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Stand-Alone Photovoltaic Systems for Telecommunication Stations, a Case Study for Kahramanmaras, Turkey

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Abstract
Telecommunication is one of the areas that photo voltaic solar systems are used. TURKTELEKOM radio link station located in Sulutarla (K: 37.62629649, D: 36,92422807, Altitude: 1367 m) operates with solar energy. 24 pieces of 350 Ah OPzV gel batteries were used in system. Each piece of battery is 2,25 V and connected in series. Total battery voltage is 54 V. Photovoltaic panel power is 85 W and 12 pieces of monocrystalline panel are used in system. Output voltage is 21.6 V and panels are installed in 3 series, 4 parallels. With a total power of 1,08 kWp Stand-alone PV system takes 7,8 m2 area and generates 1763 kWh energy per year. System performance ratio is 81 percent. Telecommunication stations located away from grid solve energy problem economically with solar energy.

Keywords: Stand-Alone, Photovoltaic Systems, Telecommunication, OPzV

1. Introduction

Telecommunication is one of the areas that photo voltaic solar systems are used. Reduced power consumption of modern telecommunication equipments have become economical with falling cost photo voltaic solar systems [1-3].
Also being off-grid resolves a significant difficulty in rural telecommunication systems. Transmitters in remote areas away from grid resolve energy issue economically with solar energy.
Design and installing of solar energy systems for telecommunication projects is important. Systems which are not calculated in optimum efficiency may be insufficient under unexpected weather conditions and may cause significant communication interruptions.
Also, a telecommunication solar energy system based on unmanned station must be extremely reliable. System must be weatherproof and it needs to work in a way that requires the least human intervention. The following parameters are taken into account while system design.

- System sizing and component mapping
- Minimization possibility of load loss
- Unattendent operation and much less service
- Choosing high quality components
- Running under extreme weather conditions (Low winter temperatures, snow cover, strong winds, moisture etc.)

Coverage of communication networks extends day by day. Territories without human population and grid connection need communication service too. Telecommunication infrastructure to cover entire rural areas is merely economical by solar energy systems.
In order to serve this growing connection demand, network of telecommunication radio link stations spread out remote regions of the world. Radio link towers may be installed in remote areas (mountainous terrain, dense forests, and deserts) without communication network or in regions where grid sources are

unsteady about grid networks. Consequently, telecommunication companies which have radio link towers rely on diesel generators for a long time. But diesel generators operate at low efficiency, charge high costs and produce high CO_2 emissions. Including solar energy options, solution based on batteries might reduce operating costs 35 percent. Some radio link towers of telecommunication operate in the regions with stable grid source, but regardless of where the radio link tower locates, R/L operator companies must inevitably confront high energy bills [6-9].

2. Advantages of Using Solar Energy in Telecommunication

2.1. Dependability

At independent installations, well designed and properly assembled photo voltaic systems are dependable systems. Solar electrification systems have no moving components and therefore very little maintenance is required.

2.2. Facility and Flexibility

Solar energy systems consist of tiny and light components relatively easy to be transported one region to another. Photo voltaic systems can be easily transported any location and they are modular systems. They don't require infrastructures such as road and grid source. Due to integration of solar energy systems, isolated telecommunication stations can be located independently.

2.3. Modularity

Although solar energy systems are designed according to a particular telecommunication system, they are flexible enough to meet new demands. System can be strengthened with new addition in future. Photo voltaic systems consist of modular components and they can be expanded independently without disassembling or replacing vital components of telecommunication stations.

2.4. Economy

Radio link stations are mostly installed on high altitudes so that radio waves transmit a large amount of terrain. Hence, number of required station are reduced and overall costs are diminished through limited energy consumption from grid source. Consequently a telecommunication station powered by solar energy become more economical.

2.5. Hybridization

Solar energy systems can operate with wind power, battery and even grid as a hybrid source. That feature is important in terms of sustainability.

3. Telecommunication Station Powered by Solar Energy

TURKTELEKOM radio link station located in Sulutarla (K: 37.62629649, D: 36,92422807, Altitude: 1367 m) operates with solar energy. Figure 1 illustrates the location of TURKTELEKOM radio link station powered by solar energy in Sulutarla region.

Solar powered TURKTELEKOM radio link station located at Sulutarla, Kahramanmaraş a great distance away from downtown and grid, at an altitude of 1367 meters shown in Figure 2.

Likewise the other batteries by developing technology, stationary batteries need to operate as maintenance-free in closed environments. For this purpose, production of OPzV – VRLA type gel batteries started. OPzv gel batteries are produced as block and cell in order to prevent system malfunctions due to sudden power failures. In addition to separator and alloy structure, they don't need maintenance and they have a life span of 20 years or more. Their capacity is between 100 Ah – 3000 Ah and their internal structure and utilization are as same as monoblock batteries. OPzV gel accumulators are durable to 1200 – 1500 charge-discharge circuit.

24 pieces of 350 Ah OPzV gel batteries were used in system. Each piece of battery is 2,25 V and connected in series. Total battery voltage is 54 V. Batteries used in system shown in Figure 3.

Figure 1. Location of Telecommunication Station Powered by Solar Energy

Figure 2. Solar Powered Telecommunication Station located in Sulutarla, Kahramanmaraş

Figure 3. OPzV Battery Used in System

Photovoltaic panel power is 85 W and 12 pieces of monocrystalline panel are used in system. Output voltage is 21.6 V and panels are installed in 3 series, 4 parallels. Specification of solar panel used in Stand-Alone Photovoltaic Systems for Telecommunication Stations are shown in Table 1.

Table 1. PV Panel Specifications

Nominal Power (Pncm)	85WP
Output Voltage (Umpp)	21.6V
Output Current (Impp)	3,72A
Open Circuit Voltage (Upc)	26.8V
Short Circuit Current (I)	4.83A
Solar Cells Dimensions	125 x 125mm
Tolerance	±5%
Weight	19kg
Dimensions	1210 x 540 x 28mm

When characteristics of panel used in Stand-Alone Photovoltaic Systems are examined, it is seen that not much voltage change occurs. Operating voltage varies between 18,6 V and 24 V. Voltage and current characteristic of photovoltaic panel with respect to irradiance shown in Figure 4, voltage and current characteristic of photovoltaic panel with respect to temperature shown in Figure 5, power and voltage characteristic of photovoltaic panel with respect to irradiance shown in Figure 6, power and voltage

characteristic of photovoltaic panel with respect to temperature shown in Figure 7. Negative effect of temperature is observed especially in power-voltage characteristic.

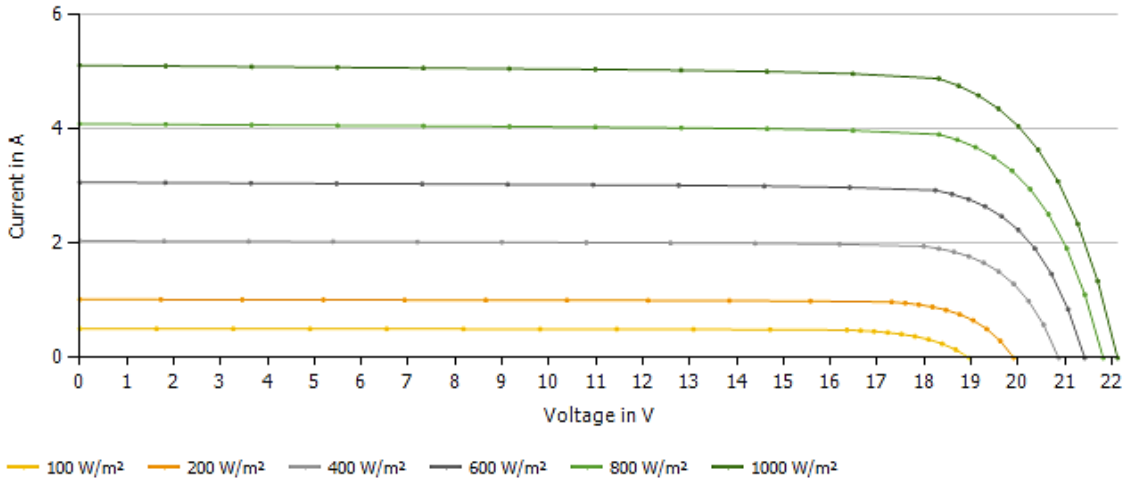

Figure 4. Voltage-current characteristic of photovoltaic panel with respect to irradiance

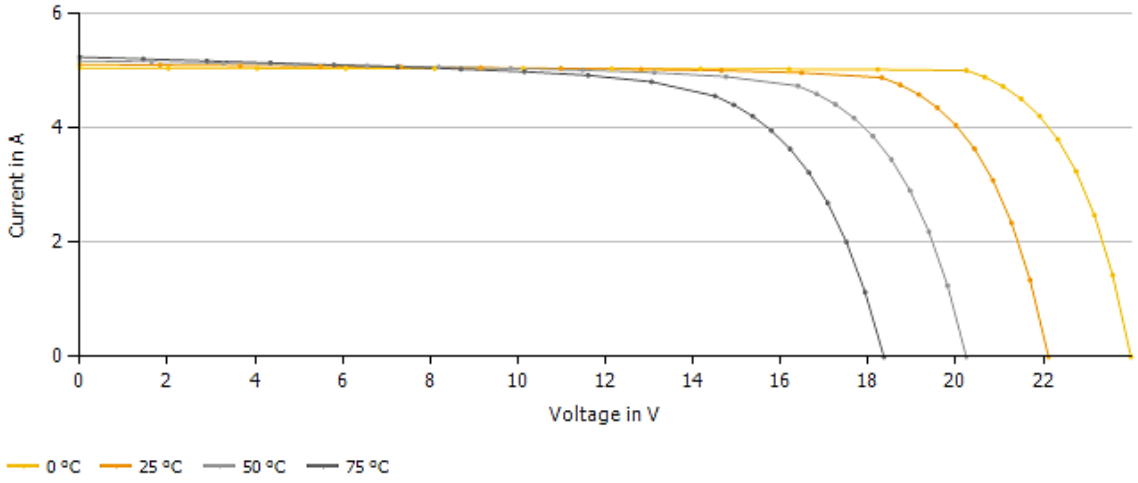

Figure 5. Voltage-current characteristic of photovoltaic panel with respect to temperature

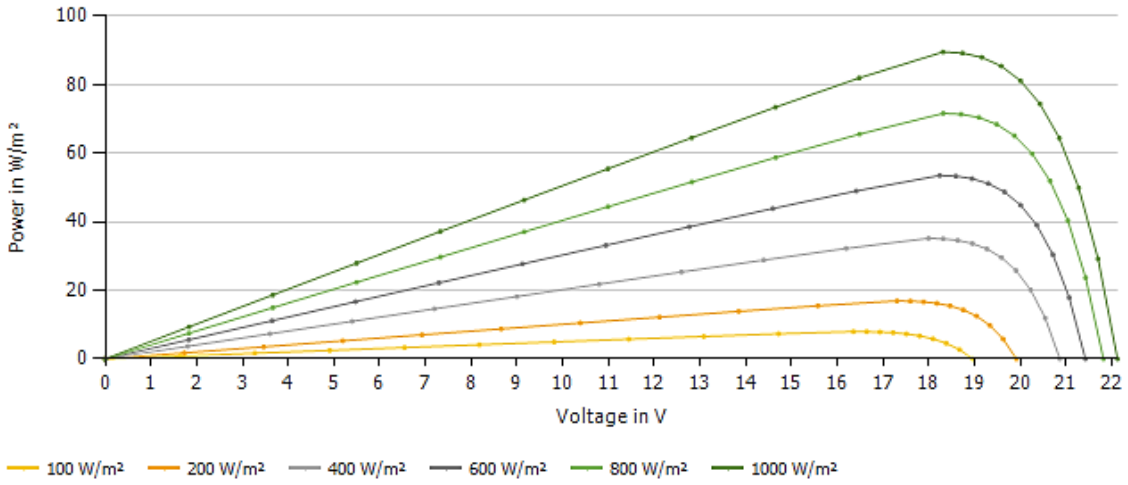

Figure 6. Power-voltage characteristic of photovoltaic panel with respect to irradiance

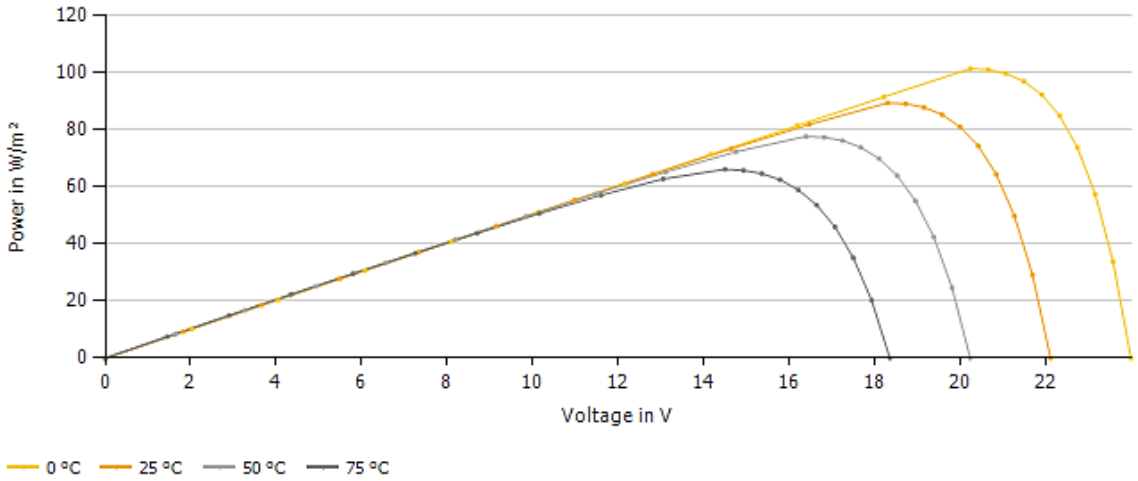

Figure 7. Power-voltage characteristic of photovoltaic panel with respect to temperature

The system observed is modelled with PVSOL program. Annual temperature and irradiance changes in Kahramanmaraş are shown in Figure 8 and Figure 9 respectively. Kahramanmaraş is rich in terms of irradiance. Annual sunlight duration is 2924 hours and annual global radiation is 1611 kWh/m^2–year.

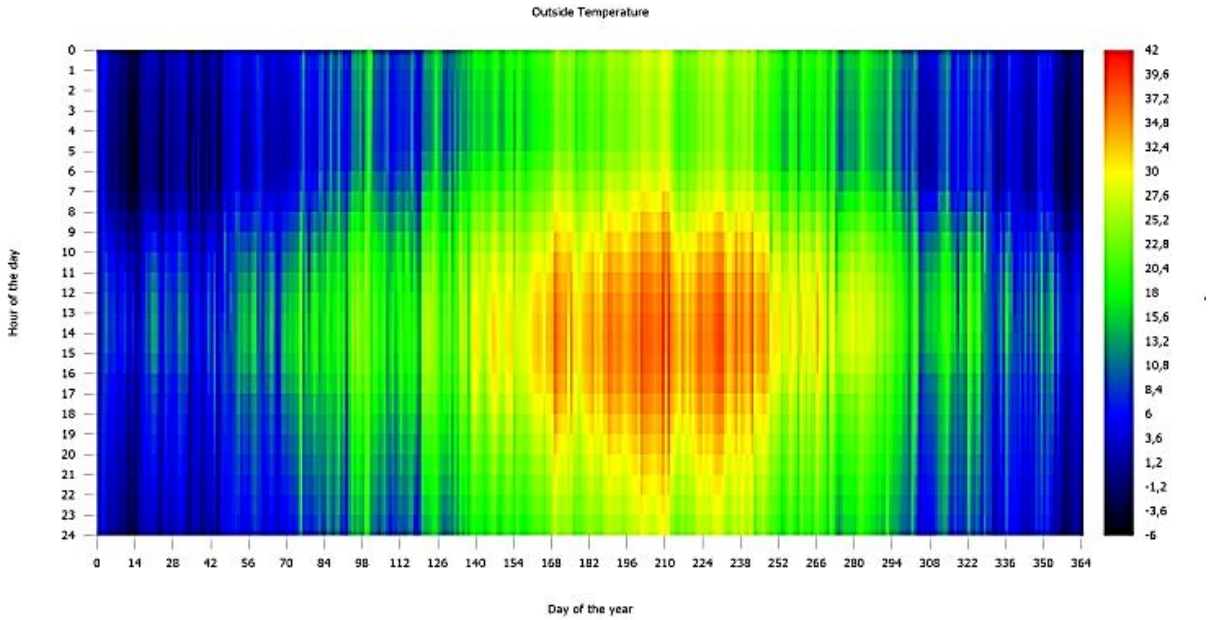

Figure 8. Annual Temperature Change in Kahramanmaraş

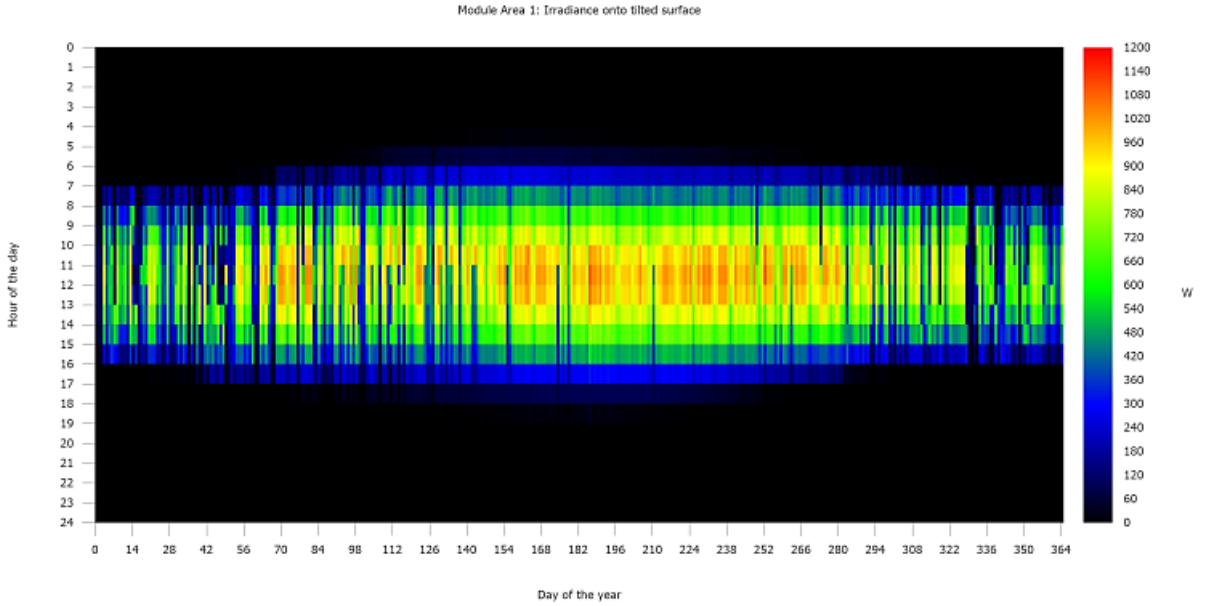

Figure 9. Annual Irradiance Change in Kahramanmaraş

System generates 1763 kWh energy per yerar. Monthly change in energy generated by PV system is shown in Figure 10. Energy balance of PV system is shown Figure 11.

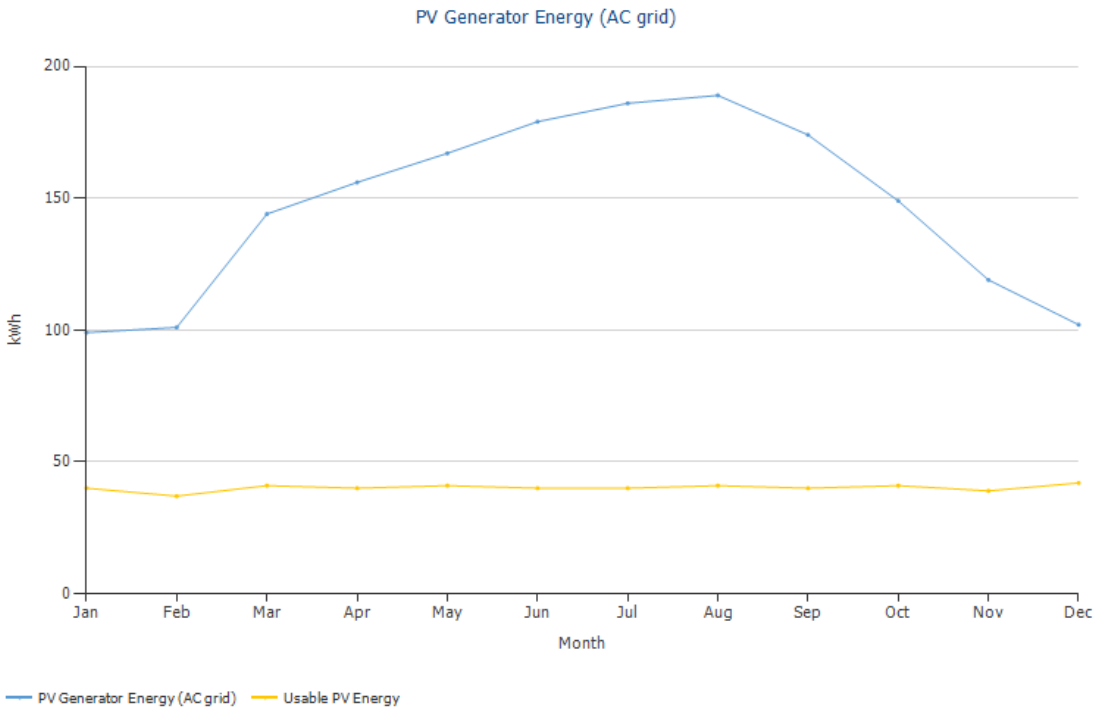

Figure 10. Monthly Change of Energy Generated by PV System

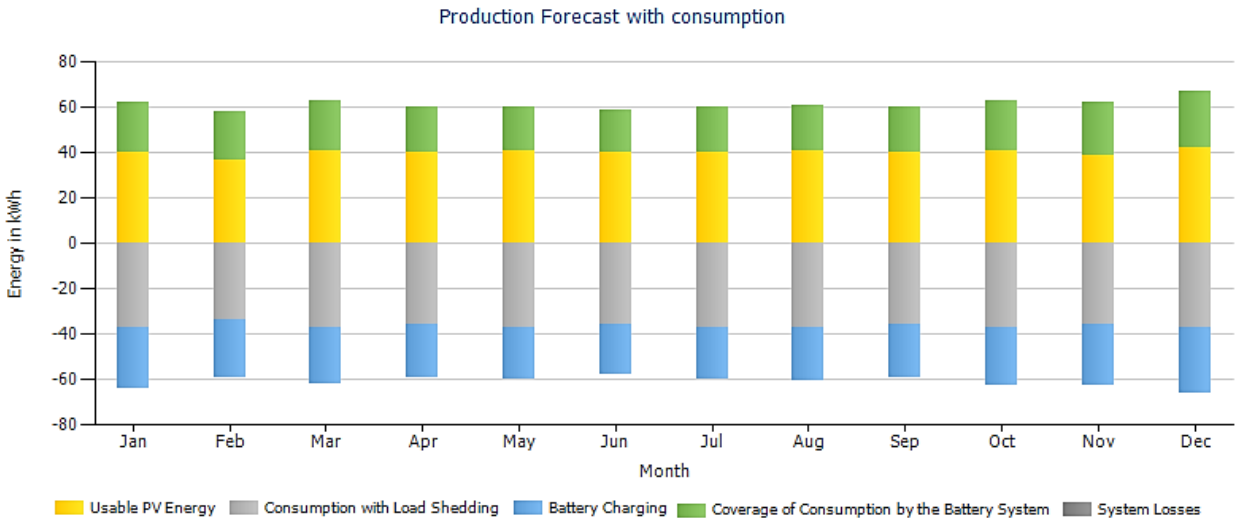

Figure 11. Energy Balance of PV System

4. Conclusion

With a total power of 1,08 kWp Stand-alone PV system takes 7,8 m2 area and generates 1763 kWh energy per year. System performance ratio is 81 percent. Telecommunication stations located away from grid solve energy problem economically with solar energy. Designing and installing of solar energy systems are important for telecommunication projects. Systems, those are not calculated at optimum efficiency might be insufficient under unexpected weather conditions and they might cause significant communication failures.

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