Is Rooftop Solar Panel Effective in the Southern Regions of Kazakhstan? Data from Field Studies and Modelling.

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INTRODUCTION

Solar rooftop installations stand out as highly effective means to harness solar energy potential in urban and rural areas. Many private homeowners use rooftop PV installations to generate their own electricity to cut down on expenses associated with grid electricity. In addition, these installations often generate surplus energy that can be fed back into the grid, improving overall energy efficiency and promoting sustainable energy use.

Currently, the extensive establishment of small-scale SPPs in Kazakhstan is still in its infancy due to existing barriers in legal and regulatory acts [1], as well as due to the tendency to develop large-scale industrial plants. However, data from the National Statistical Bureau indicate that Kazakhstan possesses significant potential for deploying small-scale rooftop solar systems. The data reveals that the country harbors approximately 5 million private houses, with 70% situated in urban areas and 30% in rural regions. Notably, around 40% of the population resides in urban private houses, while 77% inhabit rural areas. It is noteworthy that the majority of the private sector population live in the southern regions of Kazakhstan: Almaty region (67.6%), Zhambyl region (66.1%), Kyzylorda region (62.8%), South Kazakhstan region (48.1%) [2].

METHODOLOGY

Research on how temperature affects the efficiency of solar panels relies on field measurements. These measurements were conducted over the course of a year at a SPP situated in the Zhualy district of the Zhambyl region. Using Campbell Scientific weather station, data was collected on solar radiation, air temperature, solar panel temperature and wind speed. Daily meteorological conditions were recorded as well. The study utilized a 280W monocrystalline solar panel as the test subject.

Based on the data obtained from weather station, a small-scale solar energy system with a capacity of 5 kW was simulated for a private house situated in the village of B. Momyshuly, Zhualy district. The simulation was conducted utilizing PVsyst software. The study included a comparative evaluation of energy generation and losses for two different types of solar panels under the conditions of the surveyed area.

RESEARCH AREA

The Zhualy district is situated in mountainous and foothill terrain, characterized by an arid and distinctly continental climate. With approximately 2700 hours of sunshine annually, July stands out as the warmest month, with average temperatures ranging from 21 to 25°C, occasionally peaking at 45-48°C. Conversely, winters are severe, with January being the coldest month, featuring average temperatures of -8 to -12°C, and occasionally dropping as low as -45 to -50°C. The average annual wind speed ranges from 2 to 5.9 m/s [3].

DATA OBTAINED

According to meteorological station data, monthly averages of solar radiation for 2021 were obtained.

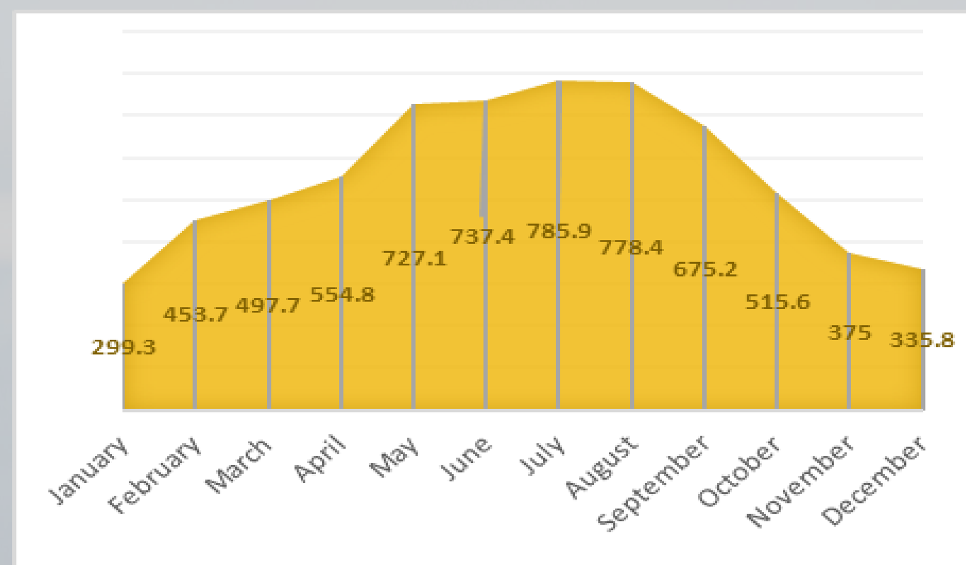

Fig.1. Solar radiation (W/m2) of Zhualy district for 2021 [4]

In July, at an ambient temperature of 32°C, the panel temperature increased to 46°C (Fig.2). In January, despite the sub-zero ambient temperatures, the panels were able to warm up, occasionally reaching 18-19°C (Fig.3).

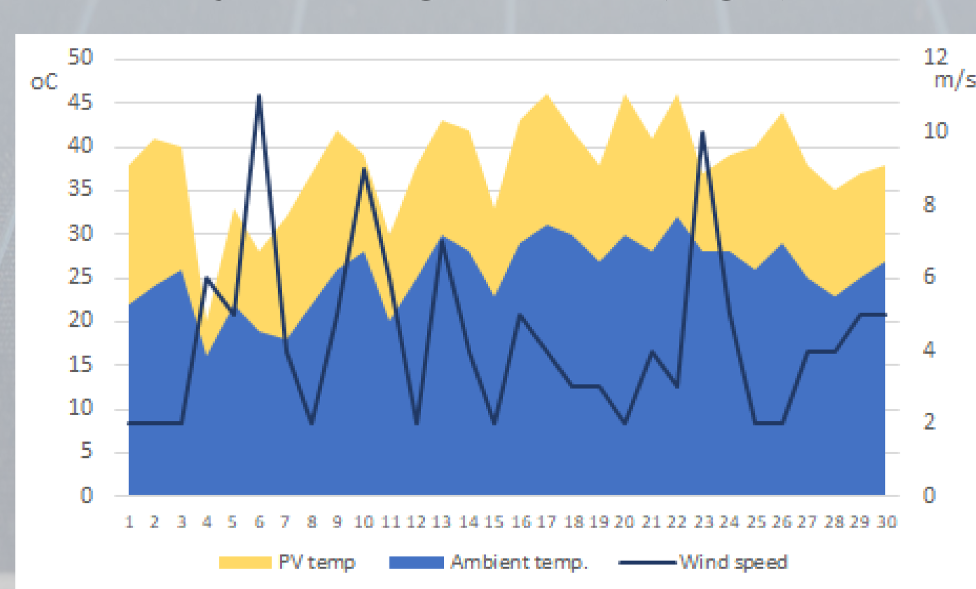

Fig.2. Temperature variation of the panel concerning ambient temperature and wind speed throughout July 2021 [4]

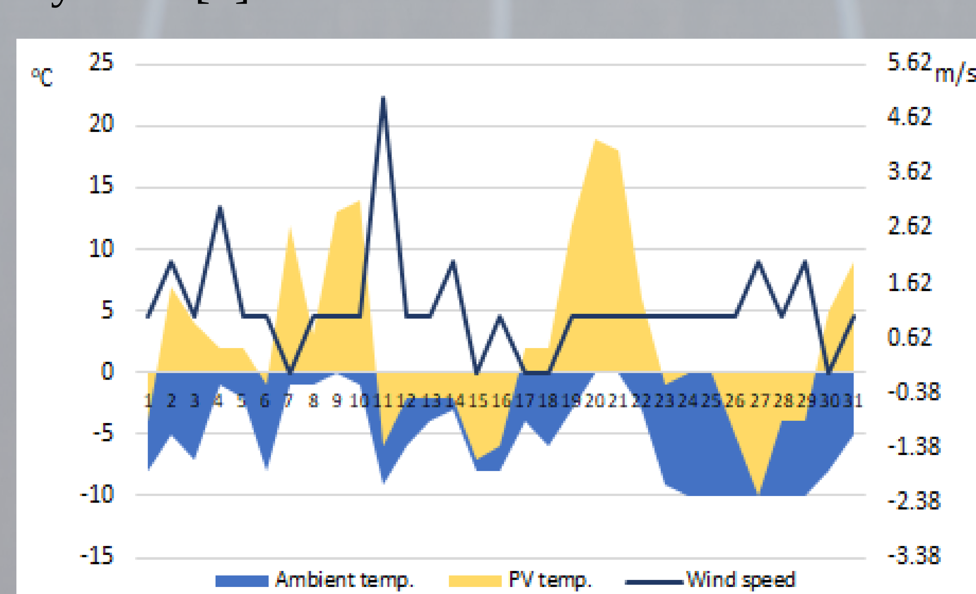

Fig.3. Temperature variation of the panel concerning ambient temperature and wind speed throughout January 2021 [4]

SIMULATION RESULTS

Table 1. Summary of the 5kW SPP simulation with two different panels.

Name	Amount	Area	Annual energy	Eff. at STC	PV loss (temp.)
	pcs	m^2	kWh	%	%
Mono 280W	2x9	30	7919	16.71	-7,3
Mono 500W	2x5	24	8026	21.10	-6

CONCLUSIONS

1.In the identified site conditions, there is a tendency for extreme heating of solar panels in summer and sometimes in winter despite the ambient cold, resulting in 5-10% reduction in efficiency and degradation of the panels. Therefore, PV panel cooling system is needed.

2.The use of higher wattage panels has no direct effect on reducing panel heating temperature, but the increased wattage allows more electricity to be generated under the same lighting conditions, which can reduce thermal heating per unit of energy produced.

3.The use of higher wattage panels also helps to save roof space by reducing the required installation footprint, which can reduce the heating area of the roof.

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