Brief information about the project

Title	AP23487428 Improving the accuracy of short-term and long-term forecasting of PV power output based on artificial intelligence
Relevance	When designing photovoltaic systems, the most important thing is their profitability and the ability to predict generation under different weather conditions. Sharp fluctuations and voltage drops have a detrimental effect on the operation of power systems connected to photovoltaic stations. Predicting voltage fluctuations in Smart grids with solar panels is an urgent task.
Goal	The goal of the project is to improve the accuracy of short-term and long-term photovoltaic system generation forecasting using artificial intelligence with a wireless IoT network, cloud recognition and a new spectrum and power of solar radiation forecasting method.
Tasks	1) Data collection and training of a neural network model to recognize cloud type and degree of cloudiness; 2) Development of a wireless IoT system to collect data for training a neural network which predicts the degree of cloudiness, cloud type and clear-sky index in the desired area; 3) Data collection and training of a neural network model for spectrum forecasting using a new method of processing the spectrum data by wavelength and intensity; 4) Creation of artificial intelligence for short-term forecasting (nowcasting) of solar radiation in the desired area based on cloudiness and spectrum data; 5) Training a neural network for long-term forecasting of solar radiation in the desired area; 6) Calculation of photovoltaic system generation using a solar power plant simulator based on short-term forecasting.
Expected and Achieved Results	A wireless IoT system based on the Raspberry Pi 4B was developed for environmental monitoring and data collection to train a neural network. The system integrates temperature, humidity, and pressure sensors (BME280), a Hamamatsu C12880MA microspectrometer, an anemometer, a solar pyranometer (connected via ADS1115 16-bit ADC), and a wide-angle IMX307 camera. It automatically collects data every 20 seconds and transmits it to a server using rclone and a 4G modem. The data, including sky images and environmental parameters, are used to build a training dataset. An artificial intelligence model was developed and trained to forecast solar irradiance based on spectral and cloudiness data over short time intervals (minute, hour, day); model optimization is underway to improve the accuracy of long-term forecasts. As a result of the project, the following were published: 1. Kuttybay, N., Mekhilef, S., Koshkarbay, N., Saymbetov, A., Nurgaliyev, M., Dosymbetova, G., ... & Bolatbek, A. (2024). Assessment of solar tracking systems: A comprehensive review. Sustainable Energy Technologies and Assessments, 68, 103879. https://doi.org/10.1016/j.seta.2024.103879 Scopus percentile – 95, SJR 1.606, Web of Science – Q2, Impact Factor 7. 2. Koshkarbay, N., Mekhilef, S., Saymbetov, A., Kuttybay, N., Nurgaliyev, M., Dosymbetova, G., ... & Bolatbek, A. (2024). Adaptive control systems for dual axis tracker using clear sky index and output power forecasting based on ML in overcast weather conditions. Energy and AI, 18, 100432.

	https://doi.org/10.1016/j.egyai.2024.100432 Scopus percentile – 96, SJR 2.0, Web of Science – Q1, Impact Factor 9.6. 3. Патент на полезную модель. Система измерения метеорологических параметров для оптимизации фотоэлектрических установок. (Принят для экспертизы. Дата поступления 07.03.2025. Заявка № 2025/0368.2.) 4. Н.Б. Құттыбай, Б.С. Иманбаев, Э. П. Ершов, Н. Ж. Қошқарбай. Разработка автоматизированной метеостанции для мониторинга климатических параметров. Вестник КазАТК – 2025. (Решение: Принять материал в № 3-138-2025 г. Выпуск журнала 25.06.2025 г.) 5. Н.Б. Құттыбай, О. Б. Байболов. Статистический анализ контроллеров заряда для различных фотоэлектрических систем. Вестник КазУТБ – 2025. (Решение: Статья будет опубликрвано во втором номере июнь, 2025)
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Publications list with links to them	As a result of the project, the following were published: 1. Kuttybay, N., Mekhilef, S., Koshkarbay, N., Saymbetov, A., Nurgaliyev, M., Dosymbetova, G., ... & Bolatbek, A. (2024). Assessment of solar tracking systems: A comprehensive review. Sustainable Energy Technologies and Assessments, 68, 103879. https://doi.org/10.1016/j.seta.2024.103879 Scopus percentile – 95, SJR 1.606, Web of Science – Q2, Impact Factor 7. 2. Koshkarbay, N., Mekhilef, S., Saymbetov, A., Kuttybay, N., Nurgaliyev, M., Dosymbetova, G., ... & Bolatbek, A. (2024). Adaptive control systems for dual axis tracker using clear sky index and output power forecasting based on ML in overcast weather conditions. Energy and AI, 18, 100432. https://doi.org/10.1016/j.egyai.2024.100432 Scopus percentile – 96, SJR 2.0, Web of Science – Q1, Impact Factor 9.6.

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Patent information	Патент на полезную модель. Система измерения метеорологических параметров для оптимизации фотоэлектрических установок. (Принят для экспертизы. Дата поступления 07.03.2025. Заявка № 2025/0368.2.)