Clim2Power

Integrating climate data on a highly resolved TIMES model

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Context: CLIM2POWER in a nutshell

A climate service that integrates seasonal climate forecasts into decision making in the electricity sector

Outcomes for
- next season
- ‘season’ in 2050

- hydro, wind and PV resource availability
- power + heating & cooling demand changes
- shifts of the power system to adapt to natural resource availability

September 2017 to August 2020
National research funding agencies: FCT, BMBF, BMWFW, ANR, EPA, FORMAS
Consortium & Coverage

Climate service covers whole interconnected European electric system & tested/validated over 4 case-studies

France: wind and solar power resources and the whole power system

Portugal: Douro river basin, wind and solar power resources and whole power system

Sweden: Lule älv river basin, wind and solar power resources and whole power system

Germany-Austria: the Danube river basin, wind and solar power resources and the German-Austrian market zone
Making energy and power models respond to climate variability

- statistical meaning-full approach to enhance the predictive skill of the current models over Europe, instead of “just” numerical downscaling
- seasonal forecast + long-term projections
- optimal power plant portfolio strategy
Clim2Power Pipeline

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

Seasonal Forecasts
MPI-ESM-HR/GCFS2.0
10/50 members, 6 months ahead, daily, 6km, monthly

Climate Projections
EUROCORDEX, 6/12 members RCP4.5 & 8.5, 1978-2100, daily, 12km

Input Indicators
- Hydro capacity factors (national)
- Wind & Solar capacity factors (NUT2)
- % variation in demand for space heating and cooling in buildings (national)

Output Indicators (national, hourly)
- % of electricity generated from RES
- g CO2/kWh
- % variation in electricity costs for final consumers
- % usage of existing electric grid interconnection capacity
- electricity stored in batteries and hydro pumped storage (GWh)
- (...)

Seasonal
2030, 2050

Long-term

Web Service Application
Interactive, User-friendly Layout

Hydrological models, Machine Learning

Energy System & Power System Models

Co-Development with User Board

Iteration with End-Users
Clim2Power regions

96 maritime regions (intersection of IHO seas and EEZ areas)

273 (+ 5) Portuguese municipalities

263 NUTS2 regions for Europa excluding Portugal

Total of 686+ regions

IHO: international hydrographic association, EEZ: exclusive economic zone, NUTS: Nomenclature des unités territoriales statistiques
Portuguese electricity system TIMES model eTIMES_PT

Time resolution

- Nº time slices per Year
  - 64 time slices per year
  - (4 seasons; 2 day-types; 8 day periods 3h)
  - Intra-daily and weekly dynamics

- Horizon of results
  - Seasonal
  - Long-term 2030 | 2050

Regions: 278 Municipalities

- Share of RES and VRES
  - 2016: 57% | 25%
  - 2017: 46% | 26%

- Nº technologies/plants
  - Hydro: 189
  - RoR/Dam/Stor
  - Wind On: 231 | NUTs4
  - PV Cent.: 1 | NUTs4
  - PV Dec.: 1 | NUTs4
  - Coal: 2
  - Nat. Gas: 4

Source: ENSTOE’s, ERSE, REN, DGEG; EDP data; e2P.pt

Douro river basin hydrological model

64 time slices per year

(4 seasons; 2 day-types; 8 day periods 3h)

Intra-daily and weekly dynamics
Comparison Results TIMES-PT vs eTIMES_PT

Capacity & Generation

2020 | 2030 | 2040 | 2050

BAU scenario - Carbon Neutral PT Roadmap 2050 (TIMES-PT)

<table>
<thead>
<tr>
<th>Year</th>
<th>TIMES-PT</th>
<th>eTIMES-PT</th>
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<tbody>
<tr>
<td>2020</td>
<td>RNC</td>
<td>C2P</td>
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<tr>
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<tr>
<td>2050</td>
<td>RNC</td>
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- ELC_COA
- ELC_GAS
- ELC_HYD
- ELC_WON
- ELC_BIO, ELC_BGS, ELC_WST
- ELC_SOL

Chart showing energy distribution over time with various energy sources (ELC_COA, ELC_GAS, ELC_HYD, ELC_WON, ELC_BIO, ELC_BGS, ELC_WST, ELC_SOL).
Summary

• "climate-proof" the national Carbon Neutrality Roadmap 2050 for the power sector
• higher disaggregation turns effect of climate variability (seasonal ad long-term) visible leading to differences in power sector portfolio: in 2050 PV is substituted by wind; more capacity of nat gas to balance VRES;

Next steps

• Assess the effect of generation of PV and wind and changes in power & heat demand variability (simulated from seasonal forecast of climate data for next Spring) in electricity mix
• Assess thermal power plants efficiency changes
• Expand the set of technologies to offer system flexibility options
• Include Spanish electricity sector to consider MIBEL region
Thank you

More on CLIM2POWER:

https://clim2power.com/
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