EMS Annual Meeting Abstracts
Vol. 20, EMS2023-380, 2023, updated on 20 May 2024
https://doi.org/10.5194/ems2023-380
EMS Annual Meeting 2023

Wind to start the dishwasher? High-Resolution Wind Atlas for Finland

Yu Tian[1], **Xu Yang**[1], Irene Schicker[2], and Alexander Jung[1]
[1]Dept. of Computer Science, Aalto University, Espoo, Finland
[2]Dept. of Postprocessing, GeoSphere Austria, Vienna, Austria

Abstract—The current climate crisis increased the demand for renewable energy sources. In northern Europe, the efficient utilization of wind power is crucial for achieving carbon neutrality. However, the spatio-temporal variability of wind energy poses a challenge to its efficient use. Wind energy may not always be available at locations and during times that match the end user's needs.

Since transmission and storage of wind energy incur losses, it is beneficial to consume wind energy near its production sites. This highlights the importance of site selection for wind power plants, requiring corresponding estimation of wind production. To assess the potential of wind energy for private households in Finland, a high spatiotemporal resolution wind power map for Finland, accessible at powermap.fedai.link, was conducted.

An exploratory data analysis using freely available weather data provided by the Finnish Meteorological Institute (FMI) was carried out. Here, we are interested in the short-term availability of wind power to operate household appliances equipped with modest battery capacity. To this end, we considered a simple power system dictated by discrete time instants t = 0,1,....The absolute time difference between any two consecutive time instants t and t+1 is Δt = 10min. The system includes a wind power plant that delivers the power $P_t^{(w)}$ at time instant t. We consider a wind power plant of type Nordex N100/25000 that is mounted at the height of 100m. The system also includes a load that is characterized by a power profile $P_{t'}^{(a)}$ for time instants t' □ [T_a]. An example of the load is a household appliance such as a dishwasher. The power profile of the load has finite support of T_a time instants.

We define the candidate starting time t_s as suitable if, starting from an empty battery, the process with a given load profile can be completed solely from wind energy. The battery is assumed ideal,

storing any excess wind energy without leakage up to its capacity and providing any wind energy deficit without losses until it is empty. The resulting relative fractions of suitable starting times during 2021 are then depicted on a map of Finland.

Our numerical experiments show that wind power has a higher availability (larger fraction) in regions along the coastline and the northern parts of Finland. Battery capacity is also a crucial factor; the useful fractions increase as the battery capacity increases until a certain value is reached. We found that the distribution of useful starting time points over 24 hours of the day is quite uniform. In contrast, the results show significant seasonal trends in some weather stations, with March and October having more useful starting time instants than the other months.