MIT Portugal

Reliability of Electricity Systems in a Marginal Cost Market

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New problems in energy optimization: the industrial perspective

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Overview

- Introduction
- Some facts - Iberia
- New challenges in the electricity sector
- Conclusion

Introduction

Relevant European Policies

- *Common rules for the creation of the internal European electricity market:*
  - European Directive 96/92/EC
  - European Directive 2003/54/EC
  - European Directive 2009/72/EC

- *European Directive 2001/77/EC repealed by the European Directive 2009/28/EC - promotion of electricity generation by renewable energy sources (RES)*

- *European Community Regulation 1228/2003/EC of 26 June 2003 – rules for cross-border exchanges in electricity to be managed by the Transmission System Operators (TSO)*

Introduction

Large-scale growth in RES-E and associated volatility:

- Lower wholesale electricity prices
- Small residual loads available
- Back-up power required by dispatchable electricity generation units:
    - nuclear, thermal or hydro power plants.
    - storage units
    - interconnections
- Combined Cycle Gas Turbines (CCGT):
    - Flexible
    - High efficiency
    - Low emissions

Introduction

Iberian electricity market was only a reality in July 2007 – MIBEL

- Electricity spot market – OMIE
- Electricity bilateral market - OMIP

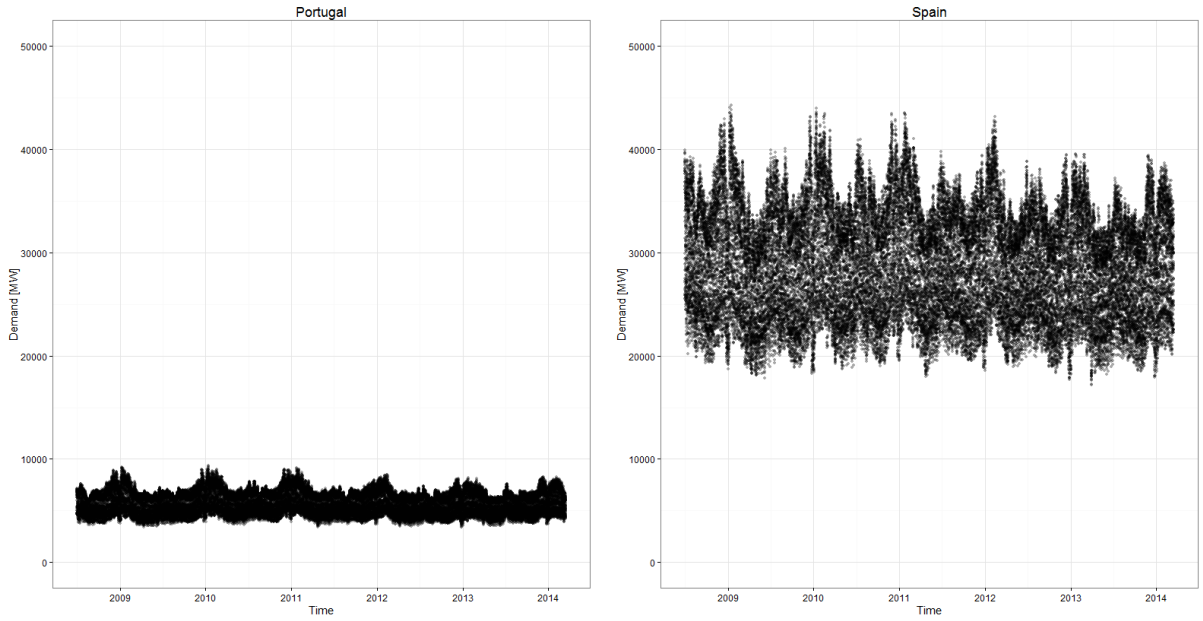
In Spain:

- Electricity sector regulator established - November 1997
- Privatisation of the electricity industry on the generation and commercialisation
- Electricity spot market introduced in 1998

In Portugal:

- Unbundling of the Portuguese electricity sector
- Regulator for the energy sector created in 1995

Some Facts – Iberia demand



Some Facts – market integration

High level of electricity market integration – 3000 MW of interconnections

Market Splitting

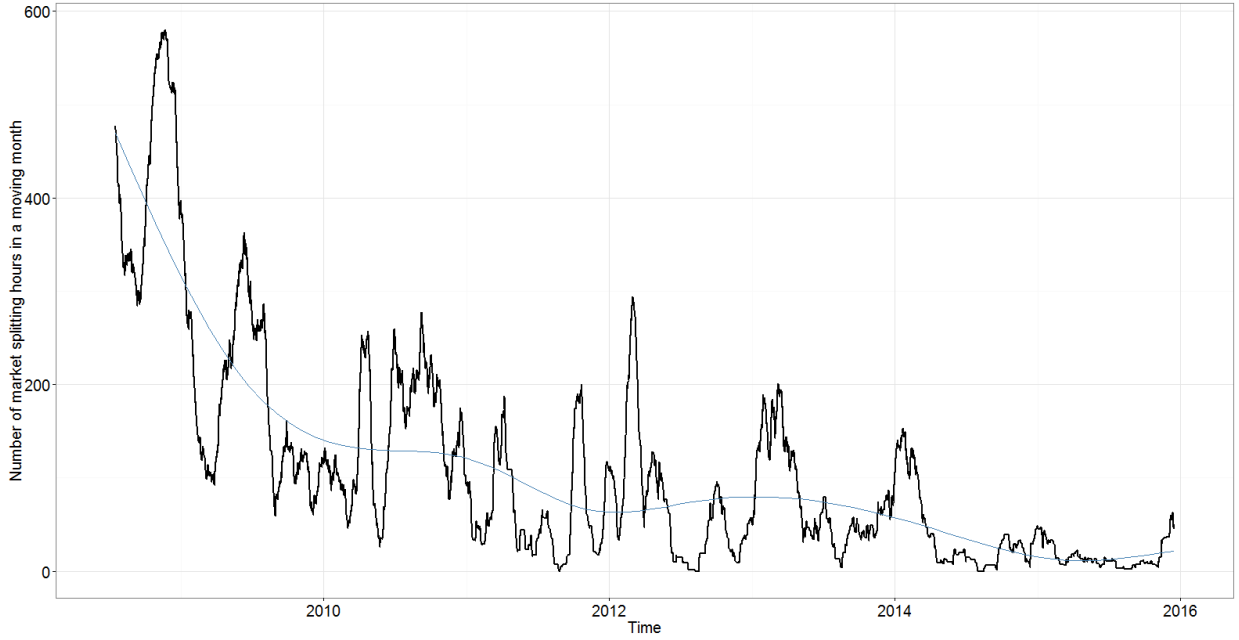


Figure 3 – Iberian market splitting evolution (REN, 2016)

Some Facts – generation capacity

Outstanding growth of RES-E through the introduction of Feed-In-Tariffs (FIT)

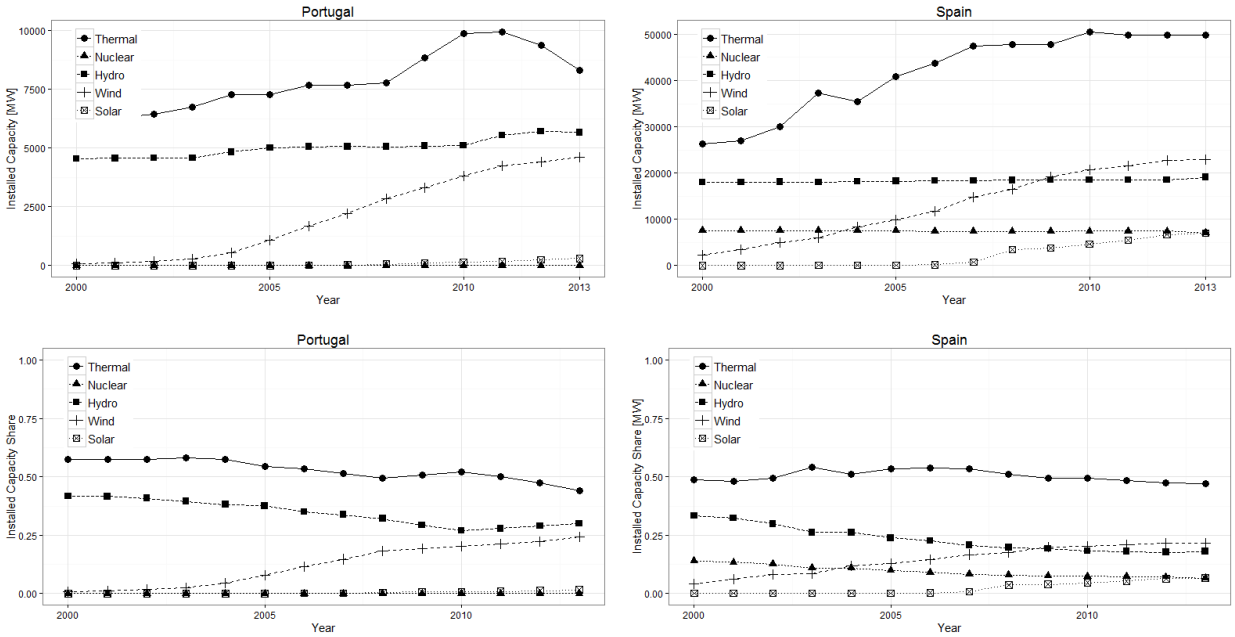
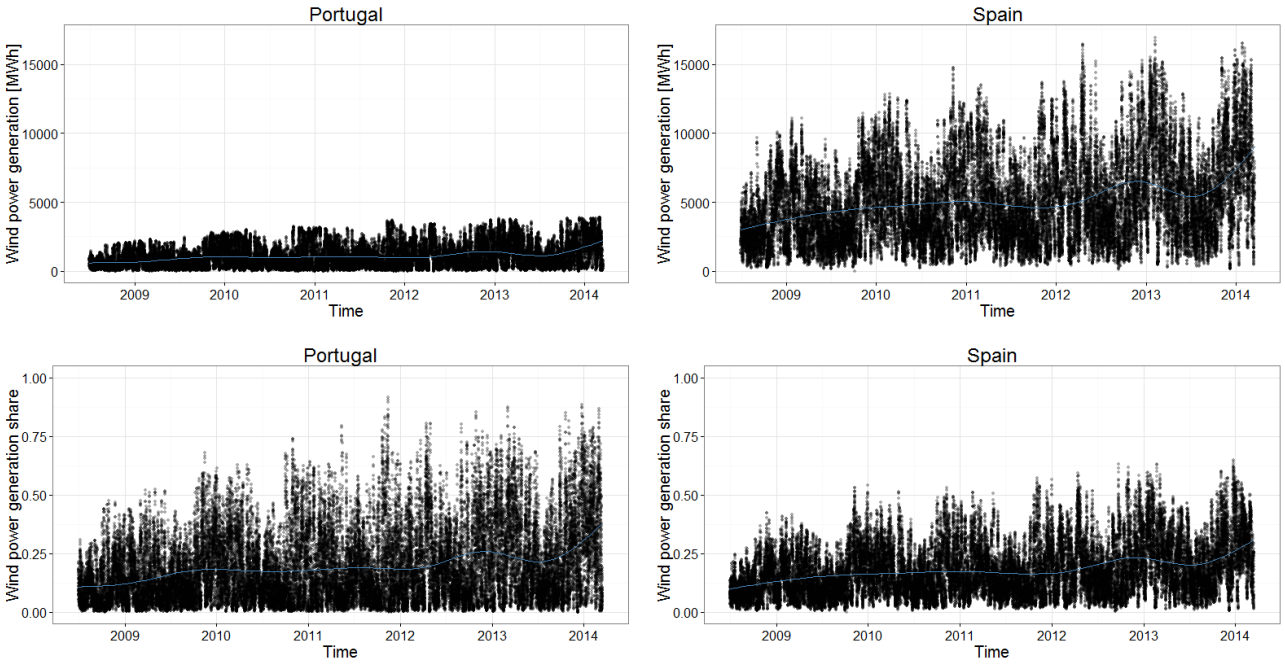


Figure 1 – Installed generation capacities and shares in Iberia (Eurostat, 2013)

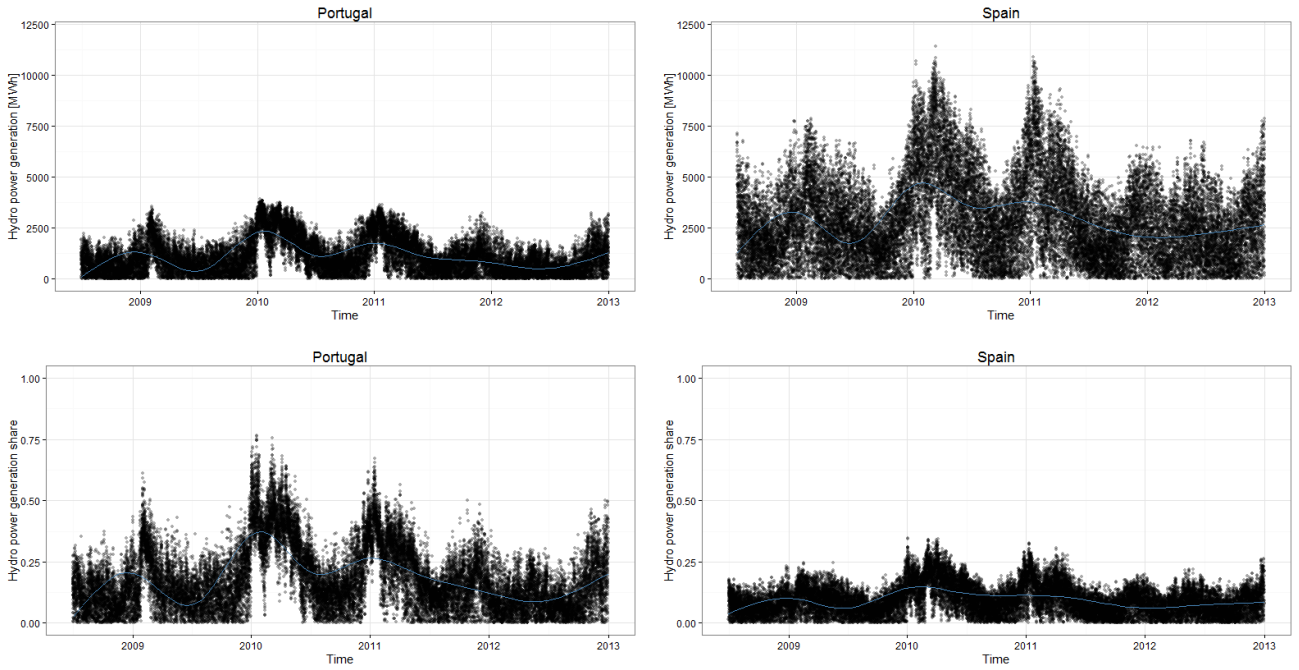
Some Facts – generation capacity

Wind power generation in Iberia



Some Facts – generation capacity

Hydro power generation in Iberia



Some Facts – wind power

With the required renewable resource, wind power is able to match demand

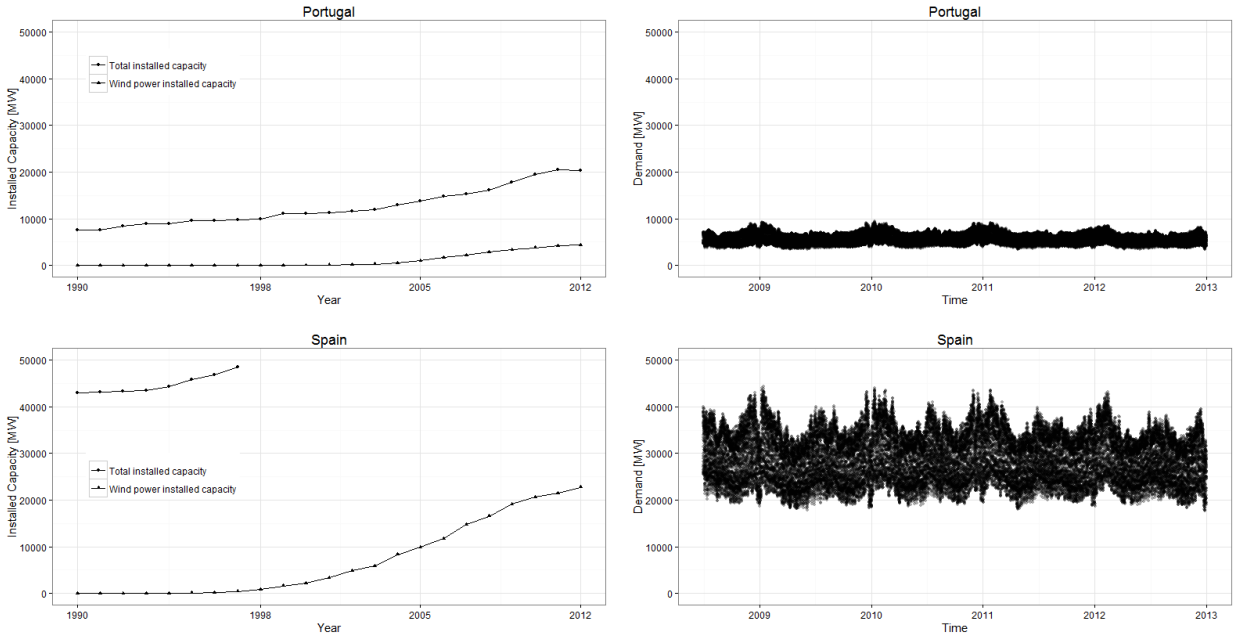


Figure 2 – Wind power generation capacity and demand (REE, 2016; REN, 2016)

Some Facts – generation mix

Iberia is a case-study:

- Generation mix in Iberia and merit-order:
  - high level dispatchable generation capacity of hydro power
  - large non-dispatchable generation capacity of wind power.

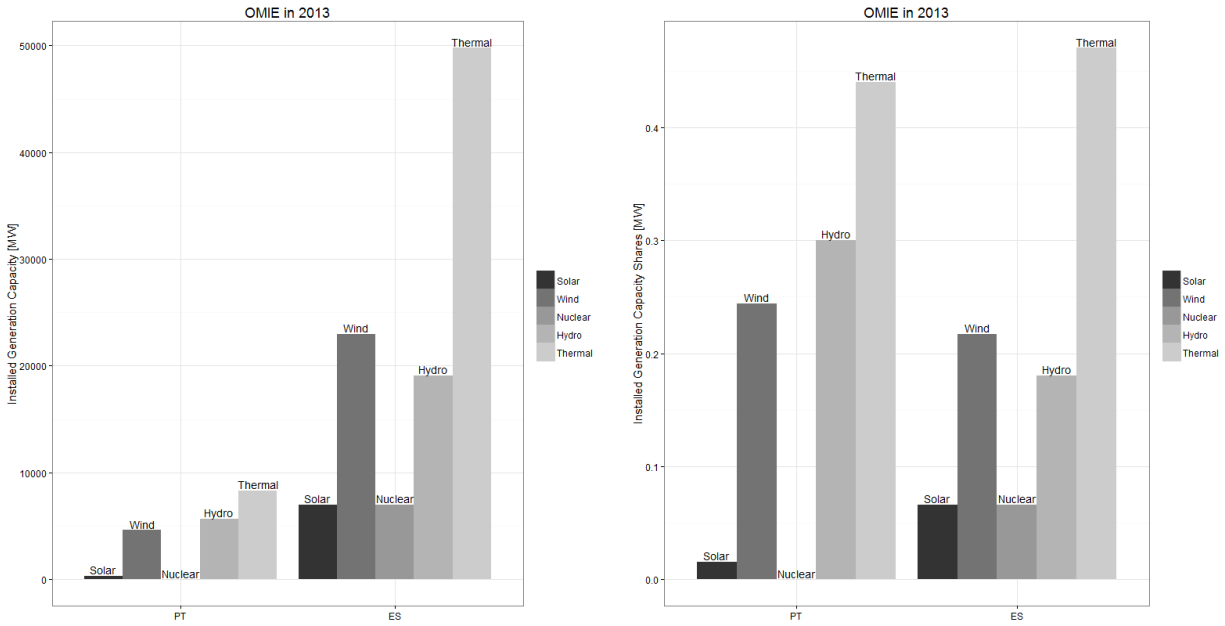


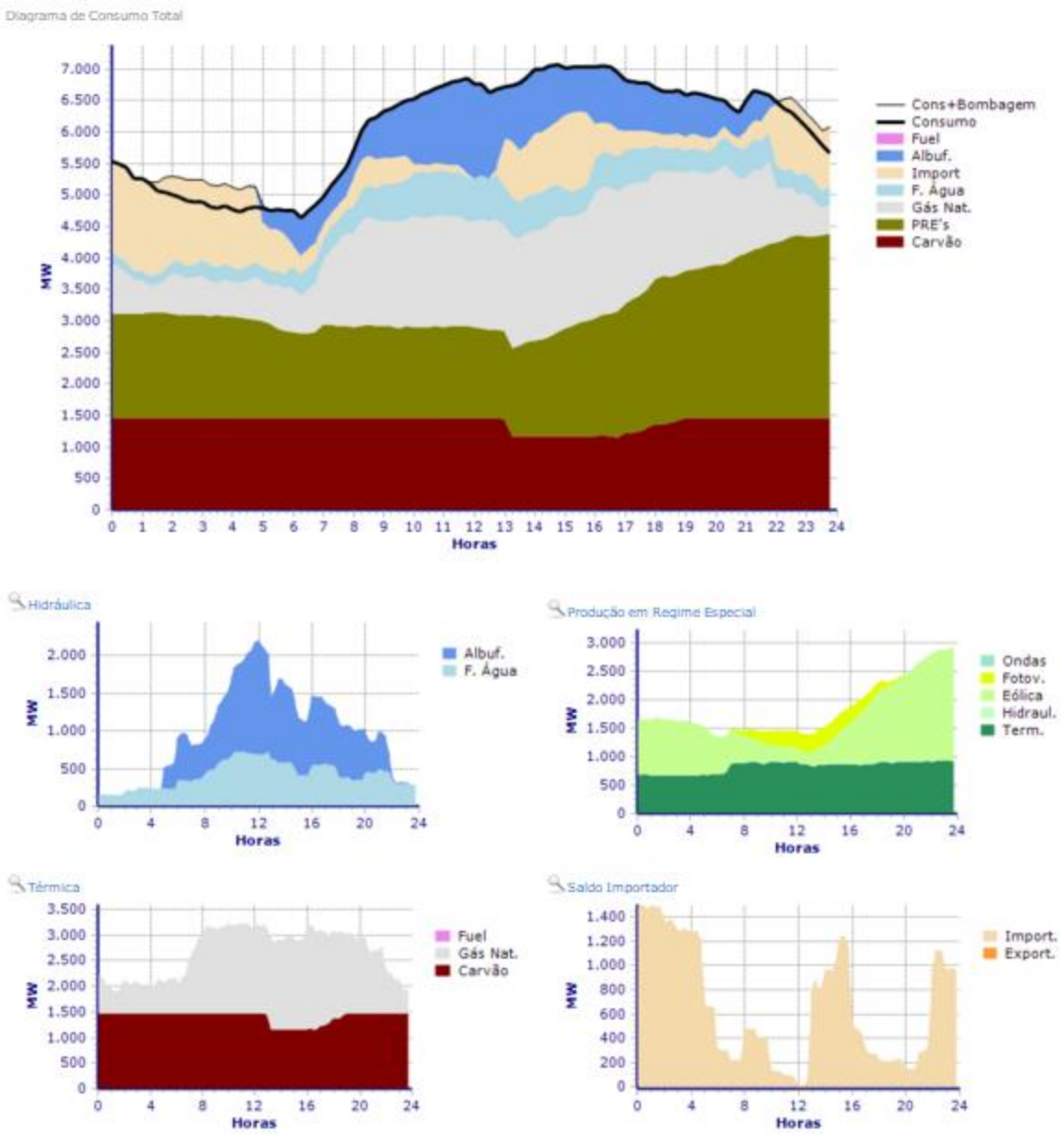
Figure 4 – Generation mix in Iberia 2013 (Eurostat, 2015)

Some Facts

15th July 2015 - Portugal

Summer with low availability of renewable resources

- Coal and CCGTs thermal generation required.
- After 14:00 RES-E picks-up and CCGTs are forced to reduce load



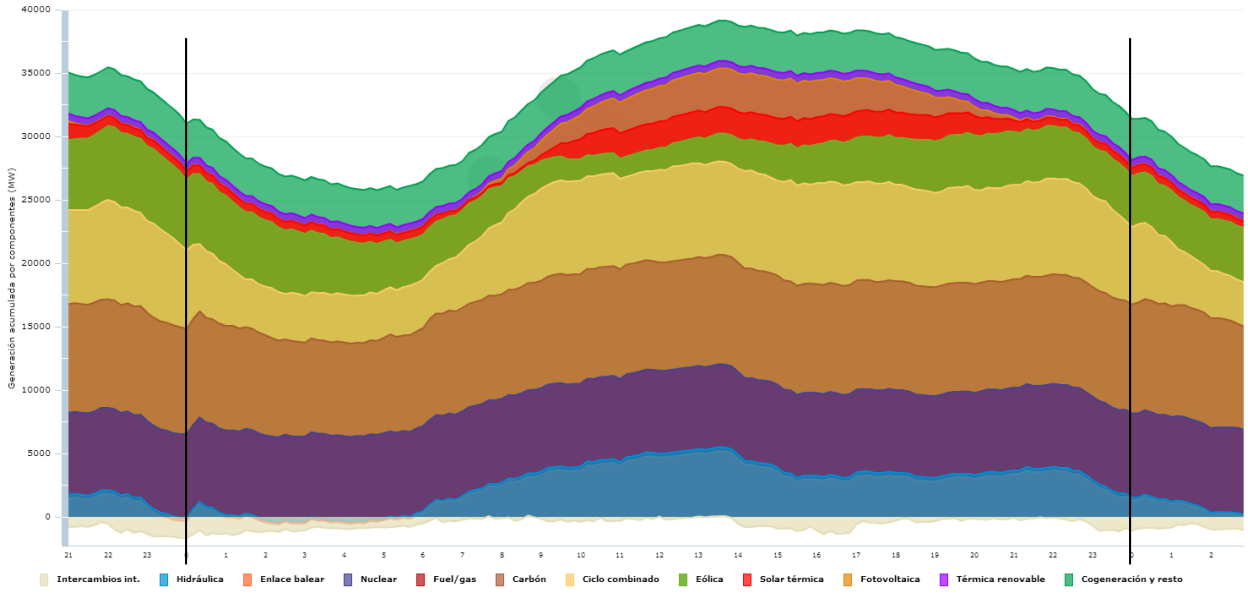
Daily load diagram for Portugal 15th July 2015 (REN, 2016)

Some Facts

15th July 2015 - Spain

Summer with low availability of renewable resources

- Coal and gas thermal generation required



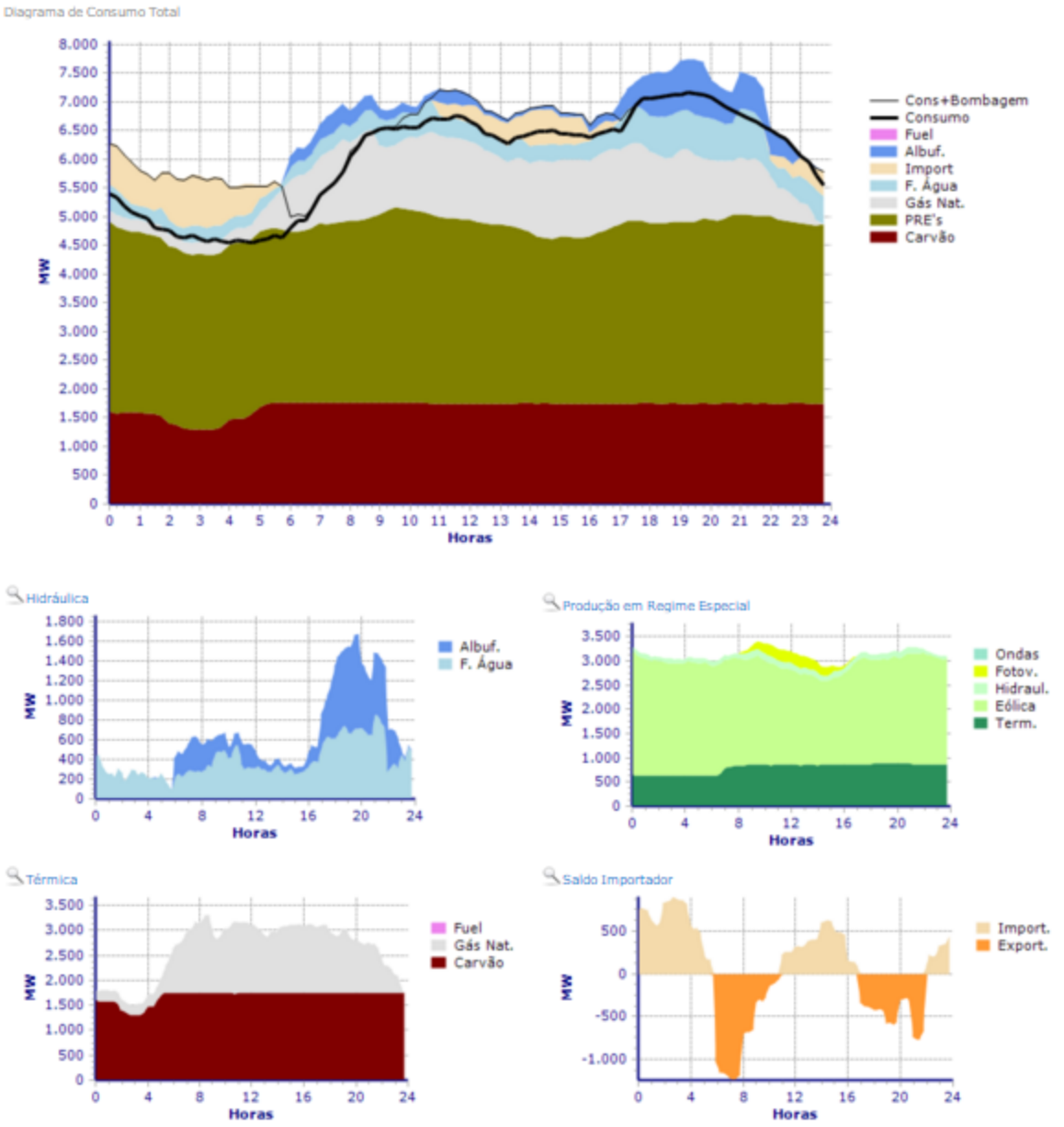
Daily load diagram for Spain 15th July 2015 (REE, 2016)

Some Facts

16th December 2016 - Portugal

Dry year with high levels of wind

- Coal fired generation is currently the thermal technology with lowest marginal cost
- CCGTs for peak loading



Daily load diagram for Portugal 16th December 2016 (REN, 2016)

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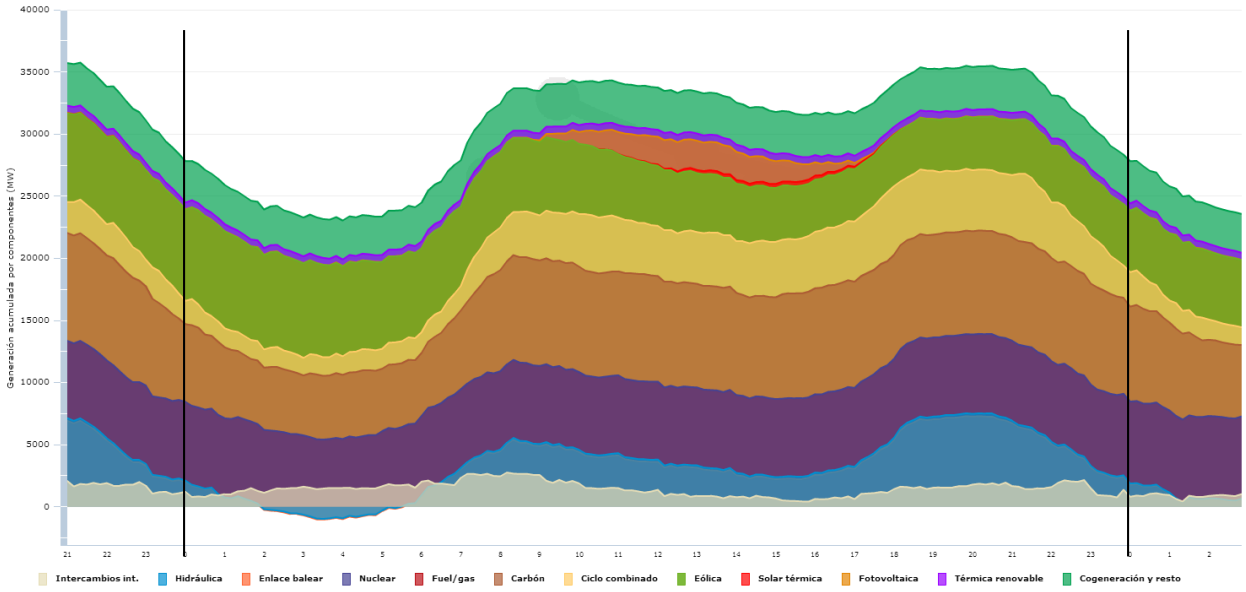


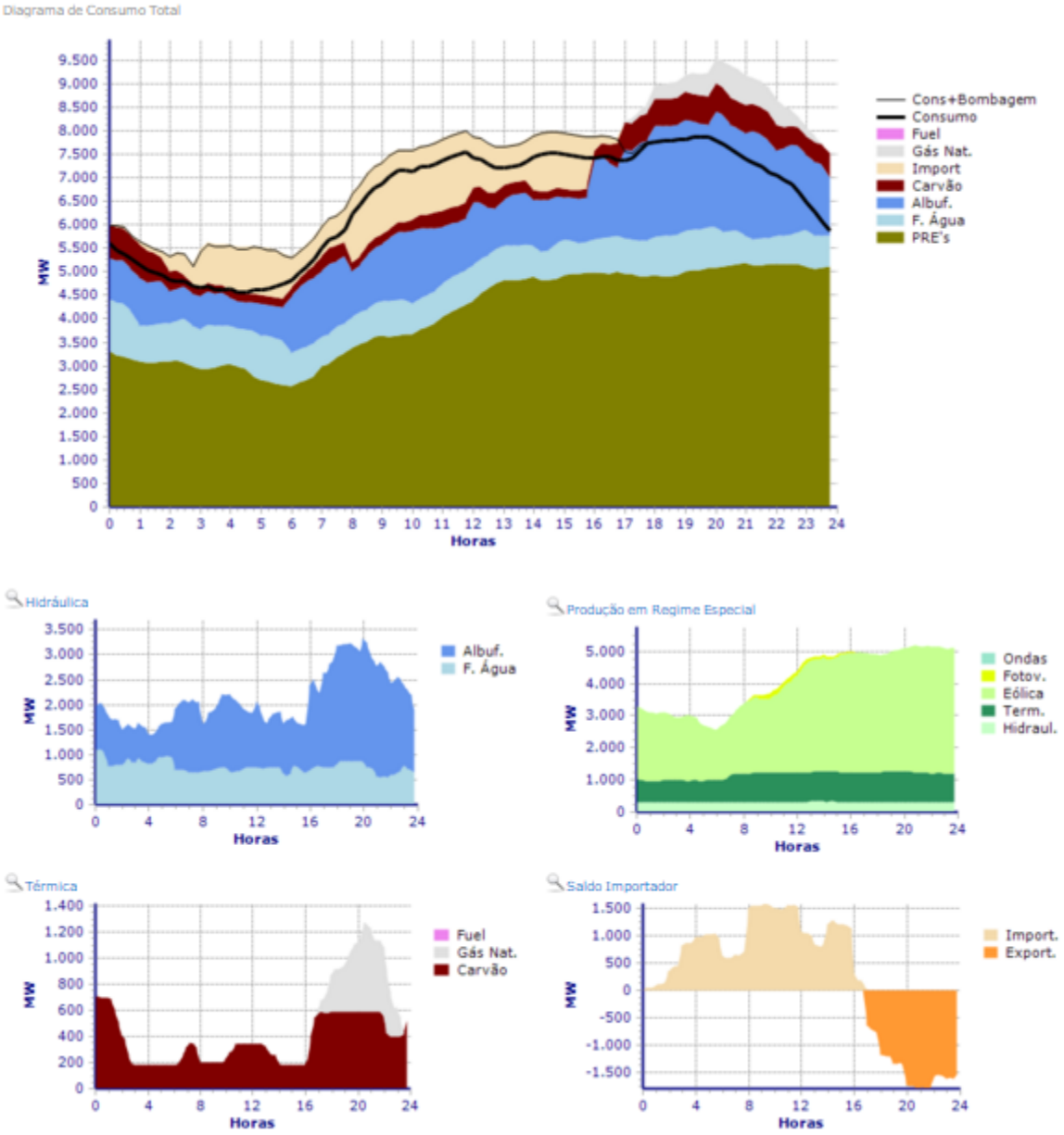
Daily load diagram for Spain 16th December 2015 (REE, 2016)

Some Facts

6th January 2016 - Portugal

High level of renewable resources (water and wind)

- Peaking coal and CCGTs

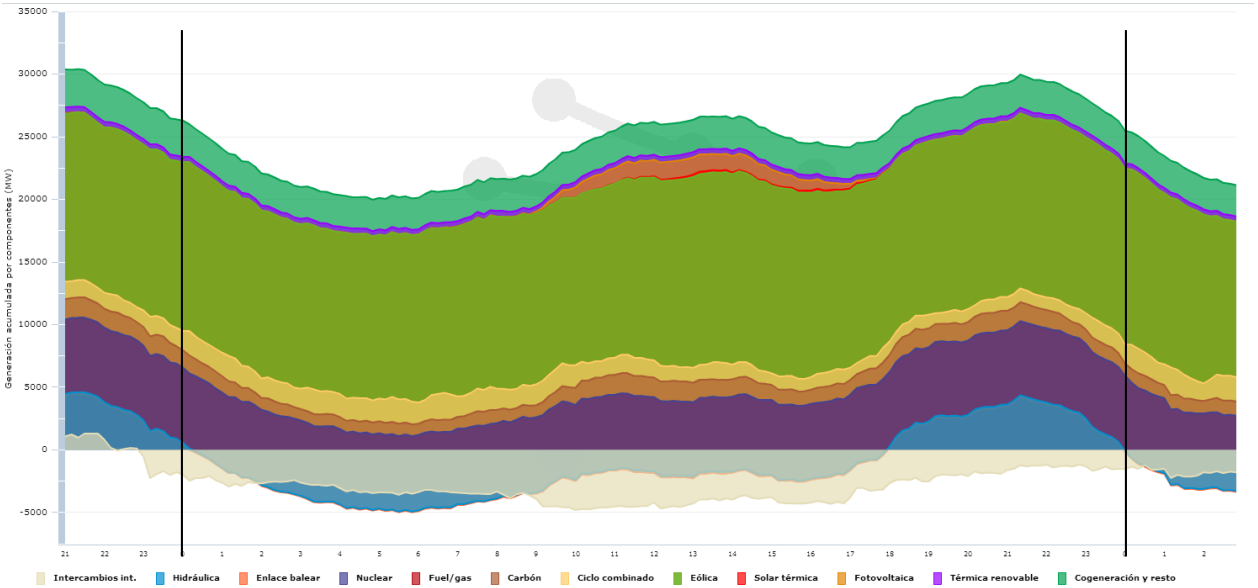


Daily load diagram for Portugal 6th January 2016 (REN, 2016)

Some Facts

6th January 2016 - Spain

High level of renewable resources (water and wind)



Daily load diagram for Spain 6th January 2016 (REE, 2016)

Problematic scenario

Electricity producing firms face turmoil in Europe:

- European electricity system restructuring,
- The renewables promotion,
- The shale gas revolution in the US and cheap coal
- The EU ETS,
- The Fukushima disaster and increasing Natural Gas prices
- Decreasing/stable demand
- low load factor of thermal power plants, in particular CCGTs.

In a full functioning electricity market, if financial damages are too big:

- merchant plants can be moth-balled or decommissioned

In Iberia, due to regulatory constraints, this is not allowed – grid security reserve:

- Availability guarantee payment introduced for new plants - CCGTs
- Not enough to cover infrastructure and fixed costs with very low load factors.

New challenges in the electricity sector

Problems due to large-scale RES-E generation:

- Transmission grid management and stability,
- Production surplus and supply/demand mismatch,
- Quality of supply and power cuts,
- Transmission constraints

Decentralisation of the electricity system with RES-E

Conventional power plants are increasingly used for back-up purposes and are becoming financially unsustainable

The new, more efficient and flexible, CCGTs are out of the wholesale electricity markets merit order - shale gas revolution; decrease of coal prices; increase of Natural Gas prices in Europe.

New challenges in the electricity sector

Reliability is at risk:

- Closure of all nuclear (safety concerns raised by the Fukushima disaster) and some of the coal fired (emission reduction) power plants in Germany
- CCGTs financial unsustainable

Adequate funding for stand-by dispatchable electricity is required:

- CCGTs,
- Hydro-pump storage,
- Electricity storage technologies – yet to be developed
- Increasing cross-border transmission capacity

Conclusion

Existing energy only market fails to provide correct investment signals for back-up power generation

e.g. CCGTs

- efficient, flexible and low emission
- currently not adequately used
- not financially sustainable

In a nutshell, investment in backup power plants is at risk

Some new questions arise:

1. How will utilities recover investment/fixed costs in backup generation units?
2. In a marginal cost/energy only market how can adequate signals can be provided to electricity system stakeholders?
3. Are we closing all conventional thermal generation due to environmental concerns and GHG reductions, together with nuclear phase-out?
4. How to maintain the electricity system stability with high levels of intermittent RES-E?