Clim2Power

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How climate trends affect the portfolio of the future Portuguese power sector

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Context

> Renewable electricity will be fundamental for limiting climate warming below 1.5°

RNC2050 Carbon Neutrality Roadmap

Carbon Neutrality Goal for Portugal up 2050

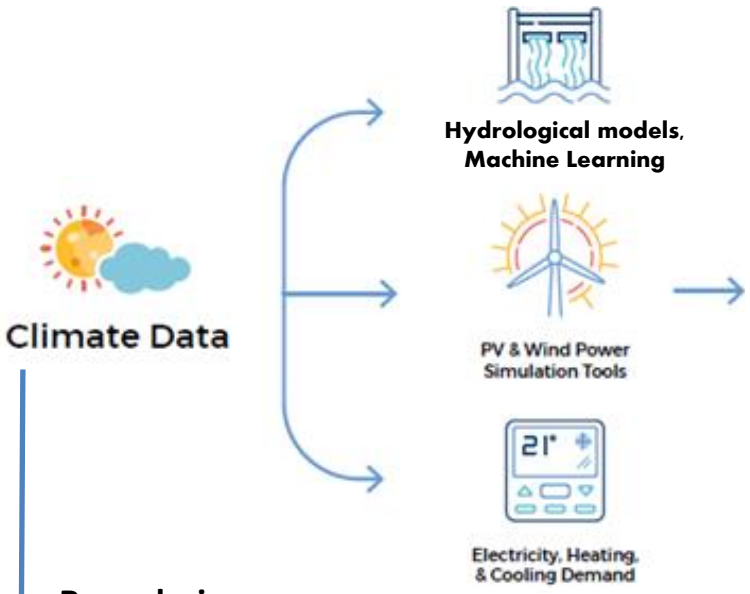
% RES electricity
- Today | >52%
- 2030 | 94%
- 2050 | ≈ 100%

> Simultaneously, **Climate Change impacts** are expected throughout the entire power system value chain, affecting the **variability and availability of renewable resources** and electricity consumption patterns

> Most models used for energy & climate policy support ignore or marginally consider future climate impacts

Objective: Assess the effects of future climate change in the cost-optimal configuration of the Portuguese power sector, integrating jointly impacts in PV, wind and hydropower capacity factors (CF) and on the electricity demand response to temperature.

Methodology | Clim2Power Pipeline – from climate to eTIMES-PT

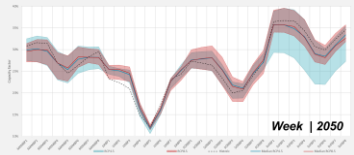


Reanalysis
COSMO REA6, 1995-2015, 1hr (daily), 6km

Future Climate Projections
EUROCORDEX:
- **11 regional climate models**
- **RCP4.5 & RCP8.5**,

1976-2065, daily, 12.5km

Load & Variable Res



Solar PV

Wind Onshore

Wind Offshore

Hydro Douro Dams

Other Hydro (Dams | Run-of-river)

Load

Linear Optimisation model eTIMES-PT

Emissions caps for power sector – RNC2050

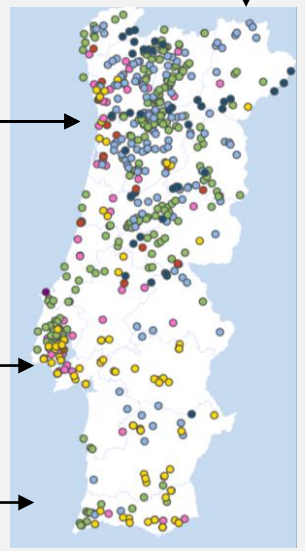
Municipal RES Potentials

Technical Cost Development

Installed Capacity

Timing of Plants Decommissioning

Fossil fuel import prices



Optimal Long term planning

2030 | 2050

Installed Capacity per technology

Power production per technology

Electricity cost

eTIMES_PT model

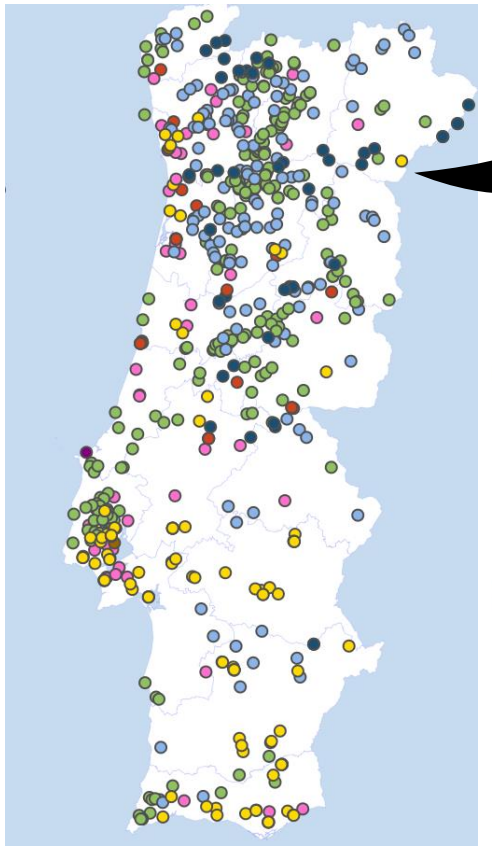
- **Model the mainland power sector in Portugal**
- **Solution:** Minimization of total system costs over the modelling horizon
- Decisions based on costs (techn. & resources) and policy constraints – **Outcomes translate the best cost-effective solutions**

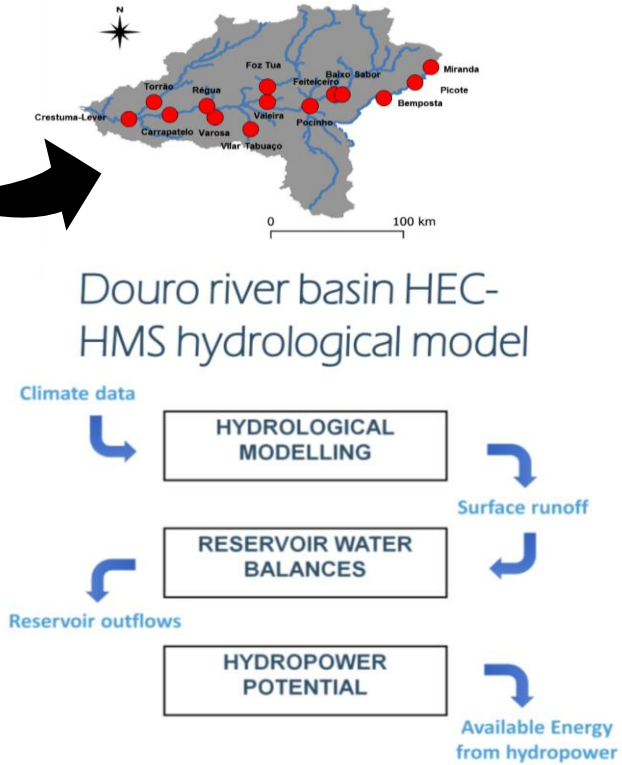
Time resolution

- **64 time slices per year**: 4 seasons | week day/weekend |8 day periods of 3h > Seasonal, intra-day and weekly dynamics
- Runs every 5 years between 2016 and 2050

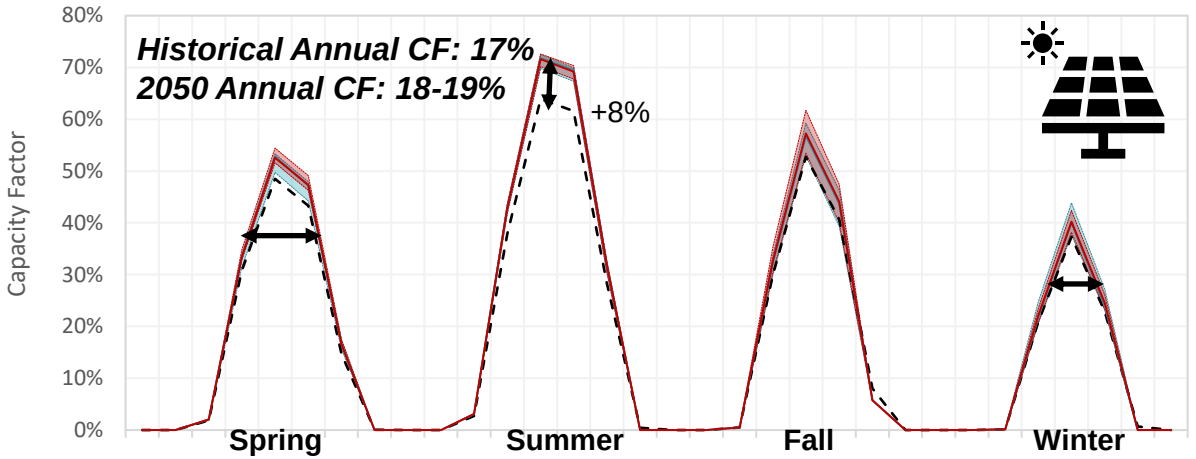
Spatial resolution

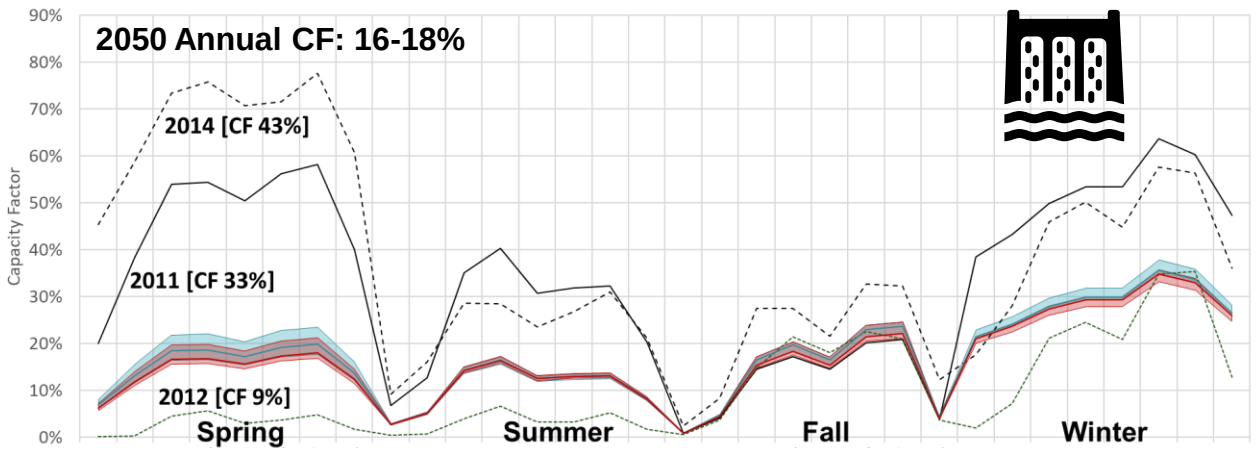
- Douro Dams individually represented
- Onshore Wind and PV (roof and utility) at municipality level
- RES potentials at NUTs4 level (municipality)

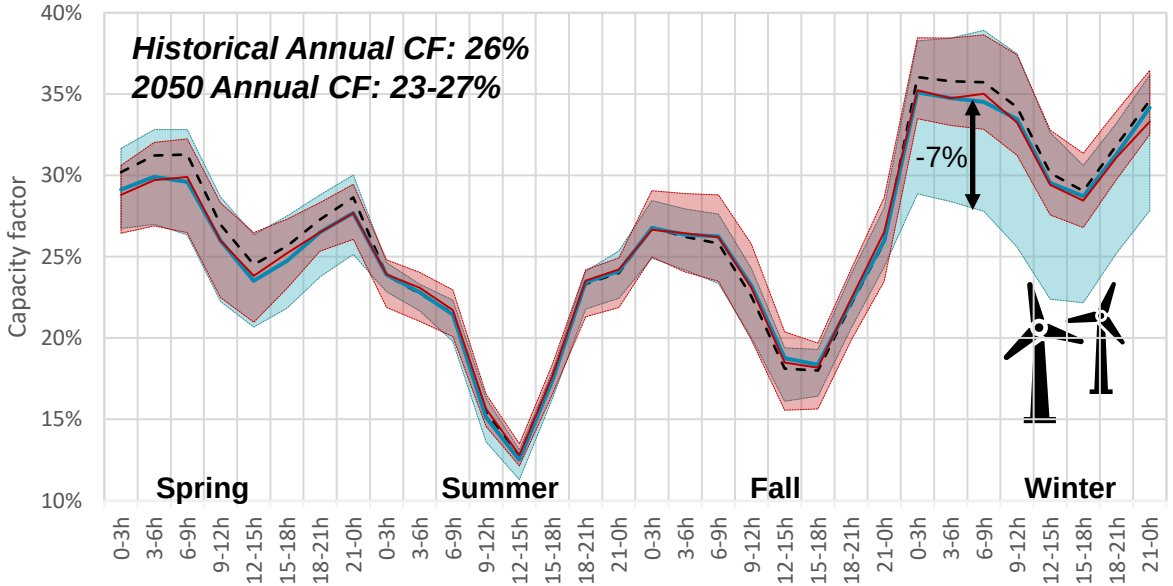


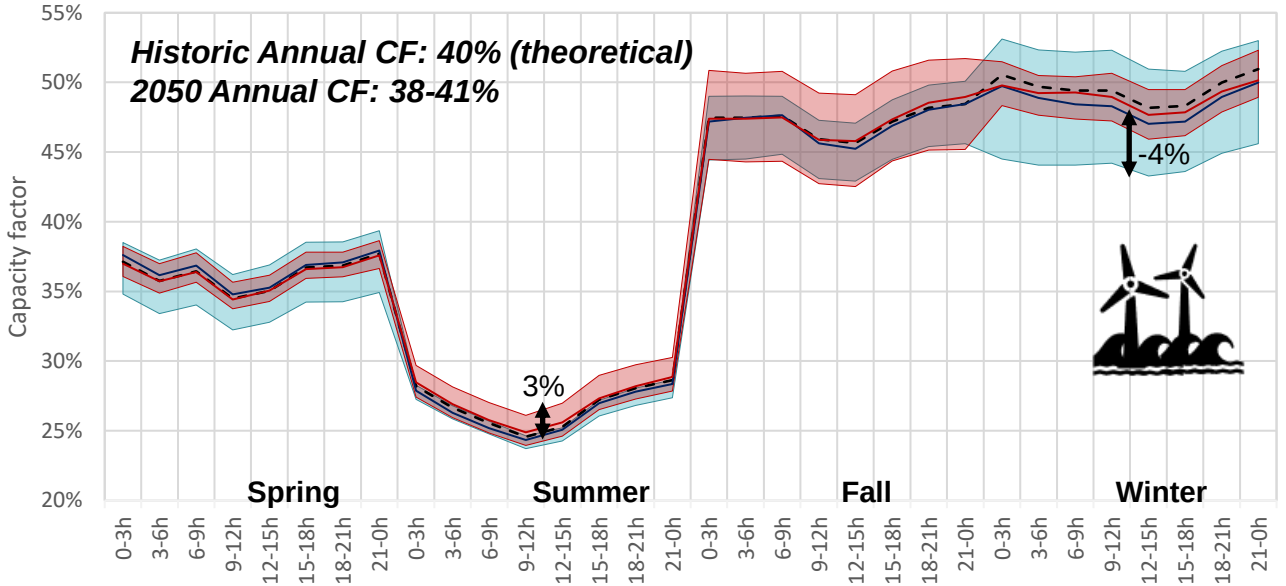


How capacity factors can look like across 22 future climate trends projections? | Climate Scenarios



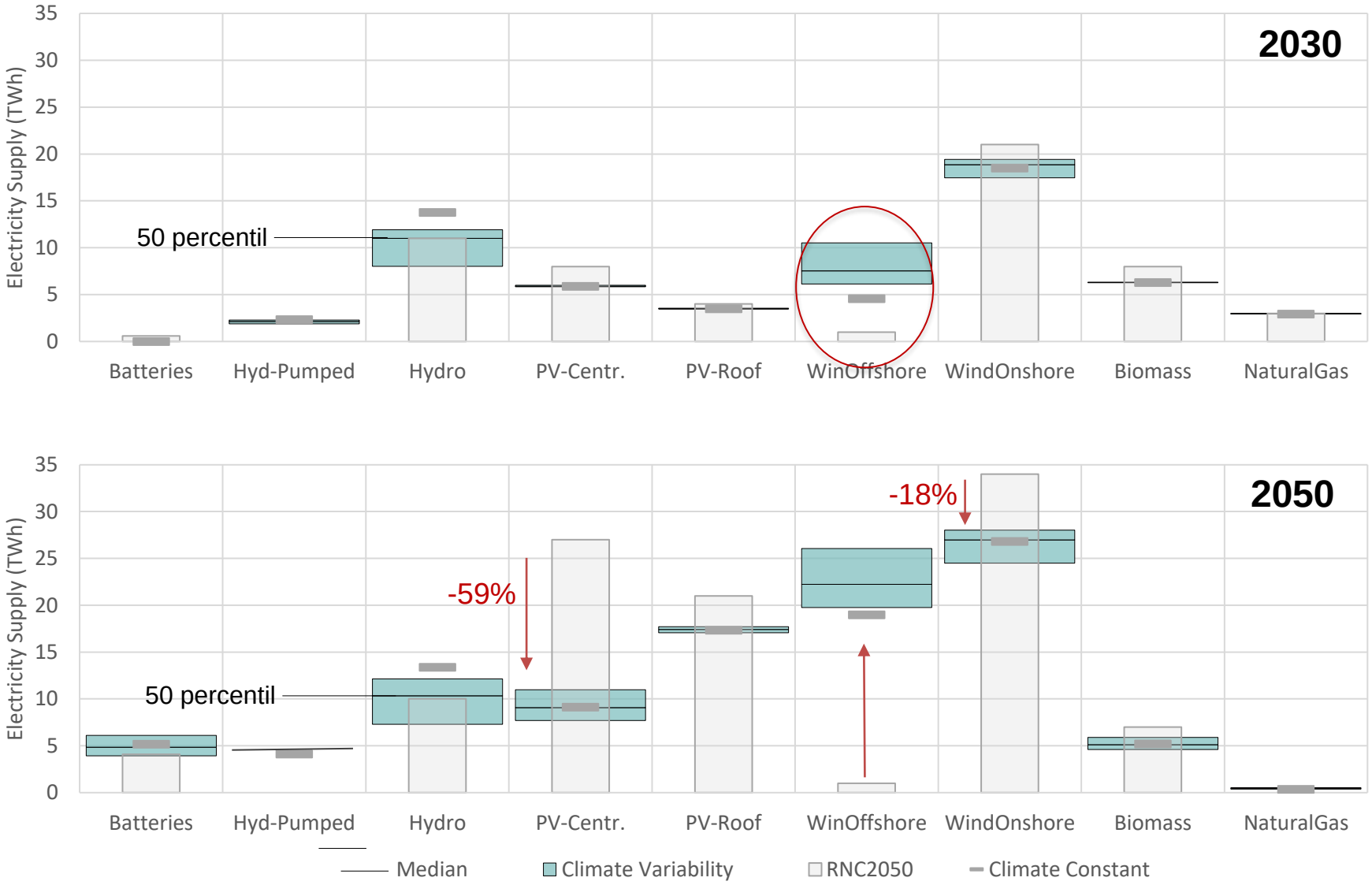






RCP4.5 RCP8.5 ---- Historic climate trends *no climate change)

Results | Power Supply



> By using a model with higher time resolution the role of solar PV and onshore wind is reduced and compensated by wind offshore

> Future climate trends (2050) (comparing with climate constant):

i. lower cost-effectiveness of hydro (-9% to -45% prod. Face to Climate Constant)

ii. increase cost-effectiveness of wind offshore (4-37%)

iii. can go either way with solar PV central (-16% to +20%) and onshore wind (-9% to +4%)

Results| Installed Capacity

- Climate variability will affect mostly:
  - Solar PV Utility scale and consequently batteries
  - Offshore Wind
- The installed capacity of each of these 3 technologies can range between ±2GW

Concluding Thoughts

- Future climate variability may have a relevant role in the cost-effective configuration of the Portuguese power system.
- As a projected hotspot region for climate change impacts, Portugal may experience a rise on temperature and a decline in precipitation, which are reflected in a lower hydropower production.
- Considering high spatial and temporal resolution may also affect modelling results, such as the reduction of role of solar PV and onshore wind vis-à-vis the modelling results of the RNC2050 → affect policy and investment decisions.
- The big winner on long term climate – Wind Offshore (absence of historic values may lead to optimistic results for this technology).

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Partners:

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