

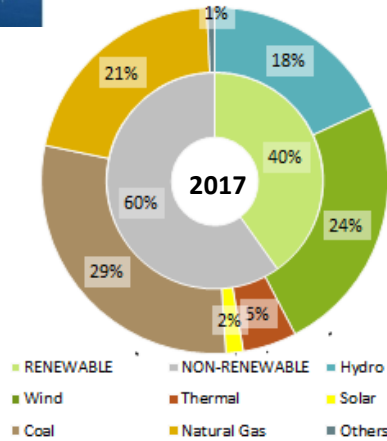
Wind Integration Workshop 2018
IEA WIND Task 25 and IEA PVPS Task 14
collaboration
KTH, 17th October 2018

Summary of wind and solar integration study results

PT Contribution

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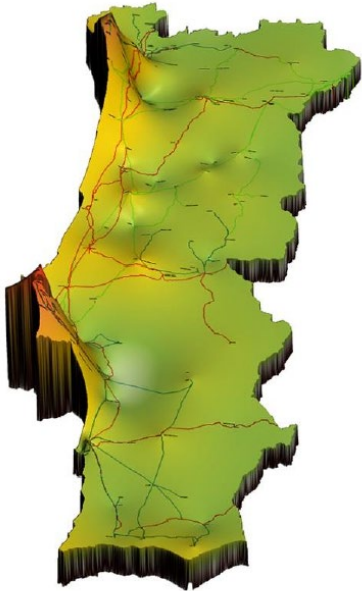
António Couto, LNEG



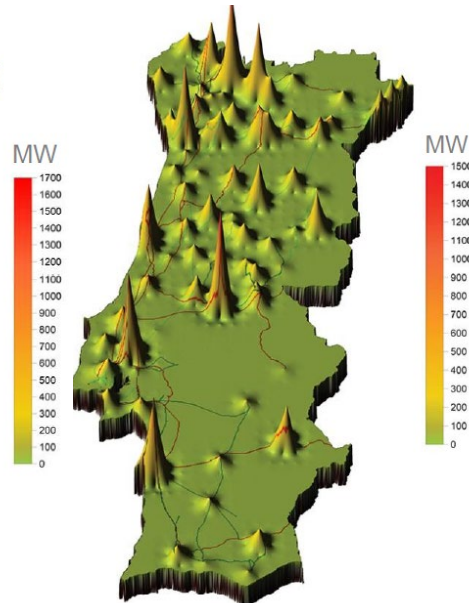
To operate and manage a high share of non-dispatchable power plants, Portugal has relied mainly on the:

- **large share of hydro power plants**
 - some reversible with pumped hydro storage system
- **limitation of local reactive power flow for wind power plants**
 - obliging to local compensation in all type I to III plants
- **installation of phase shift transformers in selected transmission lines**
- **implementation of “wind dispatch centers” already in 2007.**

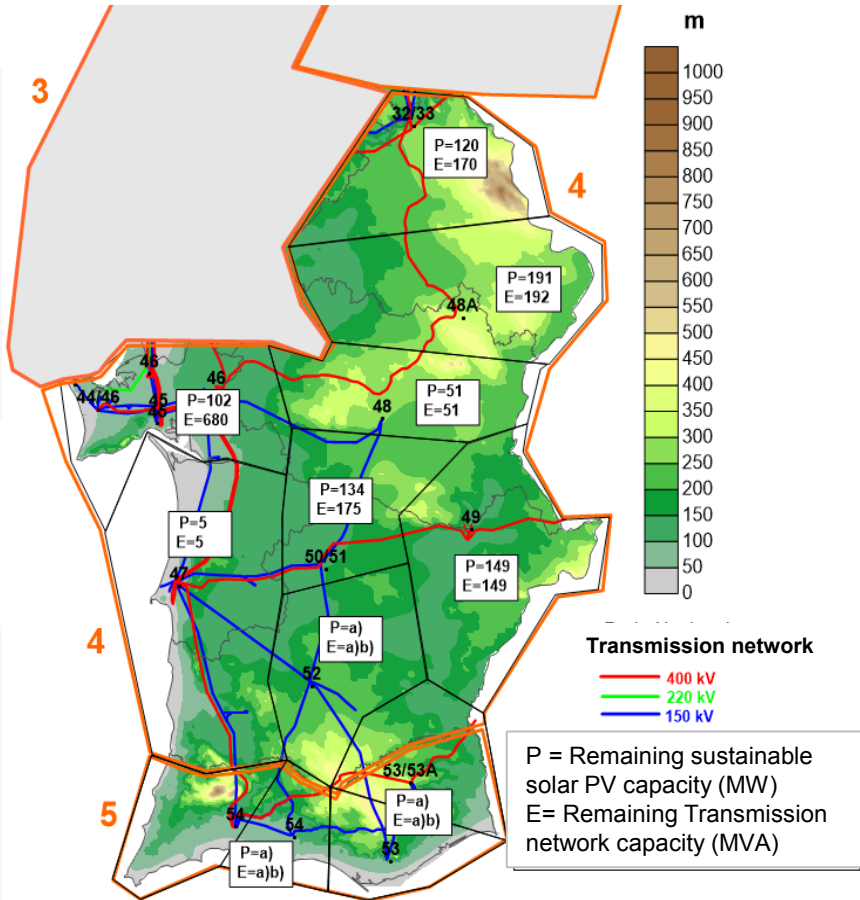
• Load



• Generation



Long term planning: transmission and generation

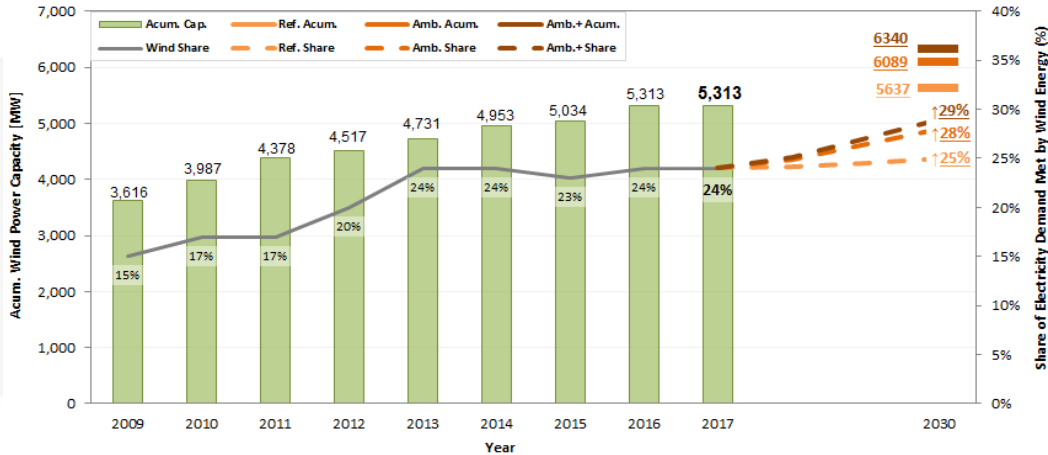


Identification of the sustainable solar PV capacity at the south of Portugal considering the transmission network capacity – LNEG (2016).

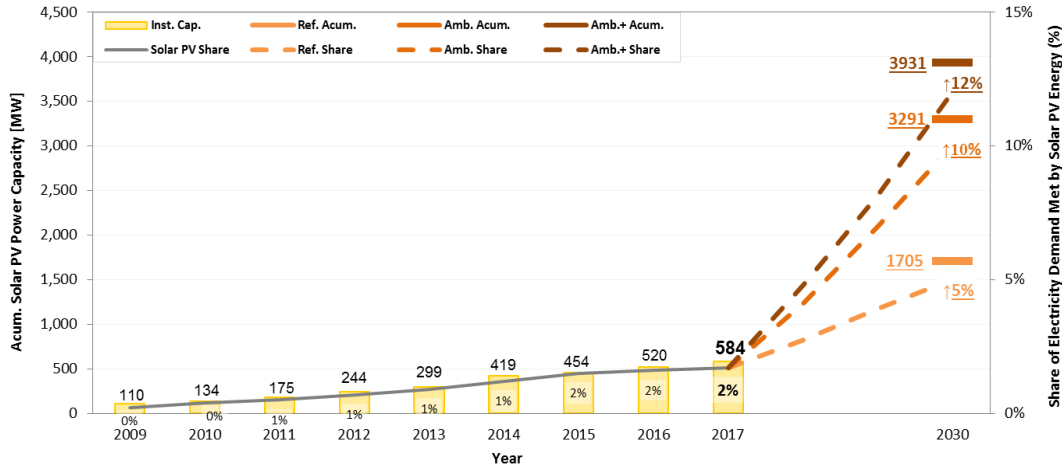
- **The governmental agency** (Directorate General of Energy and Geology - DGEG) is responsible for the generation long term planning through the *Monitoring Report on Electric Power Adequacy*.
 - Supported by other institutions, e.g., the Portuguese TSO, LNEG, ...
- **The TSO** (also holding by concession the operation of the transmission network) is responsible for the transmission network development and extension:
 - obligation to present a development plan every 4 years → reviewed by the energy regulator (ERSE) and eventually, approved and enforced by the government.

Long term planning: transmission and generation

• Wind Energy



• Solar PV Energy



- National targets (still under revision) for 2030 in Portugal considering three different scenarios highlight that:

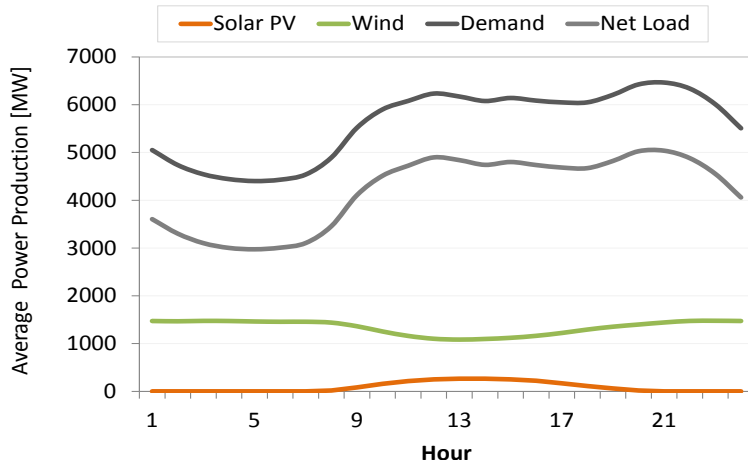
- **Solar PV will play a significant role** in the Portuguese power system;
- **Small growth in the wind power sector** is expected.

- Currently, more than 1 GW solar capacity started the licensing procedures:

- **New paradigm: no subsidies → Wholesale Electricity Market**

Note: Share of electricity from wind and solar PV energy for 2030 were estimated by LNEG taking into consideration the capacity installed in 2016.

Long term planning: transmission and generation

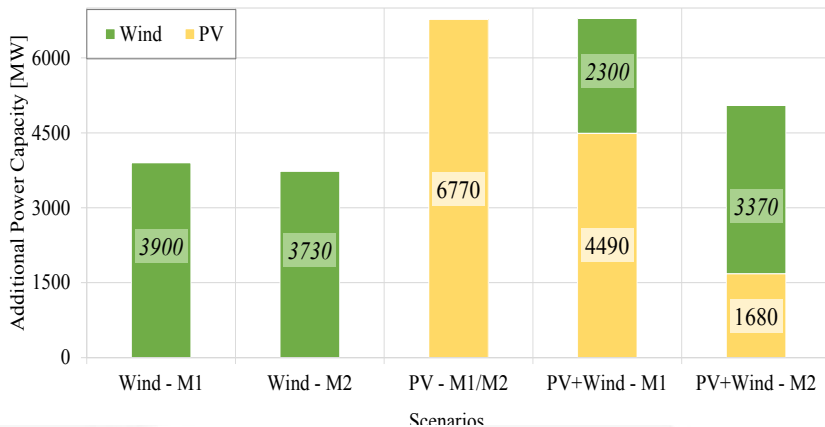


Observed national aggregated daily average power production, demand and net load according to the hour of the day.

- Taking the **VRE complementarity and demand criteria in new RES deployment is a crucial step** towards the planning of a secure and cost-effective “**nearly 100% RES power system**”.

- The wind and solar **capacity deployment options** in Portugal taking into account the **resource complementarity is being addressed:**

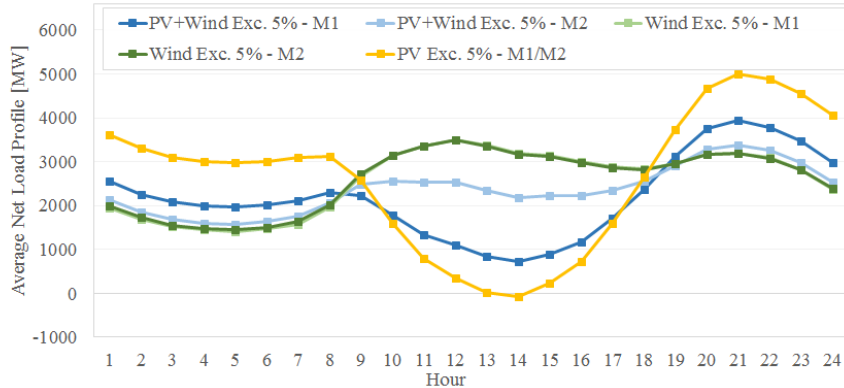
- Greedy optimization algorithm with the power production time series of wind and solar, allowing an annual excess (surplus) of electricity of 5 % on top of the electricity demand



New wind and/or solar PV power capacity in each scenario. M1 and M2 represents the minimization criterion, net load annual variability based on the annual standard deviation, and one-hour net load step change standard deviation, respectively.

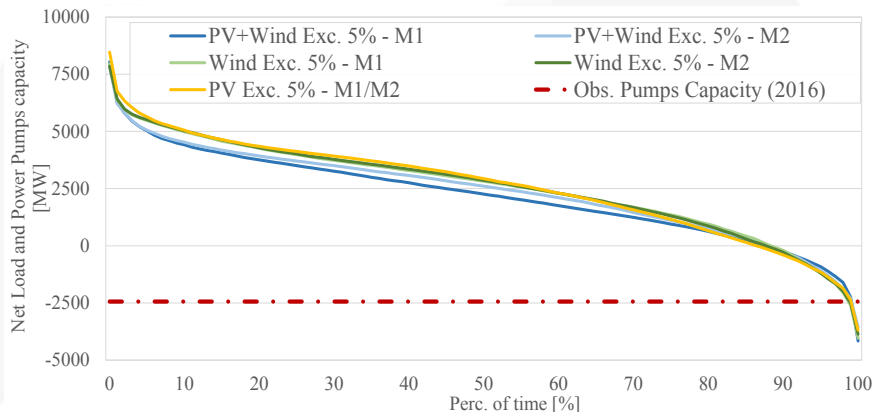
Wind and solar PV synergy exploitation to meet the demand:

✓ Average net load profile

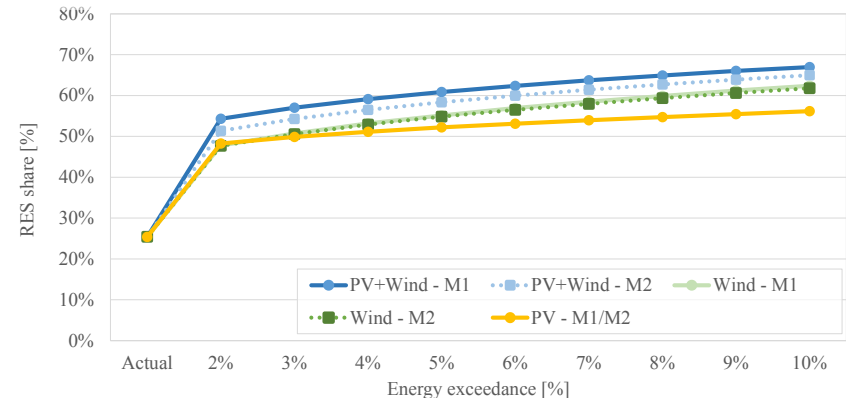


- **Strong reinforcement of PV power capacity can induce, in average, a net load near zero at 14:00h**
→ the so-called “duck curve” is observed.
- **“Strategic PV+Wind deployment scenarios”** are the most appropriate to reduce and smooth the net load and to **achieve the highest combined wind and solar share for the same annual energy exceedance value.**

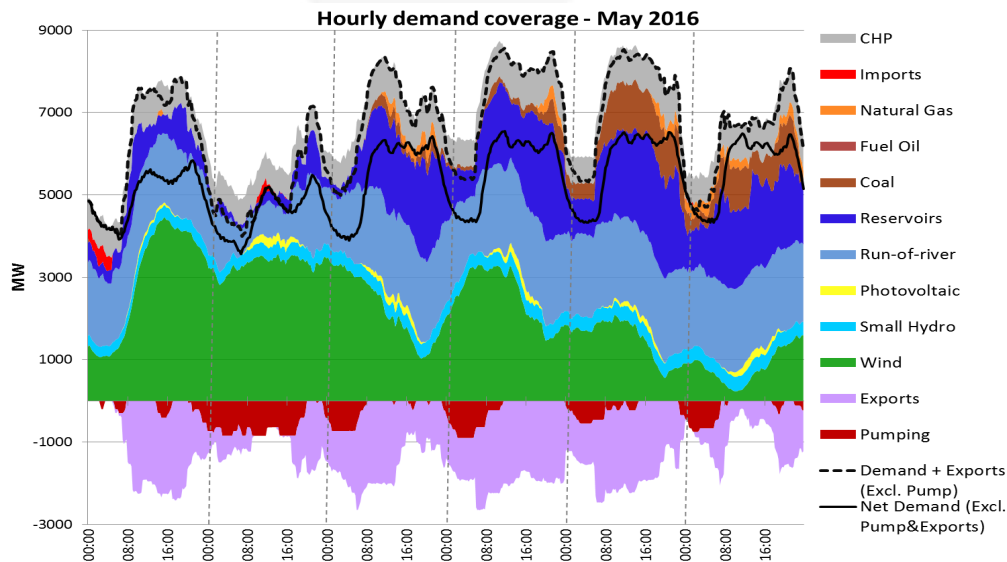
✓ Net load duration curve



✓ VRE share for each scenarios



- So far there are **no negative events in the power system worth to be reported**, even with the high VRE generation (wind and run of the river-ROR)
 - Instantaneous Share of Electricity Demand Met by wind Energy already achieve 109%;
 - 107 consecutive hours supplied by renewable energy.
- The **system operator mainly relies on the:**
 - large **pumping capacity** of the Portuguese hydro plants;
 - large **interconnection with Spain** for exporting exceeding energy during extreme generation events during no-load hours;
 - **controlling both hydro generation and pumping** for periods with large forecast errors of VRE generation.



- **Non-curtailment of VRE generation** (especially wind power) → although may have a relevant cost for the Portuguese power system.



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Thank you for your attention.

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