Fault detection of Floating Photovoltaics By Mechanical Stress Evaluation of Wind Speed and Wave Height

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Abstract

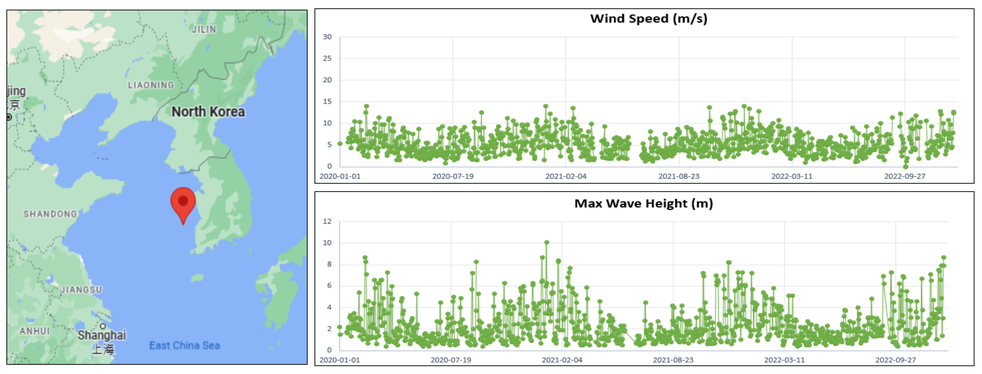
Due to the supply of eco-friendly energy sources to cope with climate change, power generation using renewable energy, including solar power, will continue to increase. Among the various renewable energy sources, PV(Photovoltaic) power generation has recently been the most active, and production costs have continued to decrease through continuous technology development, and chronic initial defects in photovoltaic modules have significantly reduced. For PV power generation, it is necessary to install structures and select areas accordingly, and problems caused by many civil complaints and environmental obstacles continue to occur during the process of selecting a power generation location. By conducting solar PV power generation on the water to compensate for this, power generation can be carried out more independently of important environmental problems occurring on the ground. Analyzed the reliability of the most important PV modules in water solar Floating PV systems with climate data, and predicted modules and deformation through material simulations accordingly, and predicted output values. Through an actual pressurization experiment, the actual change in output value when a defect occurs, and the type of defect accordingly were confirmed. As investment FPV solar power generation facilities and power generation according to capacity increase, defects and problems caused by natural disasters, and this study would like to present a directly FPV power generation prediction through prior prediction thru. FPV module dynamic Simulation base on each material properties and PV module's mechanical DOE experiment result. The mechanical reliability that may occur for FPV modules, and accordingly, the proposal will give ahead of benefit to select FPV to install structures and select areas not only a calm water conditions but also strong wind and height of a wave ocean condition.

Background and Motivation

● Floating Photovoltaics environment data

Climate and natural environment data analysis results of Buan area based on the Korea Meteorological Administration data (Period: 2020.01.01 ~ 2022.12.30)

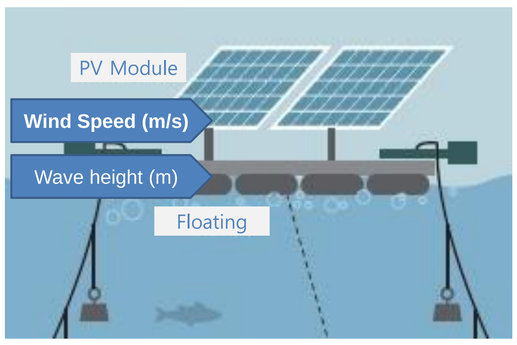
Average wind speed 5.34 m/s, Wave height 2.32m



● Calculated Force from environment data

The natural environment, air pressure, wave height, humidity and temperature are the main factors for effecting FPV. Those environment factor converted to force by Newton's law and Pascal's law.

Environmental Factors
Wind Speed (m/s)
Wave height (m)

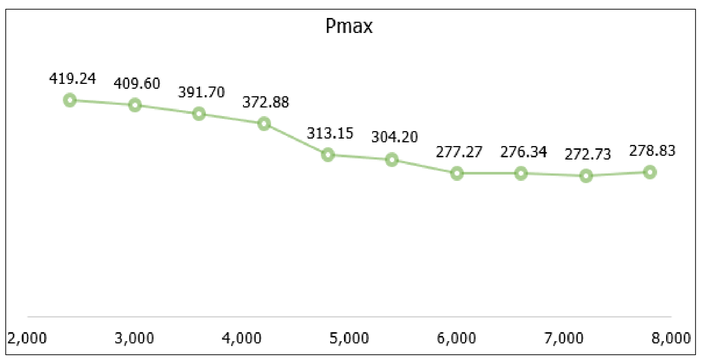


Experiments and Result

● Flow Chart

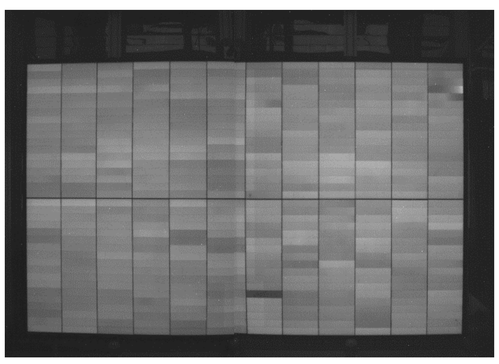
● Experiment result

The output of the module drops up to 93% at 3600Pa compared to the initial voltage, and a 14% drop in output compared to the previous one was confirmed at 4800Pa. At 7,800Pa, the output was reduced by 67%. Short-circuit current (ISC) and open-circuit voltage (VOC) were not significantly affected by the applied pressure, but the fill factor and output of the solar module showed a significant decrease at 7,800Pa by 33%. This is confirmed as a decrease due to an increase in series resistance (RS) because of cracks and damages generated in the solar cell inside by the load applied to the solar module.



Degradation of Power Output(Watt) of PV Module with Different Mechanical Stress(Pa) Conditions

Mechanical Stress Test Environment



IR Image after Mechanical stress(4800 Pa)

Conclusion

Based on the natural environment analysis of Buan, Korea, the natural factors can create deformation of FPV module. The strength of the force that simulated the natural environment data was defined and the force experiment was conducted. According to this experiment, the strength and reliability in the extreme natural environment were predicted for FPV power plant. Depending on the influence of wind and wave height in the natural environment, the FPV equipment affected the reliability of the cell in the module. At the same time, it made a significant impact on the output decrement of the power generation. The installation of FPV equipment and its reliability must be considered in advance when FPV power plant build in extreme Ocean conditions area.

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