The impact of climate change on future electricity generation and demand patterns in Europe

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SECURES

SECURING AUSTRIA'S ELECTRICITY SUPPLY IN TIMES OF CLIMATE CHANGE

Climate change impacts on energy systems

- Future, **decarbonised** energy systems: highly electrified and weather dependent (high shares of renewables like wind and solar)
- Identification and modelling of general climate **trends** and **extreme weather events** **for energy system planning and operation**
- Interdisciplinary process to generate energy system model input **data** with the aim of an **open-access database**

California, Sept. 2022
(MediaNews Group)

Climate modelling ⇄ Energy system modelling

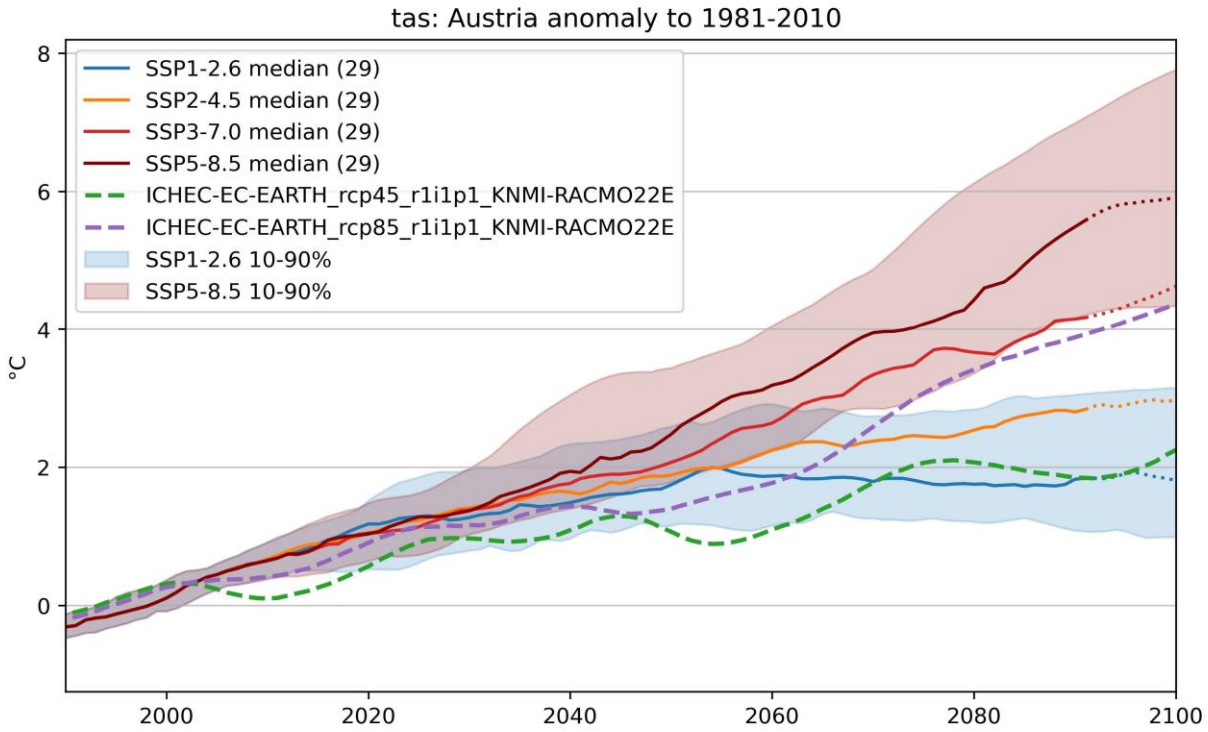
Long-term trends, high aggregation, means

!

High spatio-temporal resolution (1 h), extremes

Underlying climate modelling

- Two **climate scenarios**: Medium (RCP4.5) & strong (RCP8.5) climate change
- Two EURO-CORDEX climate scenarios (2011 - 2100): ICHEC-EC-EARTH - KNMI-RACCMO22E (RCP4.5, RCP8.5)
- Observations (1981 – 2010)
  - ERA5 and ERA5 Land
  - COSMO REA6 reanalysis
- Scope: Whole of Europe until 2100
- Aggregation levels: NUTS0, NUTS2, NUTS3 (Austria only), EEZ (wind offshore)



From climate data to energy system information

Generation	Hydro inflow	Wind speed (150 m)	Solar radiation	Temperature (2 m)*
Wind		✓		
Hydro	✓			
Photovoltaics			✓	✓ (losses)

Representative turbine types, power curves, suitable land

Mean daily generation from run-of-river and reservoir plants (eHYPE river discharge)

Consideration of temperature-related efficiency losses

Demand	Hydro inflow	Wind speed (150 m)	Solar radiation	Temperature (2 m)*	Behavioural patterns
E-heating				✓	✓
E-cooling				✓	✓
E-mobility charging				✓	✓

} Hotmaps open data repositories (2019): Temperature dependence of heating and cooling demand

Consideration of temperature-related efficiency losses

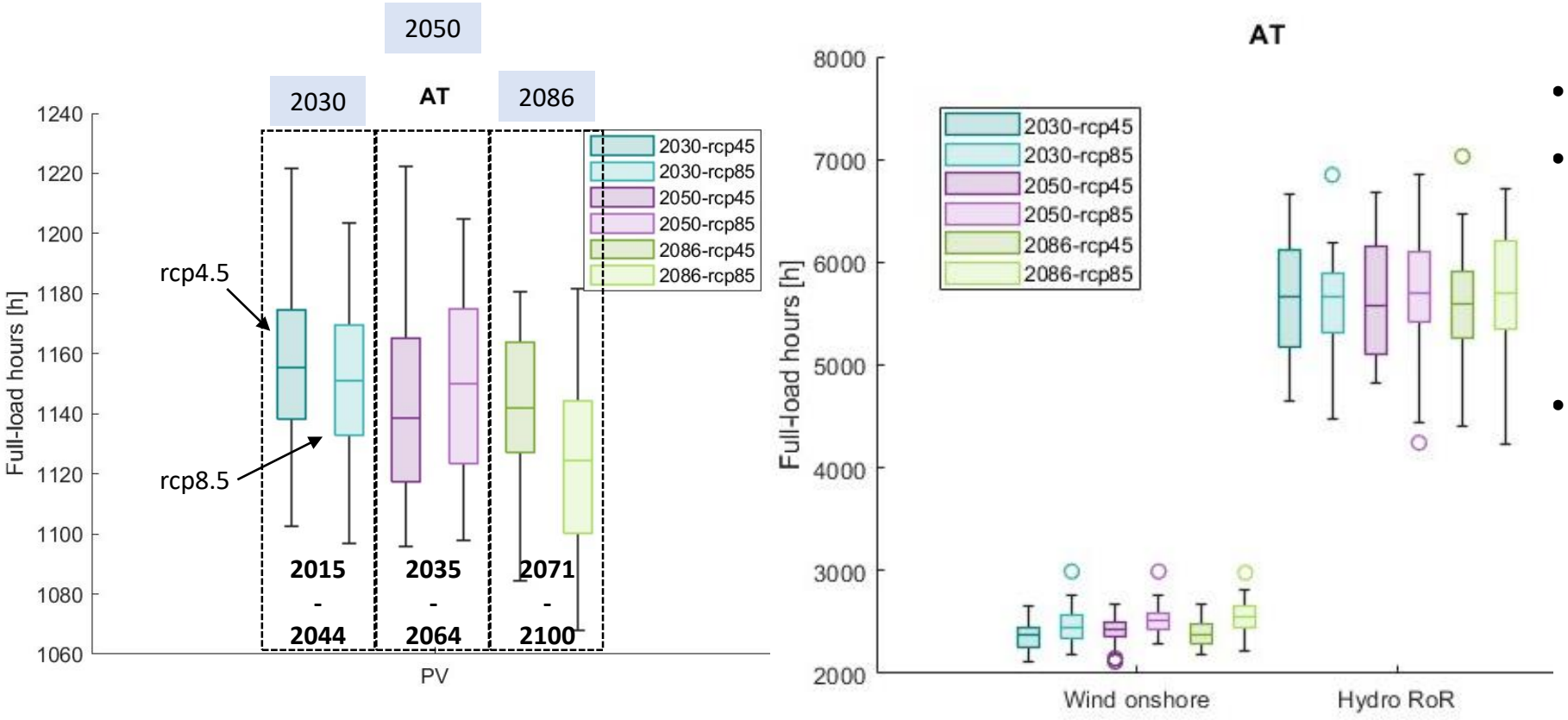
*Population weighted

HOTMAPS – Open Data Set for the EU28

Mostafa Fallahnejad. (2019). Hotmaps-data-repository-structure. Retrieved from Hotmaps-Wiki website: https://wiki.hotmaps.eu/en/Hotmaps-open-data-repositories

Pezzutto, S., Zambotti, S., Croce, S., Zambelli, P., Garegnani, G., Scaramuzzino, C., … Popovski, E. (2018). Open Data Set for the EU28. Retrieved from D2.3 WP2 Report. Load profile residential heating yearlong 2010. Reviewed by Lukas Kranzl, Sara Fritz. website: https://gitlab.com/hotmaps/load_profile/load_profile_residential_heating_yearlong_2010

Climate change impact on electricity generation in Austria

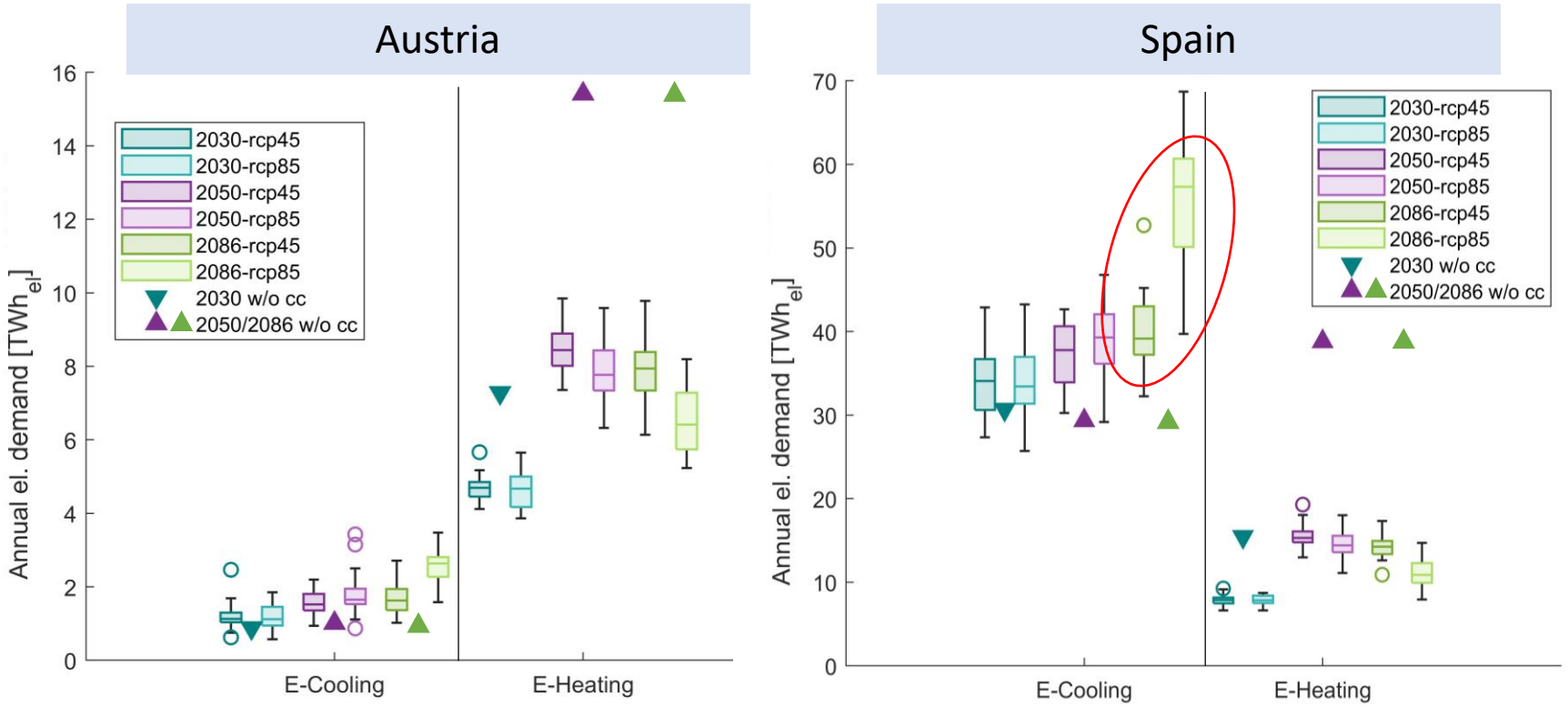


- PV: Low variability
- Slight increase of wind FLH with increasing climate change in the **considered climate scenarios**
- Large **interannual variability** in run-of-river (RoR): no clear trend over time; higher variability in rcp8.5 than rcp4.5 after 2050

BoxChart: Each box represents **30 weather years** (around the year 2030/2050/2086)

Climate change impact on electricity demand

E-Heating/E-Cooling

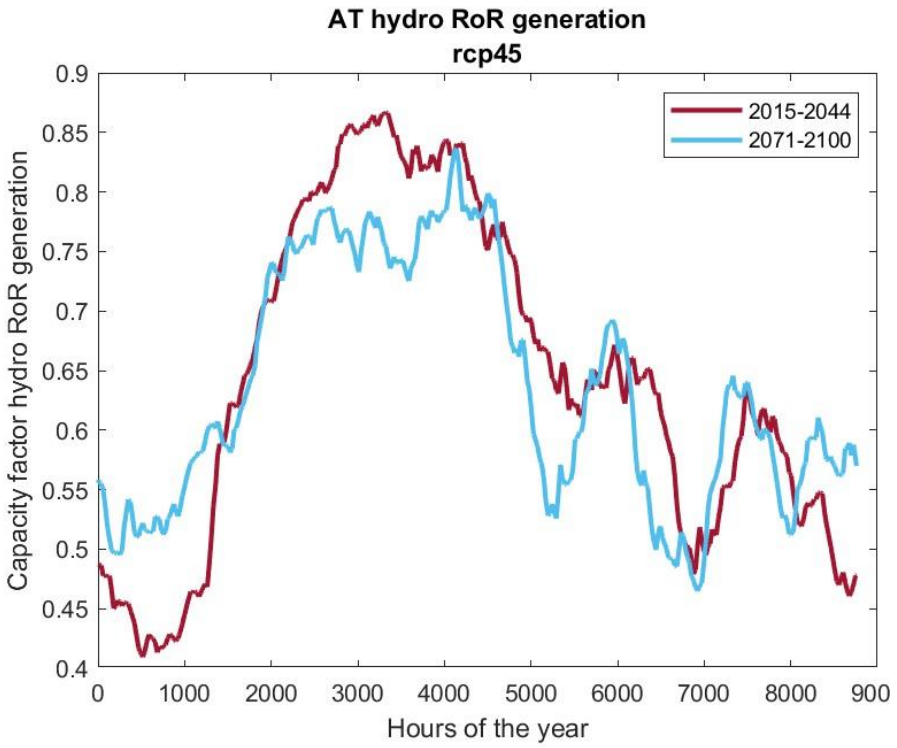


BoxChart: Each box represents 30 weather years (around the year 2030/2050/2086)
Underlying scenario: "Decarbonisation needs" – full decarbonization until 2050

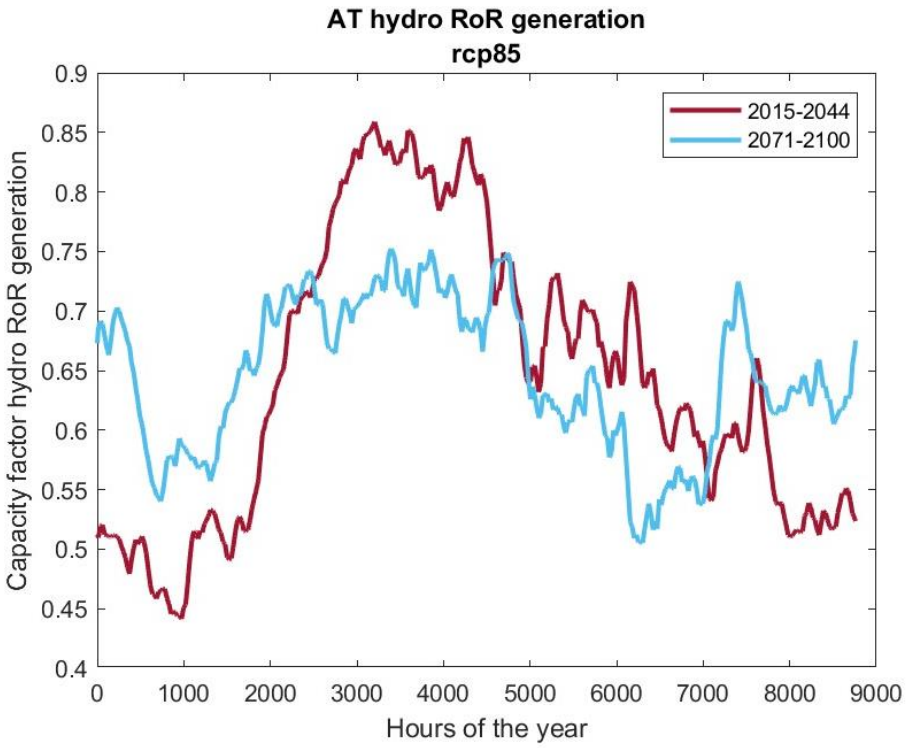
- Development of e-cooling + e-heating is dependent on the penetration level of heat pumps and air condition
- For comparison: ▲ Demand without additional climate change impact (weather year 2010)
- **Decreasing heating** demand + **increasing cooling** demand with climate change impact
- ES: Increase in e-heating demand due to electrification is **almost offset by climate change**
- **Differences** between rcp4.5 and rcp8.5 become particularly **evident at** the **end of the century**
- Seasonal demand shift is **compatible** with **photovoltaic** generation

Seasonal variation of hydropower in Austria

Medium climate change



Strong climate change



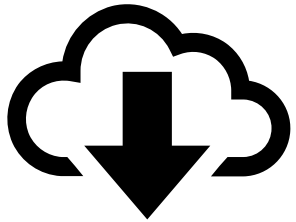
- **Temporal shift** of hydropower generation with increasing climate change **from the summer to the winter**

Conclusion

- For energy system modelling, high-quality climate data for the past and future is required and has to be transformed into relevant energy system information in high temporal and spatial resolution
- We created a comprehensive data set specifically designed for this purpose (incl. hydropower) for the whole of Europe

The **climate data** and **energy system data sets** (hourly resolution up to 2100) will be made **openly available** at the end of the project SECURES.

Check for upcoming publications here: https://www.secures.at/news



We are happy to receive your questions and comments!

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