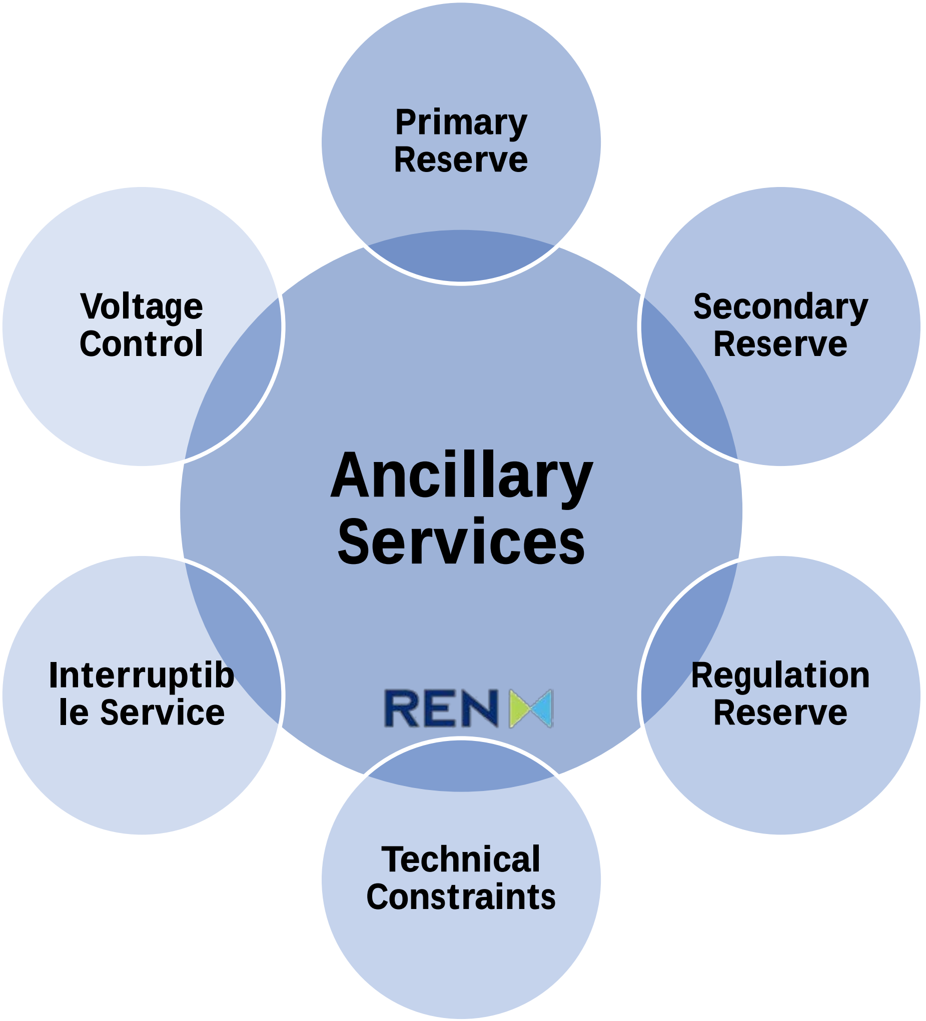
1. Minimum at more than 75 % of the time

Portugal–Spain | Market Splitting

Source: REN

Interconnections increase Security of Supply and Market Integration and contribute to avoiding energy spillage (export energy to neighbor systems)

Ancillary Services: intermittency response toolbox (system operation)



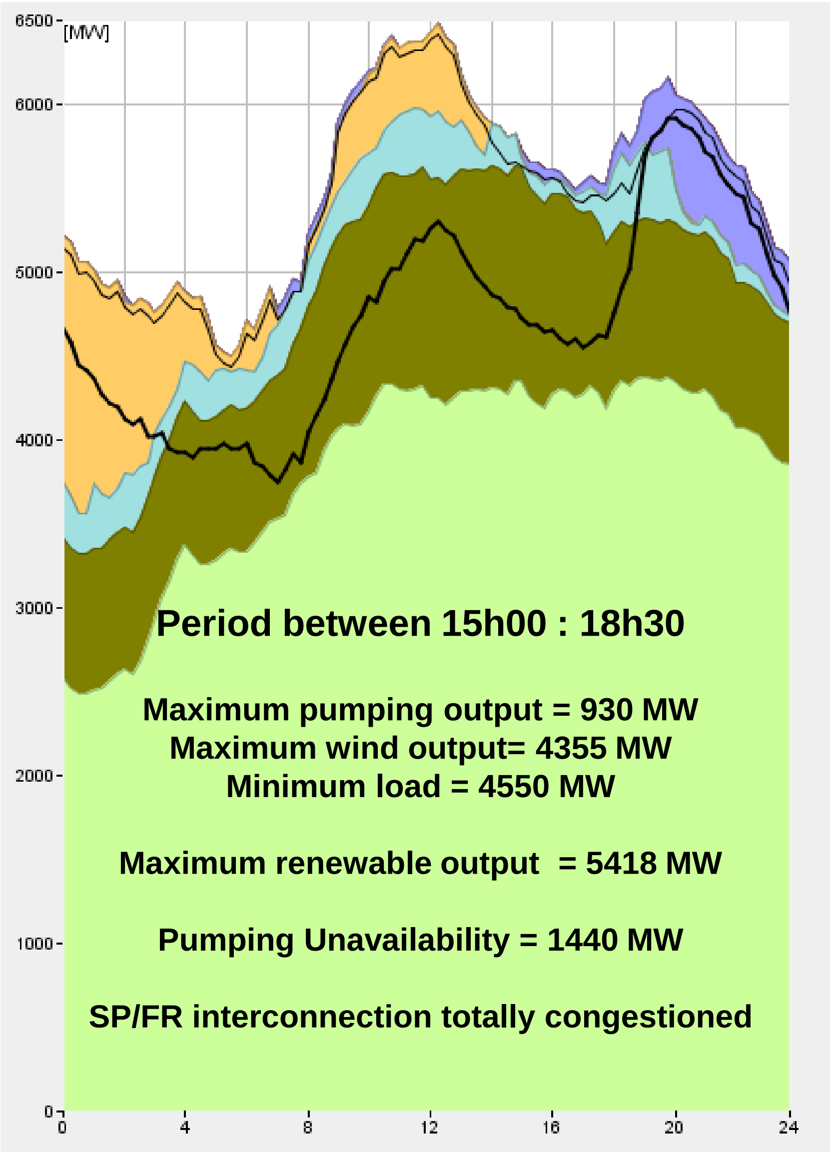
- ✓ Aims at keeping the balance between generation and demand at all times
- ✓ Managed by the System Operator
- ✓ Different types of operating reserves

Intensity of use depends on good demand and production estimation

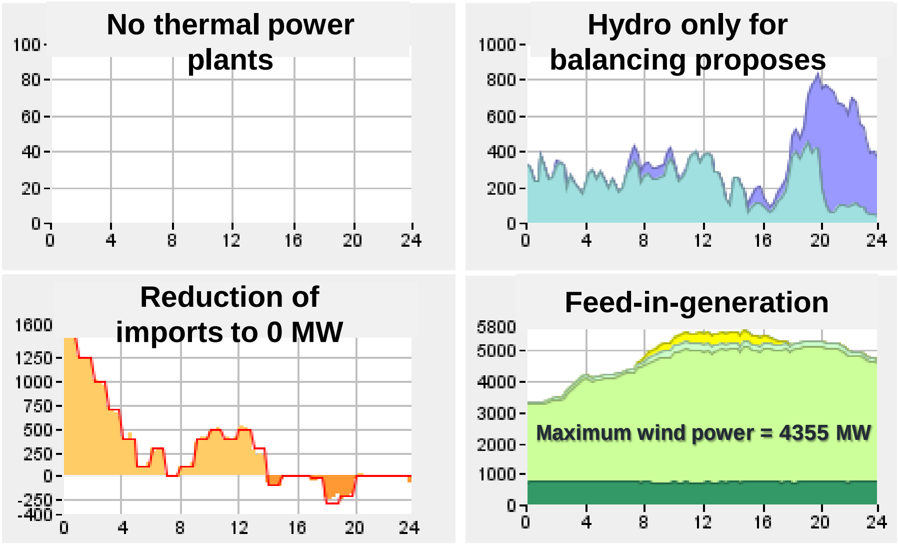
First and only wind curtailment on Portuguese System - 12/03/2017

REN

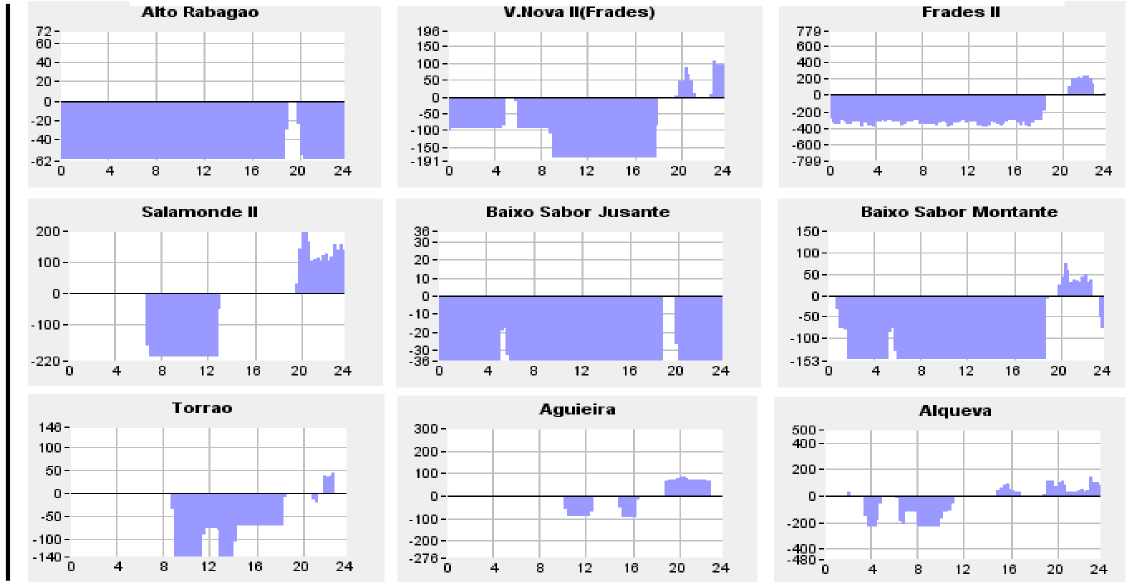
Approximately 90MW of wind curtailment accordingly DGEG Order nº8810/2015



Wind
Import/Export balance
Hydro Reservoirs
Hydro Run of river
Feed in tariff - Renewables
Coal
Consumption



The role of Hydro Pumped-Storage

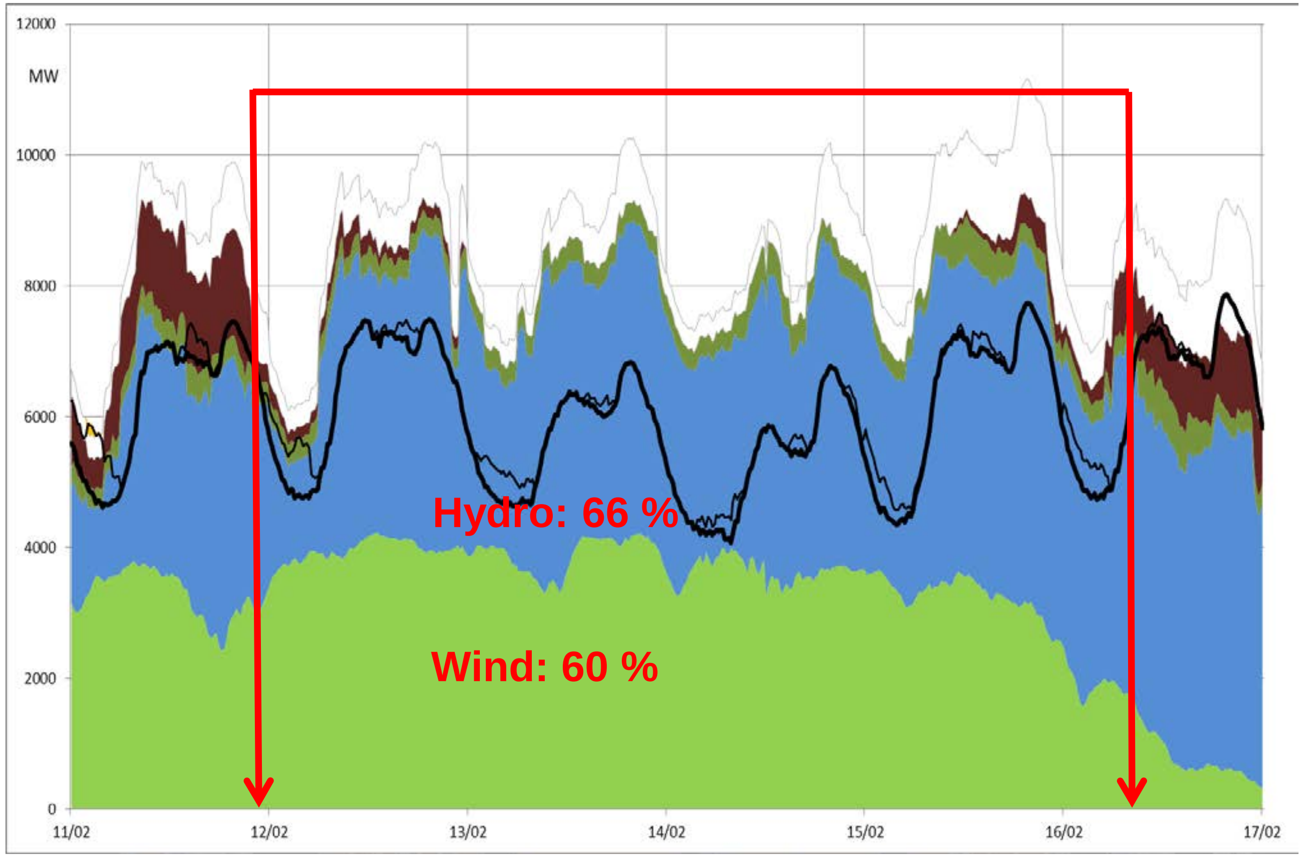


Source: REN

TSO needed to mobilise downwards reserve during this period. Strong and constant restrictions to mobilise downwards reserve were responsible for depleting system reserves (namely pumped hydro storage)

Real Case: February 2016

Renewables generation was sufficient to supply demand and enabled exports over 106 hours



Conclusions

Portuguese case study shows that the successful integration of renewable energy is supported in the following main achievements:

- ✓ **Effective energy policy design**
- ✓ **New long-term system security of supply methodologies**
  - **The role of pumped-hydro technologies to provide flexible reserve and energy storage**
  - **Adequate backup capacity (CCGTs) to face wind variability**
- ✓ **New planning processes and methodologies and improvement on transmission grid capacity (focus also on interconnections)**
- ✓ **Global TSOs cooperation in order to keep stability, reliability and power quality. Wind curtailment only occurred in one time**

In a near future, Sector Coupling (interaction between gas and electricity) will also allow good renewables integration. P2G technologies increase renewables seasonal storage

Thank you

nuno.martins@ren.pt