DESIGNING OF A LARGE-SCALE GROUND PHOTOVOLTAIC PLANT IN ESNA, EGYPT

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Egypt is considered a “sun belt” country with the annual direct solar radiation of up to 3000 kWh/m^2. The sun shines 9-11 hours a day from the North to the South of the country, with very few cloudy days. However, advantages of this favorable situation are not taken in full. In 2017 the country only had 167 MW of solar generation capacity 116 MW of which was photovoltaic plant. However, in 2015 the Egyptian government adopted the Integrated Sustainable Energy Strategy to 2035 with ambitious goal to reach 42% of the total electricity produced by renewable sources by 2035. In 2035 the renewable capacity should include some 52000 MW of distributed and large-scale generators. The current plan is to increase the share of renewables up to 20% in 2022, with to solar energy providing 2.2%. By 2027, 2800 MW of photovoltaic capacity must be installed.

In the report, designing of a large-scale ground photovoltaic plant is considered. The plant will be located near Esna, a city in the South of Egypt on the Nile (with latitude 24.8543 and longitude 32.613), not far from 86 MW Esna hydro power plant. In the location there are two substations of 11/33 kV and 11/66 kV. The plant site chosen is between Esna suburb and Aswan-Al-axour highway, which is convenient in terms of plant equipment delivery. The plant will be connected to the 11/66 kV substation that is 7 km far from the site.

The available area, the electricity grid in the location, and the climatic conditions in the Esna region concerning solar insolation, wind speed, and maximum temperature have been assessed. The data obtained from the NASA Climatology Resource for the period of five years show that the average maximum temperature is 42°C, the average wind speed is 8 m/s, and the average daily irradiance on horizontal surface is 6.3 kWh/m^2, which makes the meteorological conditions in the location suitable for setting up a photovoltaic plant. The solar irradiance on a tilted panel has been estimated, with the optimal tilt of 24 degrees providing 2,575 kWh/m^2.

The arrangement of the PV panels in the location has been calculated, the combiner boxes, inverters, and transformers chosen as function of the electrical parameters of the plant components. The substation switchgear have been selected on the basis of calculations of short currents in several nodes of the electrical grid.

The designed ground 66 MW plant will occupy some 0.94 km^2 and include 220800 300 W panels, 360 combiner boxes, 60 1000 kW inverters, 30 2 MVA 0.4/11 kV transformers, and two 40 MVA 11/66 kV transformers. To select equipment for the 11/66 kV substation, calculations of short currents in six nodes of the electrical grid have made. The annual electricity production of the designed PV plant is assessed to reach 200.4 GWh, which will be enough to meet the needs of some 1180 thousand households.