RESEARCH ARTICLE OPEN ACCESS

Sizing of a Grid-Tied Solar System for a Residential Buildings in Jordan

Mustafa G.K. Matar*, Mohamad Frzat Nashawi **
**(Department of Electrical Engineering, Princess Sumaya University for Technology, Amman, Jordan*
***(Department of Electrical Engineering, Princess Sumaya University for Technology, Amman, Jordan*
Corresponding Auther : Mustafa G.K. Matar

ABSTRACT
Grid-Tied solar systems is now used in commercial and residential buildings. It is a demanding task to integrate the renewable energy resources into the power grid. The main objective of this paper is to present an analysis and design procedure of solar grid-tied system for a residential building in Jordan, taking into account the photovoltaic module technology and inclination, power consumption, the inverter type and solar radiation. The home is simulated using SketchUp software.
Keywords - Grid Connected, PV installation, PV sizing, Renewable energy and Solar PV

Date of Submission: 03-05-2018 Date of acceptance: 19-05-2018

I. INTRODUCTION

Solar energy refers to a light and radiant heat that emanates from the sun and it is tapped using different types evolving technologies, for example, photovoltaics, solar architecture, thermal energy, molten power plants and solar heating. Solar energy is a power that comes from the sun and it is converted into electrical or thermal energy [1]. The sunlight contains photons that have different amounts of energy that corresponds to various wavelengths of the solar spectrum.

In large-scale production of solar energy, the power plant makes use of different techniques to tap the energy from the sun as the source of heat. The heat is used to boil water and this helps in propelling the turbine that later generates electricity just like the nuclear and coal power plants. The sun has been producing energy and this has been approximated to be billions of years where the sunbeams have been used in satisfying energy needs in the world.

The solar energy is the most abundant and cleanest form of renewable energy source available and some countries such as USA are richest in terms of solar resources globally. The modern technology is able to convert the solar energy and it is later used in providing heat, heating water for commercial or domestic use, generating electricity or for comfortable interior use. In the US, the solar energy market encounters both opportunities and challenges because the industry is trying to increase the production of solar technology while on the other hand, it is trying to reduce the installation and manufacturing costs. In the US, installation of solar energy has continued to grow because since 2008, the number has grown from 1.2 GW (Gigawatts) to approximately 30GW and this is enough to sustain about 5.7 million homes [3]

It is a recognized fact renewable energy currently contributes only 11% of our primary energy. Therefore, countries that have not yet utilized these natural resources such as Jordan that still rely on conventional resources such as gas generation stations, oil power plants and steam power stations are having significant impacts on the environment, the goal of this paper is to design an optimal grid-connected PV system for middle class home in Jordan, The KWh produced by the PV system is calculated as the sum of production all the year and this production should be equal to power consumes by the equipment's in the home all the year.

The solar panels convert the sun radiation to DC electric power. This DC current move to inverter includes a maximum power point tracker to keep the PV's operating at the most efficient point on their I-V curves well as an inverter convert DC current to AC current since the home is only use AC. Now this power is used by home holders is green energy. Fig.1 illustrate the consist of grid-connected system.

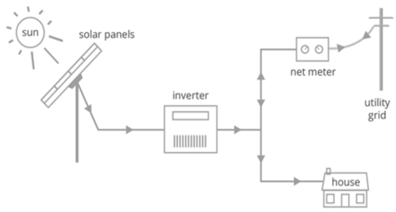

Fig. 1. Grid-connected PV system.

If the PVs supply less than the immediate demand of the Home, it will draw supplementary power from the utility grid, so the home demand is always satisfied. If the home demand less than PV supply, the excess is sent back into the grid.

The system shown above in fig.1 known as Net metering and feed in tariffs, the customer's electric bill is only for the net amount of energy that PV system is unable to supply.

II. HOME DESCRIPTION

Figure 2 shows the building contain the home, it situated in the suburb of Amman city, Jordan with Latitude and longitude 31.954, 35.912 respectively. It is obvious that Jordan is characterized by high solar radiation among regions in the world because it is located in the earth-sun belt area that has high Potential solar energy. However solar radiation differs along the seasons. Average daily solar radiation for the years (2004-2010) in Amman according to the table is: 5711 (Wh/m2.d).

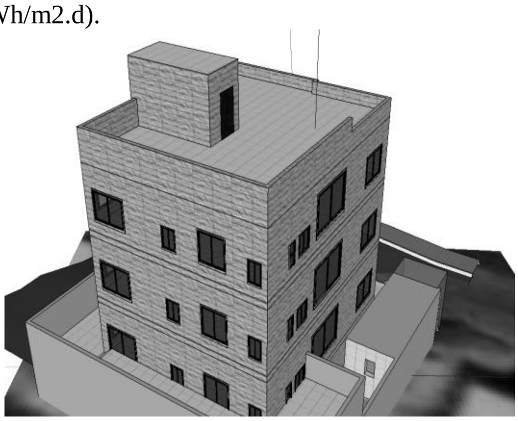

Fig. 2. The building.

This house consists of two bed-rooms, a living-room, a bathroom with a shower, a dining-room, a kitchen and a toilet with total area 140 m2 the monthly consumption for 2015 are shown in table I. Figure.3 shows the location on google maps.

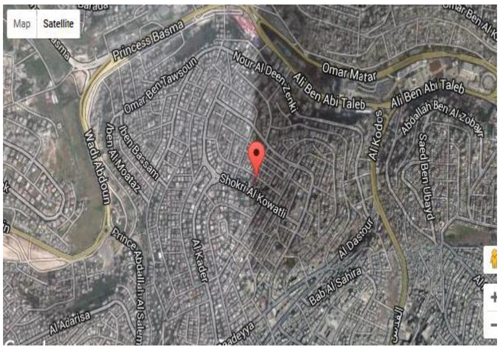

Fig. 3. Location on Google maps

TABLE I
MONTHLY CONSUMPTION FOR 2017

Month	Consumption of electricity (KWh/ Month)
January/2015	354
February/2015	529
March/2015	313
April/2015	469
May/2015	438
June/2015	406
July/2015	412
August/2015	701
September/2015	331
October/2015	511
November/2015	483
December/2015	504
The total Energy Consumption per Year = 5451 kWh/year	

III. DESIGN AND SIMULATION

It is obvious that Jordan is characterized by high solar radiation among regions in the world because it is located in the earth-sun belt area that has high Potential solar energy. However solar radiation differs along the seasons.

Highest solar potential is available in Middle East countries and the average monthly solar irradiation in Amman, Jordan is 5.59 KWh/m2.

Jordan is one of the most potentially productive region among MEC for harvesting solar power as shown in Table. 2. for different stations in Jordan. sun shine period in hours shown in Table. 3.

TABLE II
GLOBAL DAILY SOLAR ENERGY RECORDED IN JORDAN,2007 [4]

Energy((kWh/ m2)	Amman	Irbid
January	3.2	3.1
February	4.1	3.7
March	5.4	5.1
April	6.8	6.4
May	7.1	6.9
June	8.3	7.7
July	8.1	7.6
August	7.4	7.5
September	6	6
October	4.5	4.6
November	3.3	3.3
December	2.9	2.9

TABLE III
SUN SHINE PERIOD IN JORDAN,2007 [4]

Energy(kWh/m2)	Amman	Irbid
January	5.1	5.5
February	5.8	5.2

March	7.7	7.5
April	9.4	9
May	9.8	9.6
June	11.8	11.3
July	12	11.8
August	11.7	12.2
September	10	10
October	8.8	8.5
November	6.2	6.3
December	5	4.2

IV. MODELLING & CHARACTERISTICS OF SOLAR PV

The basic element of solar PV system is PV cells. These cells are connected to form modules. It is further expanded in the form of arrays as per the power requirements as shown in Fig. 4. These PV cells exhibit nonlinear characteristics. The output of the PV cell varies with solar irradiation and with ambient temperature. The equivalent circuit model of PV cell and module are shown in Fig 5.

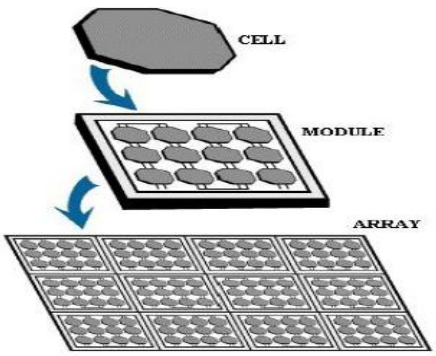

Fig. 4: Solar PV Configuration (Ahteshamul ,2016)

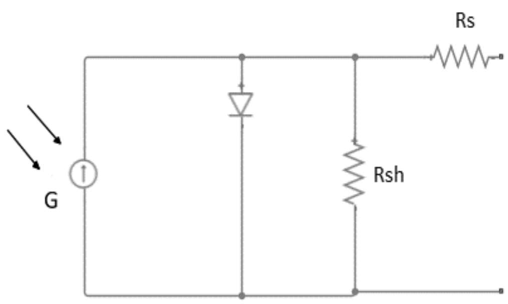

Fig. 5: Equivalent Circuit Model of Solar PV Cell, Solar PV Module

V. ENERGY SYSTEM SIZING

Energy system sizing refers to a technique that is used to match the scope and size of the energy with the projected and current energy requirements of a certain individual or a company [2]. When determining the energy system to use, one is supposed to consider the energy needs and resources available in the geographical area [3]. Installation of the right size will allow the user to meet the needs and this will ultimately ensure that long-term returns on investment are viable. Before energy system sizing is done, one is supposed to have clear goals and collect information and this will enable one to acquire a system that offers good value and ample power.

The components of energy system sizing include

- Minimize use of energy through energy efficiency.
- Mapping of resources.
- Determination of energy baseline.
- Determination of the scope and type of energy project.
- Feasibility analysis of energy project.
- Implementation of energy project.

Energy system sizing can be represented through a typical workflow in the Fig. 6 [3]

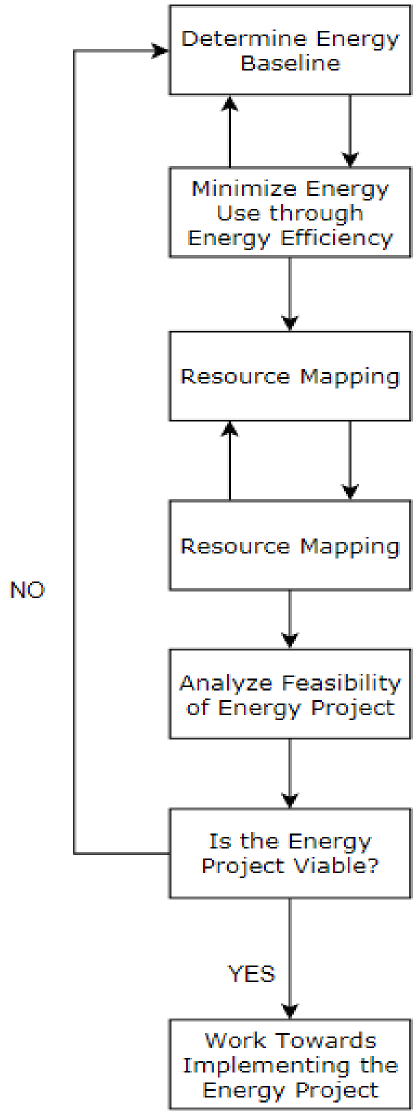

Fig. 6: Typical Workflow of Energy System Sizing

VI. CONCLUSION

Solar energy is more accessible, prevalent and affordable in the whole world. Additionally, use of solar energy has no negative impact on water and air. Solar energy has some limitations such as the system requires storage devices, for example, battery because the system does not work during the night and in cloudy weather. The technology is expensive and it requires a lot of space to collect energy that can sustain majority of homes. In this paper, we Presented Solar PV system sizing procedure for residential buildings. The concept of solar integration is been discussed, which gives better impact on environment.

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Mustafa G.K. Matar "Sizing of a Grid-Tied Solar System for a Residential Buildings in Jordan "International Journal of Engineering Research and Applications (IJERA) , vol. 8, no.5, 2018, pp. 30-33