

# Artificial Intelligence Forecasting for Photovoltaic Performance based on Temperature and Humidity

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**Abstract**— Solar power generation is one source that is highly considered in the area of renewable energy. One of the parameters that determines the efficiency of solar panels is temperature and humidity. These two parameters play an important role in the process of operating photovoltaic conversions. This determines the merits of electricity efficiency and the power output of a photovoltaic (PV) module depends linearly on the operating temperature and humidity. In this paper we try to predict the value of humidity and temperature the next day by using an artificial intelligence algorithm. This implementation can contribute to the field of energy factories to have a maintenance schedule to make PV longer.

**Keywords**— *photovoltaic, temperature, humidity, solar panel, maintenance lifetime.*

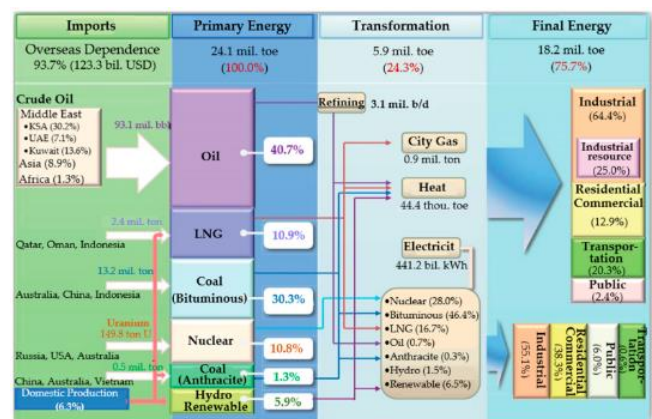
## I. INTRODUCTION

Solar power generation systems use solar energy directly and are currently developing very rapidly. The process of energy conversion in solar power plants is growing rapidly. This is because this type of power plant is considered as an environmentally friendly and clean source. Electricity production in Korea is highly considering renewable energy in its development. In this case, the meteorological phenomenon has a direct impact on the energy production of PV power plants by conditioning their electrical characteristics [1]. In its implementation, solar power plants have the potential to fail due to various environmental and installation conditions.

## II. PHOTOVOLTAIC EVALUATION

The installation configuration of a solar power plant is very important to consider based on its geographical location. Weather conditions will be quite influential on the resilience of solar power systems [2]. Generally environmental stresses create various conditions that can cause damage to solar panel components such as degradation and loss of life [3]. The South Korean government is currently working to increase the percentage of renewable energy contributions from 6.5% in 2017 (Figure 1) to 11% in 2030. In addition, 230 MW in 2012, 531 MW in 2013, 909 MW in 2014, and finally 1011 MW in 2015, respectively, were installed, reaching the highest level of installations so far.

South Korea lies in a temperate zone with four distinct seasons. It shows complex climate characteristics which reveal both continental and oceanic features. It has a wide temperature difference between summer and winter and more precipitation in comparison with that of the Continent. The failure of the production process in solar power plants is one of the main problems in industrial countries such as South Korea, which has now been ranked as the ninth largest energy consumer in the world since 2016.



**Figure 1** Summary of energy sources, strategies, and policies of South Korea in December 2017 [1]

### A. Impact of Temperature on PV Performance

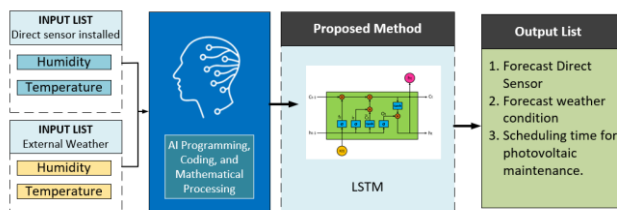
The condition of solar panels will vary under changes in temperature. Voltage and output power will change because it is influenced by temperature. In addition, increasing the temperature will reduce the amount of voltage [1]. One of the main factors affecting the amount of solar panel electricity is the temperature at which they operate. Operation of solar panels above 25 °C can reduce the performance of the solar panels themselves [2]. Generally solar panels are considered to be better if it gets a lot of heat, but in reality it is not. Solar panels have their own optimal conditions and generally have a limit of up to 25°C. The efficiency of solar panels will decrease due to temperature rises that are too high. The impact of temperature on the efficiency of solar panels is known as the temperature coefficient.

### B. Impact of Humidity on PV Performance

Water is in various degrees in the air. Relative humidity is the ratio between the pressure of water vapor in the air and the saturated water vapor pressure at the same temperature. The operation of solar panels is affected by water when it comes in contact with cellular components of the cell which causes its efficiency to be destroyed, resulting in a decrease in electrical productivity [4]. The amount of humidity describes the relative humidity of air (RH), where the RH value is variable and depends on the saturation pressure of water vapor which is directly affected by temperature. Moisture can penetrate into PV cells through cracks in hot and humid climates. This causes a significant reduction in the productivity of solar panels. This damage causes many effects, such as corrosion of the weld joint and others [2].

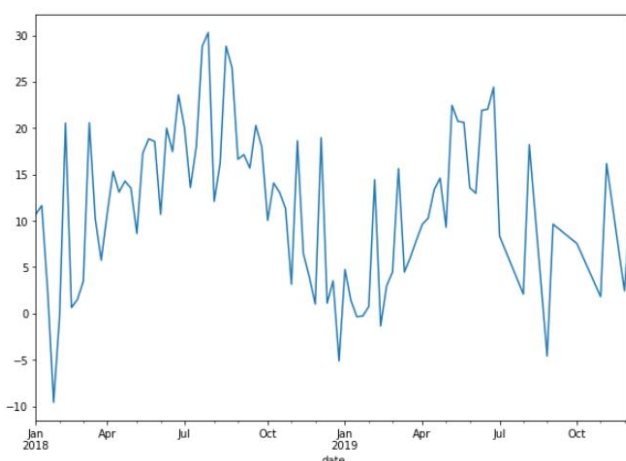
### III. IMPLEMENTATION

A comprehensive evaluation of solar panel forecasting method should include based experiments, as this will increase confidence in the results. In this paper we use datasets of temperature and humidity in solar panel which is located in Seoul, South Korea. The data source was from Korea Meteorological Administration (KMA) Weather Stations. The data that used is from January 2018 until June 2019.

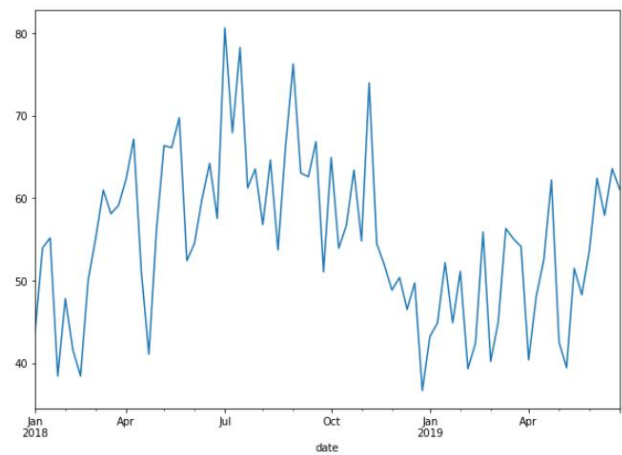


**Figure 2.** Temperature and humidity data area

In order to get precision analytics, the author uses *jupyter* application which the data retrieved from KMA. By using temperature and humidity data, we can predict the value of its data in the future using LSTM algorithm.



**Figure 3.** Temperature data from photovoltaic area



**Figure 4.** Humidity data from photovoltaic area

### IV. CONCLUSION

This paper presents the implementation of AI Algorithm to provide data reliability and interoperability based on the data pattern. By using machine learning, the algorithm will find the pattern of the data and will forecast in the next step using LSTM. This implementation can be used as the solution strategy for Energy Factories. So we can have a good maintenance schedule of solar panel for lifetime purpose. Sustainable improvement needed to this implementation in order to give the result of prediction, more precisely and accurately.

### ACKNOWLEDGMENT

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### REFERENCES

- [1] W. M. Sarhan, A. N. Alkhateeb, K. D. Omran, and F. H. Hussein, "Effect of temperature on the efficiency of the thermal cell," *Asian J. Chem.*, vol. 18, no. 2, pp. 982–990, 2006.
- [2] R. Tariq *et al.*, "Humidity impact on photovoltaic cells performance: A review," *Www.Ijrer.Com //*, vol. 03, no. 11, pp. 27–37, 2018, [Online]. Available: <https://www.researchgate.net/publication/329425029>.
- [3] M. D. Kempe and J. H. Wohlgemuth, "Evaluation of temperature and humidity on PV module component degradation," in *2013 IEEE 39th Photovoltaic Specialists Conference (PVSC)*, 2013, pp. 120–125, doi: 10.1109/PVSC.2013.6744112.
- [4] M. Fadhil, A. Prastianto, A. Rahardjo, F. H. Jufri, and F. Husnayain, "Solar irradiance estimation at certain location using artificial neural network and ASHRAE clear-sky model," *2nd IEEE Int. Conf. Innov. Res. Dev. ICIRD 2019*, 2019, doi: 10.1109/ICIRD47319.2019.9074735.