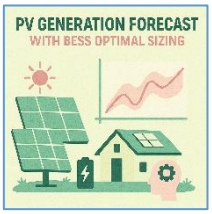

Опис за достапната инфраструктура и опрема

Во тековната еволуција на електроенергетскиот сектор батериски системи за складирање на електрична енергија (БССЕЕ) ќе имаат важна улога во максимизацијата на ефикасноста и профитабилноста на фотоволтаичните електрични централи (ФЕЦ) и просјумерите. Во овој контекст, оптималното димензионирање и оперативна експлоатација на БССЕЕ е суштинска за максимизација на ефикасноста и профитот на ФЕЦ+БССЕЕ системот. Оваа софтверска алатка обезбедува длабоко проникнување во димензионирањето и оперирањето на БССЕЕ, со користење на технологии на вештачка интелигенција. Корисникот ќе има неколку кратна корист од конформното прогнозирање на производството на ФЕЦ и напредните техники на оптимизација за ефикасни стратегии на полнење и празнење на БССЕЕ.

Infrastructure / Equipment Overview Table

	Details
Partner	УКЛО-ТФБ
Equipment type	Софтверска алатка за оптимално димензионирање и оперирање на батериски системи за складирање на електрична енергија за ФЕЦ и просјумери
Target Group	Индустрија, фотоволтаични електрични централи и просјумери
Key Technology	Вештачка интелигенција, конформно прогнозорање, машинско учење и оптимизација
Status	Достапно за користење
Requirements for Participation	Основно знаење од ФЕЦ технологии и батериски системи за складирање на електрична енергија

Technical Context and Examples

Today’s electricity markets are facing many challenges because of high penetration of PV generation and prosumers. Daily peak demand occurs after sunset, when PV power is no longer available. In areas where a substantial amount of PV capacity has been installed, the need for power that must be generated from sources other than PV rises rapidly around sunset and

reaches its peaks in the mid-evening hours, producing a graph that resembles the silhouette of a duck. The price of electricity is following the same duck shape as the demand (generation) curve. This fact has significant impact on the profit of utility scale PV generation and prosumers from one side and it is one of the major concerns of grid operators for technical security and technical efficiency of the system. The implementation of BESS with optimal size and operation is one of the methods for efficient mitigation of the detected problems and challenges.

Detailed Explanation of Core Concepts

The infrastructure software developed at FTSB-UKLO is a highly effective and efficient tool for solving the problem of BESS optimal sizing and operational exploitation for PV power plants and prosumers. The computer program is completely developed in Python. The forecast of solar radiation is based on the developed model using the Neural Hierarchical Interpolation for Time Series (NHITS). In order to obtain more precise results and to avoid insufficient training of the model due to not enough available data, Transfer Learning technique is used. This approach gives possibility to train the forecast model on large database with similar data and after that fine-tuning of the model is performed on the available historical data for the specific location. Conformal prediction technique is also used and it gives possibility to forecast the solar radiation in the range and increase the confidence of the obtained results. A 90% confidence is used, meaning that the forecasts have a 90% probability of falling within the predicted range. The clustering technique is used to narrow the range.

After this, obtained forecasts are used to estimate the radiation for one year using Monte Carlo simulation, according to the probability of occurrence of specific radiation. The methodology performs 1000 simulations of the value of radiation in the range of obtained forecast and one curve is randomly selected. This simulation is obtained for each day of one year and it is repeated 100 times in order to obtain enough data to simulate PV generation using the open Python library PVlib.

Calculation of BESS capacity is performed with advanced optimization techniques based on linear programming. The algorithm calculates efficient charging and discharging strategies and merit order of the PV+BESS system per day to achieve goal function (maximum profit according to market prices or other specified by the user). The optimization process takes into account all technical data and limitations of the battery and net present value economic analysis is use for PV and battery investment evaluation.

Conclusion and Unique Value

The developed infrastructure software tool has several unique advantages that can be summarized as follows:

- A novel and more precise forecast approach for PV generation
- Strategies for optimal BESS sizing and merit order calculation for charging and discharging during each day, according to market prices
- Maximizing the profit of PV power plants and prosumers.