UNIVERSITY OF OSLO

Department of Technology System
Section for Energy Systems
Gunnar Randers vei 19, 2007 Kjeller

Bias-correction and spatial downscaling of weather data for energy system modelling

Understanding the resource availability and variability of solar and wind energy generation is essential to design and planning optimal energy systems. This becomes more important when climate change has changed the weather conditions of different regions of the world, increasing the intrinsic uncertainties associated with these types of renewable sources.

Energy system modeling should consider these uncertainties to obtain an accurate and helpful solution for decision-makers. To achieve this, considering appropriate databases is fundamental: the higher resolution weather data is available, and the better they represent local weather conditions, the more accurate and precise the final design is.

In this sense, data resolution and bias correction are crucial issues that energy modellers must deal with every time they create a new model for a country, region, or small area. If the available data show lower spatial resolution than the area considered for the problem or present a significant bias, it will lead to overestimating the renewables installed capacities in a place since it is impossible to capture its resource availability and variability. Moreover, this problem becomes more important when investment and operational decisions are taken based on the resulting solution, which needs to be as accurate and precise as possible.

In the literature, there are weather and climate models for predicting the variability of weather conditions by considering how the atmosphere, ocean, and land surface interact. However, they are computationally demanding due to the complexity of the different systems and the finer resolution required to capture the weather condition of each area. Moreover, the output of these models presents systematic errors due to this limited spatial resolution and other simplifications of the global climate system. In this sense, applying external techniques such as machine learning and bias correction is fundamental for an accurate solution.

These summer projects aim to (i) downscale the output of future climate models and (ii) correct its systematic error (bias) to improve the renewable energy generation used in the energy system design for Chile and Norway. The main task for the first one is to apply machine-learning techniques to weather data to increase their spatial resolution, and the second is to use bias-correction techniques to overcome the significant biases in climate models.

Both projects will be supervised by Guillermo Valenzuela and Marianne Zeyringer, members of the AtLAST project and the Department of Technology Systems at the University of Oslo. The projects will be carried out at the Department of Technology Systems located in Kjeller.

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Number of available projects:

- 2

Preferred period of the project:

- Summer/Autumn 2023

The application must include:

- A short motivation letter
- CV
- Transcripts from University

Preferred background of candidate 1:

- Computational Science, Informatics, Physics, Energy Systems, Meteorology, or similar.
- Experience in machine learning techniques (required)
- Experience using Python (required)
- Experience in working with weather data forecasting (desired)

Outline of project work, including expected outcomes/deliverables (summer project 1)

- Study the applicability of different machine learning algorithms to predict meteorological or generation data (wind speed, solar irradiation, or capacity factors).
- Select and apply the most appropriate machine learning techniques to downscale spatial resolution weather data.
- Determine an adequate set of parameters for the selected algorithm based on performance measurements.
- At the end of the project, the expected outcomes will be a methodology based on machine learning techniques to increase the spatial resolution of weather data in Chile and Norway.

Preferred background of candidate 2:

- Computational Science, Informatics, Physics, Energy Systems, Meteorology, or similar.
- Experience in working with weather data (required)
- Experience using Python (required)
- Experience in working with bias-correction of weather data or renewable capacity factors (desired)

Outline of project work, including expected outcomes/deliverables (summer project 2)

- Study the applicability of bias-correction techniques to reduce systematic error in weather data.
- Select and apply the most appropriate technique.
- At the end of the project, the expected outcomes will be a methodology based on techniques to overcome the significant bias in weather data for Chile and Norway.