X INTERNATIONAL CONFERENCE
INDUSTRIAL ENGINEERING AND ENVIRONMENTAL PROTECTION 2020
IIZS 2020 , October 08-09, 2020, Zrenjanin, Serbia

ANALYSIS OF PHOTOVOLTAIC SOLAR PANEL EFFICIENCY

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Abstract

Solar energy, as an alternative energy source can be exploited without causing harmful effects on the environment. From the environmental point of view, usage of photovoltaic solar systems (PV systems), which is the main topic of this paper work, is acceptable mostly because it doesn't produce pollution related to exploitation and usage of fossil fuels. The main point of this work is to show possibility of using PV solar systems on a practical example.

MATERIAL AND METHODS

Photovoltaic solar panels are made of solar (photovoltaic) cells, which are in charge of electricity generation by direct conversion of photon energy of the Sun into electric energy. PV module (PV panel) is the smallest replaceable unit in PV string.

Monocrystalline solar panel

In monocrystal of Silicon (Si), atoms are forming a complex cubic lattice – each Si atom is bounded with four other atoms over his four valence electrons. In this way, interconnection between two atoms is enabled by two electrons, which is called covalent chemical bond. Due to crystal heating, this covalent bond is breaking and electrons are releaseing – transition from valence to conductive zone. Due to the electrons transition there comes to an "empty space" in valence zone, and this "empty space" is so called current carrier – similar to electron but with opposite electrification.

Experimental measurements

PV solar panel that contains 24 monocrystalline Si cells is made due to experimental purposes. Measurements were performed by devices: *Sollar charge controller* (the output voltage [V] regulating device) and analog ammeter – amperage device [A], which are shown on the pictures below.

Sollar charge controller

Analog ammeter

Equation used in order of calculating the useful power gained:

$$P = U \cdot I \ [W]$$

P – useful power [W]
U – optimal voltage [V]
I – amperage [A]

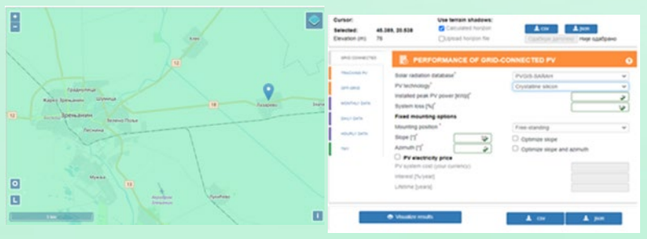
RESULTS AND DISCUSSION

The measurements were performed for 15 days (Jun 15 – Jun 29, 2020), every day between 07 – 19h (frequency: 2h) with different orientations of PV panel.

During this time panel was set in three different positions: horizontal β=0, with an angle of inclination β=24°, with an angle of inclination β=38°. Panel orientation in all of the three positions is south, which means that the deviation angle from the south is α=0. In the following figures are shown datas gained during the measurenments of output voltage, so as maximal useful power.

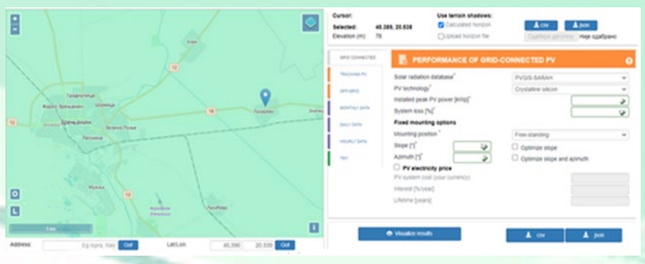
Simulation results

In the following figures simulation is shown for location of PV solar panel where the experimental measurements were performed, which is Lazarevo, located on L =45,389° latitude and 20, 538° longitude. Simulation of Sun radiation and potentially generated energy was done for each one position of solar panel during the measurement of the output voltage and amperage.. Potential electrical energy annual production provided by PV solar panel amounts 1228,82 kWh (panel position with an angle of inclination 38°), 1209,06 kWh (panel position with an angle of inclination 24°) and 1053,28 kWh (horizontal panel position). In all of the three cases PV panel is south oriented and in a fix position.



Setting of the location and angle of the receiver - 38° in PV GIS

Simulation of monthly radiation in plane with PV panel and simulation of generated energy with fixed angle of PV panel



Setting of the location and angle of the receiver - 24° in PV GIS

Simulation of monthly radiation in plane with PV panel and simulation of generated energy with fixed angle of PV panel

Setting of the location and angle of the receiver - 0° in PV GIS

Simulation of monthly radiation in plane with PV panel and simulation of generated energy with fixed angle of PV panel