

Forecasting of Solar Power Plant's Capacity Utilization Factor in Ukraine using Satellite Data and Random Forest Regression

Drozd Sofiia^{1,2}, Kussul Nataliia^{1,2},

¹ Department of Mathematical Modeling and Data Analysis, Institute of Physics and Technology, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", mmda.ipt.kpi@gmail.com

² Department of Space Information Technologies and Systems, Space Research Institute NASU-SSAU, inform@ikd.kiev.ua

Corresponding author

Introduction

Ukraine, supporting the Green Deal, needs scientifically grounded solutions for the successful restoration of solar energy development, which was interrupted by the war.

In this research, we propose a regression model based on satellite data on climate and topography to predict the annual Capacity Utilization Factor (CUF) for solar power plants.

We aim to verify the suitability of this approach for assessing the potential of solar energy production in different locations of Ukraine and restoring its green course.

Data and Method

In this study, we used data from the Global Power Plant Database (2013-2017) for 21 solar power plants placed in different locations of Ukraine and calculated the annual CUF for each.

Additionally, we collected satellite data on climatic variables (accumulated annual Global Horizontal Irradiance, accumulated annual hourly temperature > 25°C, total annual precipitation, average annual wind speed) from the ERA5-Land dataset and topographic indicators (elevation, slope) from the Shuttle Radar Topography Mission database.

We constructed a Random Forest regression model using satellite data and installed plant capacity as predictors to forecast the CUF. To assess model accuracy, we applied cross-validation using data from one year as testing and the other for training, and averaged the results.

Results

The calculated CUF for the investigated solar power plants varies between 15.2-19.2%. According to the regression analysis, the averaged R^2 is 0.64 with averaged RMSE of 0.45 and MAE of 0.36. The average relative error is about 2%.

Conclusion

Our study demonstrates the feasibility of using satellite data and machine learning to predict the CUF of solar power plants with high accuracy. This approach can help identify the best locations for the construction of cost-effective solar power plants and promote the development of green energy in Ukraine.

Keywords

Solar power, Capacity factor forecasting, Satellite data, Machine learning.