DESIGN OF 20MW PHOTOVOLTAIC POWER PLANT OSLOMEJ IN NORTH MACEDONIA

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Abstract
North Macedonia has a good location and climate, with a large number of sunny days a year. Solar radiation ranges from 1 168 kWh/m^2 to 1 650 kWh/m^2, but the sun, as a renewable and never-ending source of energy, especially to produce electricity, is unfortunately the least used.
This paper presents the planning and construction of a new photovoltaic power plant PvPP Oslomej with an installed capacity of 20 MW. The location was chosen close to the Oslomej thermal power plant with an installed capacity of 125 MW. The distance of PvPP Oslomej from TS 110/35/10 Oslomej kV/kV/kV is up to 5 km, and the land is in state property, so JSC ESM Macedonia can easily take it over since this largest producer in RN Macedonia is in state ownership property. The calculations obtained using the PVsyst software are presented. The most suitable type of panels and inverters that are available on the market in RN Macedonia are selected. The orientation of the panels is east-west. That is, half of the panels will be placed towards the east and the other half towards the west. At the same time, the most favorable angle towards the sun will be chosen, which would make the most of the sun's energy during the day. In this way, PvPP Oslomej with 20 MW, would produce the largest amount of electricity.
With the construction of the PvPP Oslomej with 20 MW, the Thermal Power Plant, Oslomej which uses very low caloric value coal from the nearby Oslomej mine, would be phased out. By implementing renewable energy sources, the environment will be protected.

Keywords: Renewable energy, Photovoltaic power plants, Thermal power plants, energy transition

INTRODUCTION

In this scientific paper, an overview of the project solution with the construction of a new photovoltaic power plant (PvPP) Oslomej 2 with an installed capacity of 20 MW, are given.

The construction of this Photovoltaic power plant is planned to be on land owned by the largest electricity producer Join Stock Company Energy Generation of North Macedonia (JSC ESM Macedonia). The location of the newly planned PvPP Oslomej 2 is in the immediate vicinity of the thermal power plant TPP Oslomej.

The PvPP Oslomej 2 with 20 MW is located near the transformer station TS 110/35 kV/kV Oslomej. The connection will be on the electricity distribution network of JSC ESM Macedonia at the 35 kV voltage level. 35 kV voltage level from TS 110/35 kV/kV Oslomej is the property of JSC ESM Macedonia, too.

In this working paper it will be shown the selection of the equipment, the

placement of the panels, the expected annual production as well as the benefits of the construction of this photovoltaic power plant. In this way, JSC ESM will start to independently to build photovoltaic power plants with its own resources, which will increase the percentage of domestic electricity production.

EXPOSITION

Photovoltaic power plant PvPP Oslomej - 2 is planned to be built near the village of Oslomej, southeast of the city Kicevo, close a proximity to TPP Oslomej. The Design and the simulations were done using PVsyst software. Figure 1 shows the location of the selected site of FEC Oslomej 2 with 20 MW.

In this part for the selected location, the solar radiation is 1 539 kWh/m^2. [1] Figure 2 shows the annual solar radiation, monthly. [2]

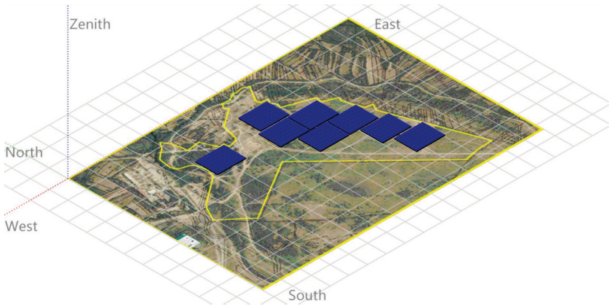

Fig. 1. *Location and frequency of panels at PvPP Oslomej 2, with 20 MW*

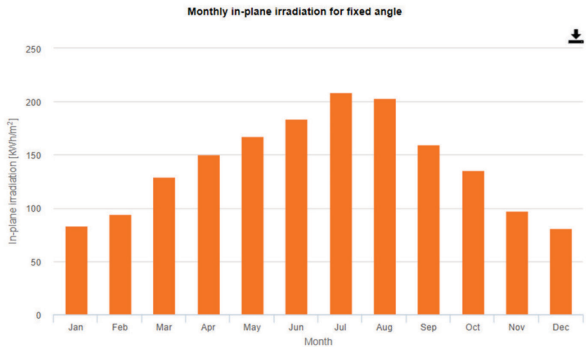

Fig. 2. *Average irradiance at a fixed angle for the given location expressed in kWh/m^2*

Figure 3 shows a graphical representation of the expected annual production of electricity, as well as the losses of the electricity, by months, which are significantly very small. The annual production of PvPP Oslomej 2 with 20 MW will have amount of 27 823 MWh. [3]

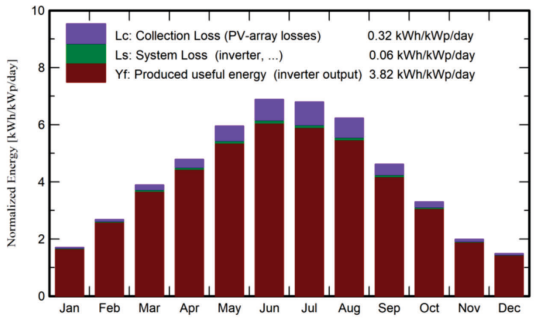

Fig. 3. *Expected annual electricity production by month kWh*

A total of 36 608 photovoltaic modules with monocrystalline bifacial technology, JETION type JT545SSh(B), with panel dimensions of 2279 x 1134 x 30 mm and peak module power of 545 Wp are planned to be installed at this location. 88 inverters type SUN2000 -185 KTL – H1 are also planned to be part of the system. The installed power of Oslomej - 2 will be 19 950 kWp, i.e. 20 MW.

The Photovoltaic panels are planned to be placed towards the sun at an angle of 10^0. The half of the number of planned panels are placed in the east and the other half on the west, with an azimuth of 90^0 and -90^0. In this way, the electricity will be produced the largest and continuously throughout all day.

The following figures 4 and 5 shows the placement of the panels, the azimuth angle and the angle directly to the sun.

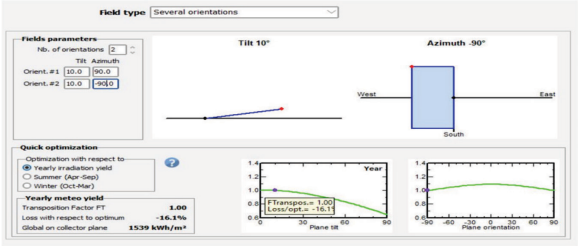

Fig. 4. *Orientation of the azimuth to the east*

During the construction and designing of the PvPP, the shadowing of the mutual panels was taken into account too, and the choice was made so that the shadowing is minimal.

Figures 6 and 7 shows the mutual shading of east and west facing panels, separately.

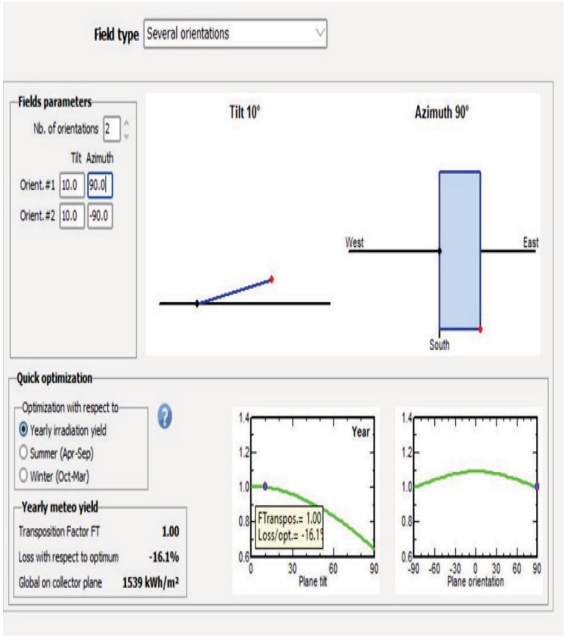

Fig. 5. *Azimuth setting to the west*

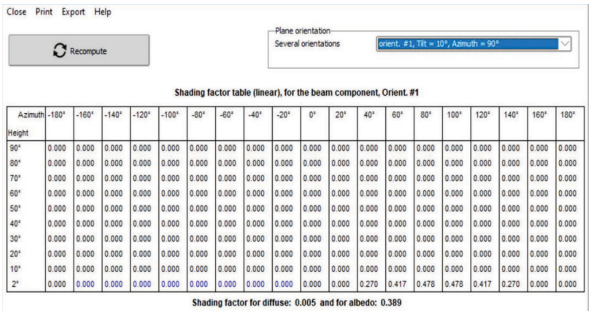

Fig. 6. *Shading of panels facing to the east*

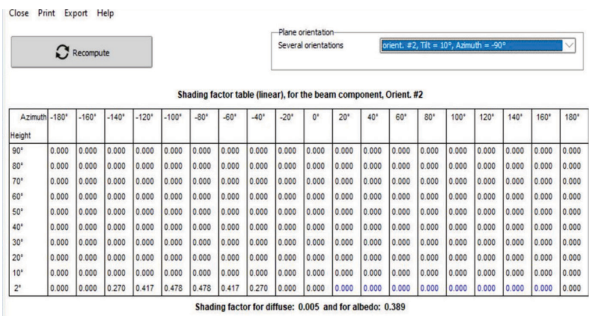

Fig. 7. *Shading of panels facing to the west*

Characteristic of this Photovoltaic power plant is that it will be the first one where the panels are placed on the ground and are in touch each other and have an azimuth of +/- 90^0. This placement of the panels is a common practice placed on the rooftops, and not as on free-standing photovoltaic power plants.

Figure 8 shows the placement of the east-west panels.

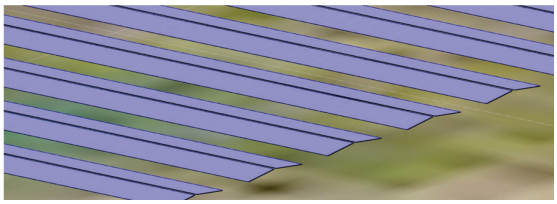

Fig. 8. *Placement of the panels east-west*

The produced electricity from the inverters will be transmitted to 8 transformer stations TS 0,8/35 kV/kV with a power of 8 x 2 500 kVA, The last transformer station will finally be connected to the 35 kV level of TS 110/35 kV/ kV. The layout of the transformer stations is shown in Figure 9.

Fig. 9. *Distribution of transformer stations in FEC Oslomej 2 with 20 MW*

According to the calculations and simulations, 1 408 strings are foreseen to which 26 panels will be connected in series to a total of 88 inverters.

Figure 10 shows the string and series connection according to the inverters.

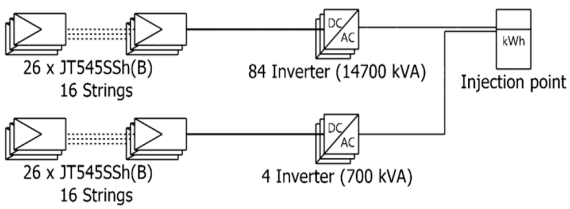

Figure 10 shows the string and series connection according to the inverters.

The total investment for the construction of FEC Oslomej 2 alone, 20 MW, will amount to EUR 12 568 554 including VAT. While the plug would amount to 613 600 euros. Which means that the total investment would amount to 13 182 154 euros with VAT. The return on investment would be 3 years.

The construction of PvPP Oslomej 2 with 20 MW, is planned on barren land, thus fertile land will not be occupied and agriculture in the RN Macedonia will not be endangered.

CONCLUSION

It is significant for this Photovoltaic power plant PvPP Oslomej 2 with 20 MW, that the land owned by JSC ESM Macedonia, which is the largest producer of electricity, will be used. This means that there will be no land acquisition costs.

The location is in close near to the TPP Oslomej, where there is the nearest power point for connection. With the construction of this photovoltaic power plant JSC ESM Macedonia, the energy of the sun will begin to be used for the production of electricity.

It is unfortunate that the RN Macedonia, as a country located in the southeastern part of Europe and abundant with many sunny days, has the lowest percentage of PvPP in the total production of electricity. Solar radiation in the RN Macedonia amounts of 1 400 - 1 800 kWh/m^2. [4]

The choice of equipment is made according to the equipment that is offered to the couple and has the lowest price.

Also significant is the placement of the panels with an east-west azimuth as well as an angle to the sun of 10^0, which enables the greatest production of electricity. In the future JSC ESM Macedonia should continue with the construction of other photovoltaic power plants.

With the construction of PvPP Oslomej 2 with 20 MW, it is expected to be reduced a small percentage of electricity imports, which in 2021 amounted up to 2 407 GWh. Domestic electricity production would also increase by a small percentage, which in 2021 was 5 285 GWh. [5]

Although the annual electricity production of PvPP Oslomej 2 with 20 MW will amount to 27 823 MWh, it would still contribute to the diversity of the produced electricity in the range of renewable energy sources.

At the same time, the percentage of electricity production from PvPP within renewable energy sources would increase significantly.

The interest of foreign investors in the construction of photovoltaic power plants is really great, especially with small powers with connections to the electricity distribution network.

Recently, foreign investors have also appeared who invest in photovoltaic power plants with large powers and with connection points in the power transmission network, but their number is much smaller.

REFERENCE

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[3] PVsyst photovoltaic software, https://www.pv syst.com.

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