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Climate, weather and energy production from photovoltaic system mounted on innovative, demonstrative pavilion in Sofia, Bulgaria for 2020

Iliana Popova[1], Krasimir Georgiev[2], Lyubomir Angelov[3], Miglena Nikolaeva-Dimitrova[4], Maya Stoyanova[5],

[1] *Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, Tzarigradsko chaussee, Blvd. 72, 1784 Sofia, Bulgaria, iliana79@abv.bg*
[2] *Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, Tzarigradsko chaussee, Blvd. 72, 1784 Sofia, Bulgaria, krasimir.georgiev@gmail.com*
[3] *Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, Tzarigradsko chaussee, Blvd. 72, 1784 Sofia, Bulgaria, l.angelov@yahoo.com*
[4] *Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, Tzarigradsko chaussee, Blvd. 72, 1784 Sofia, Bulgaria, miglena.nikdim@gmail.com*
[5] *Central Laboratory of Solar Energy and New Energy Sources, Bulgarian Academy of Sciences, Tzarigradsko chaussee, Blvd. 72, 1784 Sofia, Bulgaria, mayasto@abv.bg*

Key words: Green energy, Photovoltaics, Renewable sources, PV system, Meteorological data

Abstract

Seeking of Europe to reduce carbon gas emissions and a clean environment offers opportunities to increase the use of renewable sources. The innovative Demonstration Pavilion in the Scientific Complex II of BAS in Sofia is such an example. The meteorological data for 2020, obtained from measuring devices installed on the roof of the Demonstration Pavilion, are analyzed and the production of electricity from the PV system installed on the roof is estimated. The annual production by months of the received electricity from PV system is presented, depending on the climatic conditions.

Климат, време и производство на енергия от PV система монтирана на иновативен демонстрационен павилион в София.

Илиана Попова[1], Красимир Георгиев[2], Любомир Ангелов[3], Миглена Николаева-Димитрова[4], Мая Стоянова[5],

[1] *Централна лаборатория по слънчева енергия и нови енергийни източници, БАН, Цариградско шосе 72, 1784 София, iliana79@abv.bg*
[2] *Централна лаборатория по слънчева енергия и нови енергийни източници, БАН, Цариградско шосе 72, 1784 София, krasimir.georgiev@gmail.com*
[3] *Централна лаборатория по слънчева енергия и нови енергийни източници, БАН, Цариградско шосе 72, 1784 София, l.angelov@yahoo.com*
[4] *Централна лаборатория по слънчева енергия и нови енергийни източници, БАН, Цариградско шосе 72, 1784 София, miglena.nikdim@gmail.com*
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Ключови думи: Зелена енергия, Фотоволтаици, възобновяеми източниц, PV система, Метеорологични данни

Резюме

Стремежът на Европа към намаляване на вредните емисии и чиста околна среда, предлага възможности за увеличаване използването на ВЕИ. Построеният иновативен демонстрационен павилион в Научния комплекс II на БАН в София е такъв пример. Анализирани са метеорологичните данни за 2020 г., получени от измервателни уреди монтирани на покрива на Демонстрационния павилион и е оценено производството на електроенергия от PV системата монтирана на покрива. Представено е годишното производството по месеци на получената електроенергия от PV система, в зависимост от климатичните условия.

The innovative demonstrative pavilion in Sofia

The innovative demonstrative Pavilion is situated in the Scientific campus II of Bulgarian Academy of Sciences in Sofia. The pavilion (Pic. 1.) is a temporary building, which relies on a supporting steel construction the building is oriented in clear geographic directions east-west, north-south. The east, west and south facades are transparent and built with Fluid flow glazing (FFG) system. In addition, there are internal partition wall. North façade is opaque and contains the entrance door and the installation block.

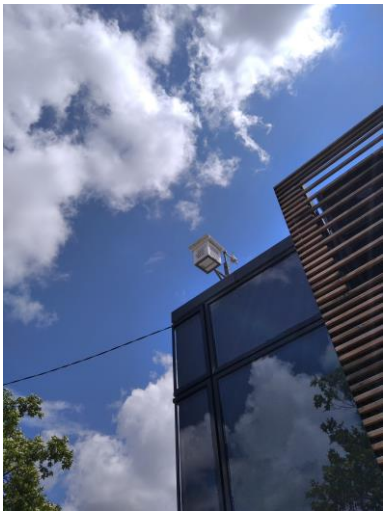


Pic. 1. Innovative demonstrative pavilion in the Bulgarian Academy of Science, Sofia, Bulgaria

With total 63m² of external FFG the glass façade to floor area ratio is 63/30.2 = 2.08. The total area of internal FFG wall is 19 m².
On the roof of the pavilion 18 c-Si Photovoltaic (PV) modules in total installed capacity 5.040 kWp are mounted. (see pic. 2.) The panels are oriented south with 10 degree inclination from the surface related to the limited space and shadows, on grid connection. [1]



Pic. 2. PV system on the roof of the innovative pavilion Sofia with installed capacity 5.04 kWp



Pic. 3. Meteo Station is mounted on the roof innovative pavilion Sofia for monitoring Relative Pressure, Outdoor Humidity, Temperature, Wind, Dewpoint Gust, Rain and etc .

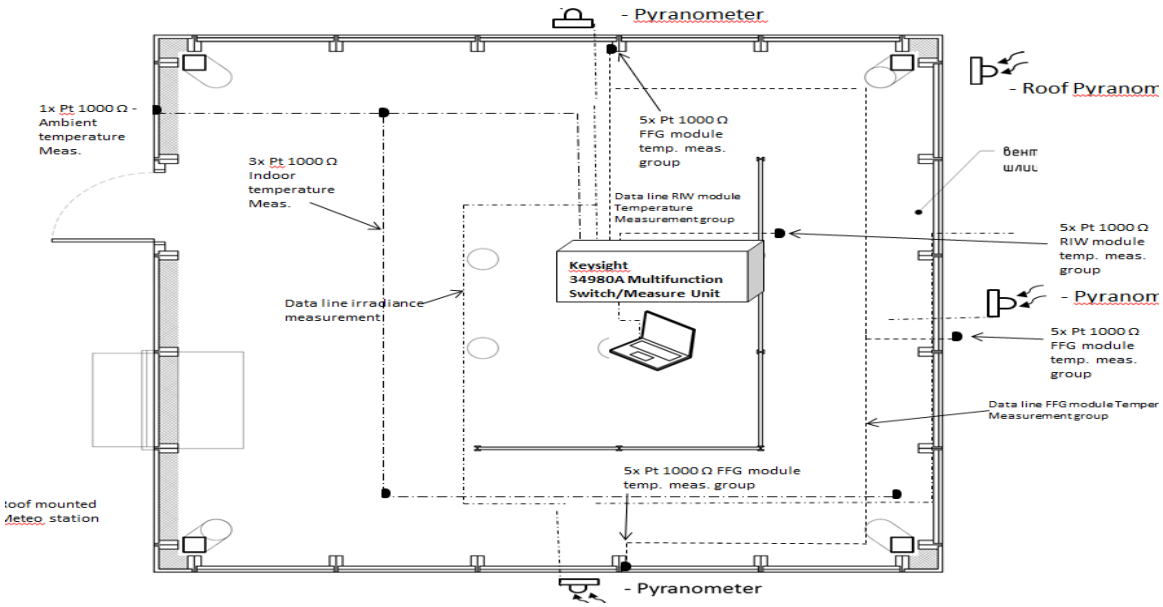


Fig. 1. Scheme of the system for monitoring of incident/transmitted solar radiation, FFG module and room temperature of the innovative demonstrative pavilion (Project Documentation, Project ref. 680441)

On each facade internal and external, the pyranometers are mounted to measure the total irradiance incoming to the façade. The temperature sensors over a distance of 0.7 m in height (Pt 1000; class A) are installed on a single FFG module on every facade. All temperature and radiation data are collected by data acquisition system Keysight Technologies 34980A (see fig. 1.). Meteo Station is mounted on the roof for monitoring Relative Pressure, Outdoor Humidity, Temperature, Wind, Dewpoint Gust, Rain and etc (see pic. 3.). The data are registered in the system at every 5 minutes.

Monitoring of the Meteorological elements and PV energy production

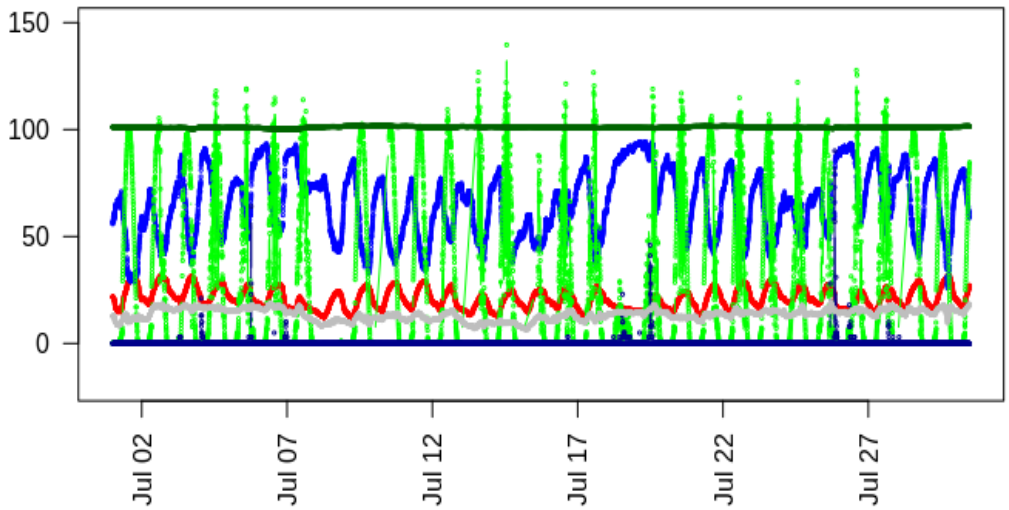


Fig. 2. Meteorological elements recorded from Meteo station on the roof of the pavilion during July 2020 at every 5 minutes

Red dots - presented Outdoor Temperature in °C
Blue dots - Outdoor relative humidity in %
Green dots - Solar radiation in W/m^2 has to be multiply x 10
Dark blue dots - Relative Rain in mm has to be devided by 10
Dark green dots - Relative Pressure in hPa has to be multiply x 10
Grey dots – Dewpoint in °C

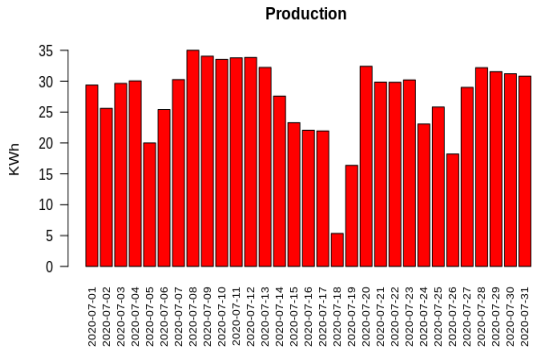


Fig. 3. Energy production from PV system mount on the roof of the Pavilion during July 2020

Month July is usually warm, sunny month with maximal temperature 32 °C and minimal temperature 11.3 °C for 2020 recorded on the meteorological station on the roof. Mean outdoor temperature is 20.9 °C. Relative pressure is between 1001 and 1017 hPa. The mean pressure in July is 1011 hPa. The relative humidity is between 26 % (sunny days) and 94 % (cloudy, rainy days) with mean humidity in July 65 %. The dewpoint is between 6 and 19 °C. With mean value 13.8° C. The piranometer shows solar irradiation with maximal value approximately 1200 – 1300 W/m^2 in sunny days. (see fig. 2.)

Rain occur in 3,4,6,7, 17,18,19,20,26,27 and 28 July 2020, the total perspiration is approximately 100 mm for the hole month . Cloudy and rainy days witch significantly affected the PV energy production are just 18,19 and 26 July 2020
In Sunny days, the PV production is more than 30 kWh per day. In cloudy rainy days the energy production is less than 10 kWh. The total energy production during July 2020 is 853 kWh (see fig. 3.)
This is example for one month monitoring. Monitoring data are 24/7 and free under project InDeWaG and they are used for diferent estimations.

Energy production from PV system of 5.040 kWp for 2020 in Sofia

The year 2020 for Sofia, Bulgaria, is with mean temperature approximately 11 °C (see https://www.stringmeteo.com/synop/temp_year.php?year=2020&month=1&len=12&an_per=6190&ord=num&submit=%D0%9F%D0%9E%D0%9A%D0%90%D0%96%D0%98#sel)

Energy production by months for 2020 in Sofia are presented on fig. 4. For the whole year total energy production from the PV system on the roof is 5840 kWh.
The hottest month is august with mean temperature approximately 21.5 °C. The energy production is 800 kWh . The coldest is January with mean temperature close to 0 °C. The production in January is 150 kWh,
This year is only the first year of monitoring of the innovative pavilion. The monitoring of the pavilion will continue in the next 4 years.

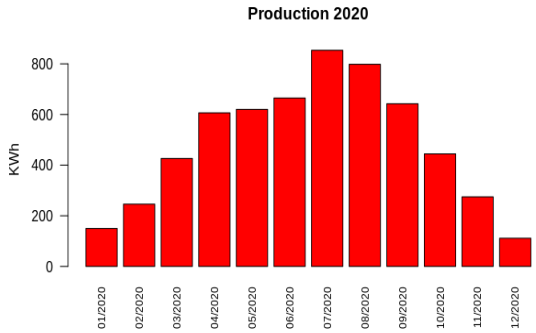


Fig. 4. Energy production from PV system mount on the roof of the Pavilion during 2020 year

Acknowledgments

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