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Meeting a dwelling's energy need with solar energy: An application study from Turkey

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Abstract

Electricity generation and having energy resources are one of the most important issue for societies from past to these days. Fossil fuels that providing three quarters of world's basic energy needs cause global warming with greenhouse gases becomes progressively smaller as well. Energy consumption is constantly increasing in parallel with population growth in the world, urbanization, industrialization and expansion of technology. While fossil fuels are quickly running out, energy demand is increasing rapidly. It is assumed that Petroleum is getting run out 2050 years. Natural gas and coal will have reserve until 2050 and 2150. In addition, the uses of fossil fuels have many negative effects to our environment. Cities are covered with black exhalations and sometimes it is hard to breathe because of air pollution. The Ozone layer has pierced and has became unable to fulfill the task of filtering. We have started to feel the effects of global warming strongly with each passing day. In such an environment, electricity generation with solar energy is becoming really important which is an endless source of clean energy. However, Dwellings to fulfill their own electricity need contribute significantly to environmental pollution and energy production. In this study, meeting a dwelling's energy need with clean energy that is one of the future energy generation methods has been examined. A system which generates electricity from solar energy was designed for this purpose. In this study we want to show the applicability of solar energy system at houses and make a practice about cost and productivity analyses.

Keywords: Electricity Generatio; Renewable Energy; Solar Energy; A House's Electricity Need; Air Pollution.

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1. Introduction

Solar cells generate power by absorbing the energy of photons from the Sun. When a photon strikes the surface of a solar cell, electrons are transferred through the cell, and a measurable current is formed. This process is known as the photoelectric effect, and it is the basis for solar power. The total power produced by a solar module is limited by the total amount of solar energy, in the form of photons, striking the surface of the panels. [1] The most abundant fuel source in the realm of renewable energy is the sun. Solar panels produce electricity through individual photovoltaic cells connected in series. This form of energy collection is viable in regions of the world where the sun is plentiful, and can be used in isolated regions or on houses to supplement the rising cost of electricity from a power grid. To convert the sun's energy, the cells capture photons to create freed electrons that flow across the cells to produce usable current [2]. The efficiency of the panel is determined by the semiconductor material that the cells are made from as well as the process used to construct the cells. Solar panels come in three types: amorphous, monocrystalline, and polycrystalline [3]. The more efficient of panel material is constructed from, the greater cost. To maximize results, there are many features that can be used to control the output of the photovoltaic panels. The power needs determine what components are used to produce the desired voltage and current for the project such as converters, solar trackers, and the size of the panel [2].

2. Electricity generation from solar PV

Photovoltaic (PV) energy applications can be divided into two categories: one is stand-alone system and the other is grid-connected system. Stand-alone system requires the battery bank to store the PV energy and it is suitable for low-power system [5]. Stand-alone PV systems, shown in Fig. 1, are used in remote areas with no Access to a utility grid [6].

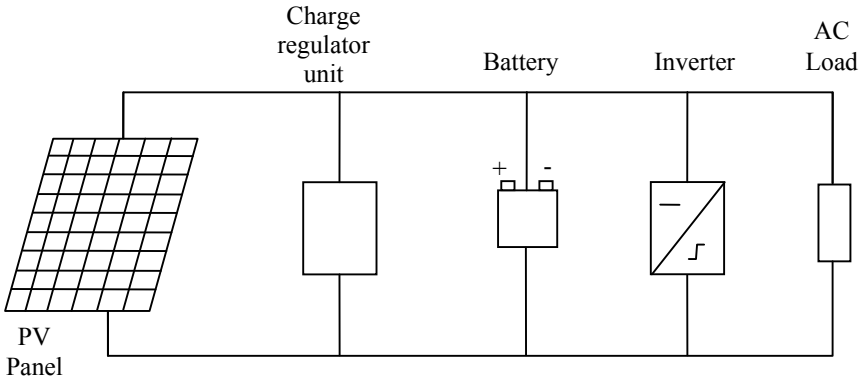

Fig. 1. Stand-Alone Photovoltaic Systems Block Diagram [6]

Grid-connected system does not require the battery bank and has become the primary PV application for high-power applications. The main purpose of the grid connected system is to transfer maximum solar array energy into grid with a unity power factor. Because of the high cost of PV modules, PV generation systems are attractive only for remote isolated areas and for small-scale applications such as PV refrigerators and water-pumping systems [4].

A PV system for the grid-connected applications is typically composed of five main components: 1) a PV array that converts solar energy to electric energy, 2) a dc-dc converter that converts low dc voltages produced by the PV arrays to a high dc voltage, 3) an inverter that converts the high dc voltage to a single- or three-phase ac voltage, 4) a digital controller that controls the converter operation with maximum power point tracking (MPPT) capability, and 5) a AC filter that absorbs voltage/current harmonics generated by the inverter [7]. Block diagram of grid-connected photovoltaic system is shown in Fig. 2.