Economic Effect of Connecting Renewable Energy to Grid Station in Nigeria

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Abstract

Solar power has the ability to play a main role in the electrification of the developing world. Autonomous energy systems based on solar photovoltaic is, for some cases, a feasible alternative to a grid connection. Solar power can also be used as a complement to a weak grid, for facilities that requires a higher reliability of power. The main objectives of this thesis were to know the economic effect of connecting solar power system to grid station, based on existing but non-operational solar panels, and to present a cost-effective autonomous energy system, with a good reliability

The performance of solar power plant is evaluated based on a developed model comprise photovoltaic array, battery storage, controller and converters. The model is implemented using MATLAB/SIMULINK software package. Perturb and observe (P&O) algorithm is used for maximizing the generated power based on maximum power point tracker (MPPT) implementation. The outcome of the developed model are validated and supported by a case study carried out using operational 28.8kW grid-connected solar power plant located in Bayelsa state, Nigeria

Measurements were taken over 21 month's period; using hourly average irradiance and cell temperature. It was found that system degradation could be clearly monitored by determining the residual (the difference) between the output power predicted by the model and the actual measured power parameters
The conclusion from the results in this paper is that already today solar power is a cost-effective energy source, for countries with much solar insolation and a weak grid. However, it is very important that the system is designed for the specific facility and that the required maintenance is communicated with the operator in order to get a reliable system that will be in operation throughout its expected lifetime.

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1. Introduction

The world constraint of fossil fuels reserves and the ever rising environmental pollution have impelled strongly during last decades the development of renewable energy sources (RES). The need of having available sustainable energy systems for replacing gradually conventional ones demands the improvement of structures of energy supply based mostly on clean and renewable resources. At present, photovoltaic (PV) generation is assuming increased importance as a RES application because of distinctive advantages such as simplicity of allocation, high dependability, absence of fuel cost, low maintenance and lack of noise and wear due to the absence of moving parts (Catelani et al, 2012).

Furthermore, the solar energy characterizes a clean, pollution free and inexhaustible energy source. In addition to these factors are the declining cost and prices of solar modules, an increasing efficiency of solar cells, manufacturing technology improvements and economies of scale (Chan F,2011).

Chow TT(2010)The increasing number of renewable energy sources and distributed generators requires new strategies for the operation and management of the electricity grid in order to maintain or even to improve the power-supply reliability and quality. In addition, liberalization of the grids leads to new management structures, in which trading of energy and power is becoming increasingly important.

The power-electronic technology plays an important role in distributed generation and in integration of renewable energy sources into the electrical grid, and it is widely used and rapidly expanding as these applications become more integrated with the grid-based Systems. During the last few years, power electronics has undergone a fast evolution, which is mainly due to two factors. The first one is the development of fast semiconductor switches that are capable of switching quickly and handling high powers. The second factor is the introduction of real-time computer controllers that can implement advanced and complex control algorithms (Collins E et al, 2009).

Photovoltaic (PV) power supplied to the utility grid is gaining more and more visibility, while the world's power demand is increasing Not many PV systems have so far been placed into the grid due to the relatively high cost, compared with more traditional energy sources such as oil, gas, coal, nuclear, hydro, and wind. Solid-state inverters have been shown to be the enabling technology for putting systems into the grid(Collins E et al, 2009).

2. Previous Research

Joe-Air Jiang, et al. (2005) designed a three-point weight comparison method to avoid rapidly moving of the operating points of PV when it is under varying atmosphere conditions which could overcome the drawback of P&O method.

Starrett and Iskender, (2005)proposed neural fuzzy network for MPPT control scheme. The neural network used to train sets of data off-line for inputs of fuzzy logic controller, while the fuzzy logic controller used to control the duty cycle effectively and hence the MPP can be tracked effectively.

Amrouche, et al. (2007) proposed artificial neural network, (ANN) based modified P&O method to predict the power value during the next perturbation cycle so that the value of perturbation step can be adjusted for next perturbation cycle.

M. G. Molina , (2008) proposed a The proposed multi-level control scheme for the three phase grid-connected photovoltaic system consisting of external, middle and internal level, is based on concepts of instantaneous power on the synchronous-rotating dq reference frame. They used“perturb and observe”, for MPP

Zhang. L, et al. (2009) built a Genetic Algorithm trained Radial Basis Function Neural Network (GA-RBFNN) model to predict the reference DC bus voltage of the control system to maximize the output power.

F.Bouchafaa et al. (2010) propose an intelligent control method for the maximum power point tracking (MPPT) of a photovoltaic system under variable temperature and insulation conditions. This method uses a fuzzy logic controller. It can be deduced that the fuzzy controller is fast controller in the transitional state and presents also a much smoother signal with less fluctuations in steady state. It was able to find the point of maximum power in a shorter time runs.

F. Huang et al. (2013) a microcontroller based automatic sun Tracker was designed and implemented. The automatic sun tracker is implemented with a dc motor and a dc motor controller.

The novelty of this unit is that the switching device of the chopper is not only used for power conversion but also for Maximum Power Point (MPP) detection. MPP is determined by simple embedded software with a current sweep approach.

Veerachary. M, et al. (2003) implemented a feed-forward MPPT scheme for coupled inductor interleaved boost converter fed PV system by using fuzzy logic controller, while ANN is trained offline to estimate the voltage reference

3. Methodology and results

Two digital multi-meters were respectively arranged in series to measure output current and in parallel to measure working voltage. The output power is then the product of measured current and voltage. Observation of solar irradiance and temperature were taken and recorded each time the load was changed. Current and voltage of the PV module where recorded after a delay of 1 minute after the resistance was changed. It was found that both simulated and measured results for the output characteristics of PV module are good agreement, as shown in figures 4.1 and figure 4.2. This proves the correctness of the proposed model.

4. Discussion of Result

One field that still requires more attention is the prediction of irradiance, which is a complicated task as compared to the prediction of wind speed. This is mainly because of the variety of factors that affect the accuracy of prediction including the wind speed and direction and type, height and thickness of clouds.

The accuracy of any of these models is usually dependant on the location where the PV system is being installed, thus, it is important to choose a suitable model for the case under consideration. One of the main activities in this area is the development of irradiance models suitable for specific locations. The fluctuations in irradiance due to passage of clouds also received a lot of attention from researchers, where most of the work done in this field relied on the frequency domain analysis.

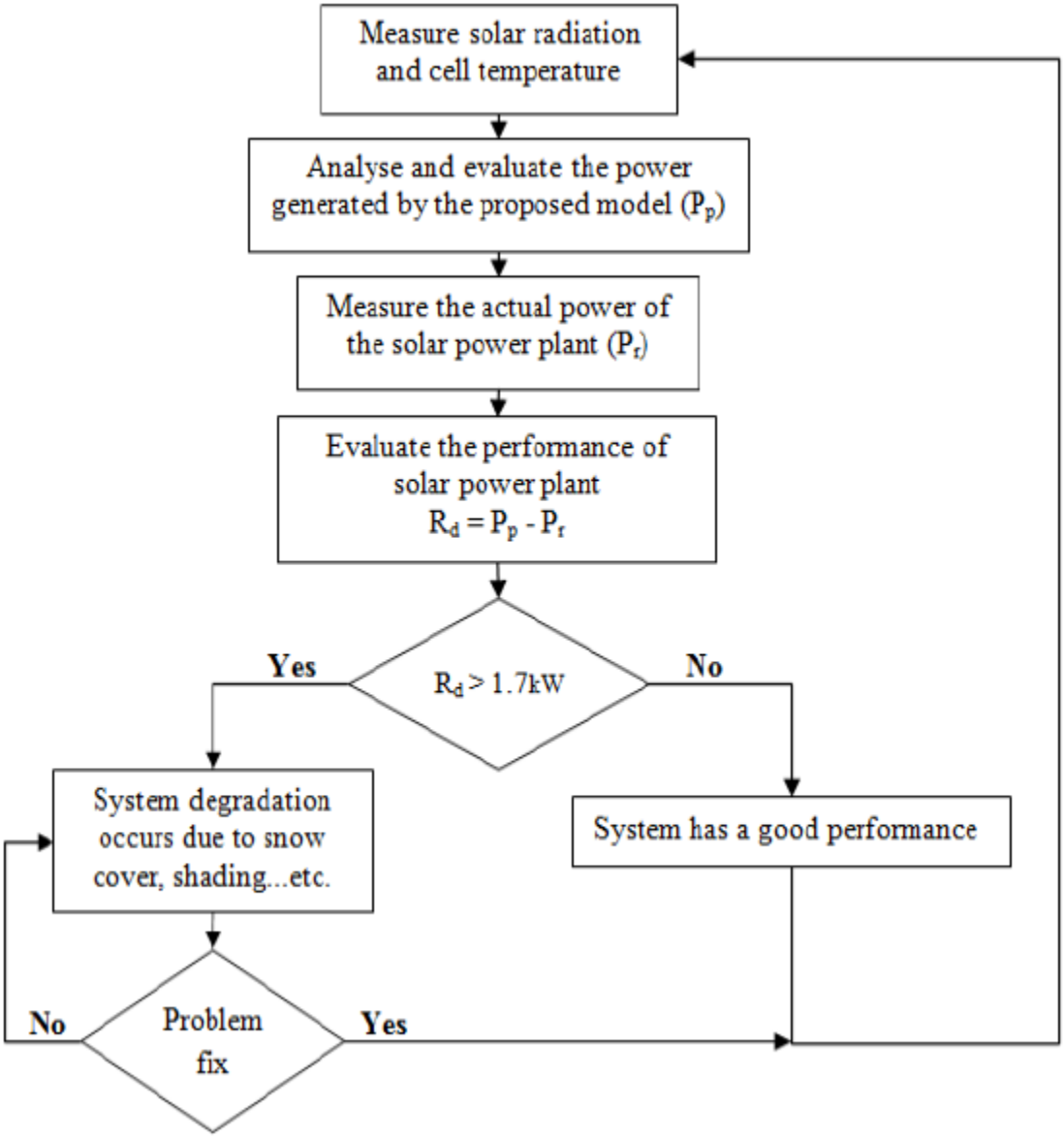

Figure 1: Flowchart for the Renewable Solar Energy

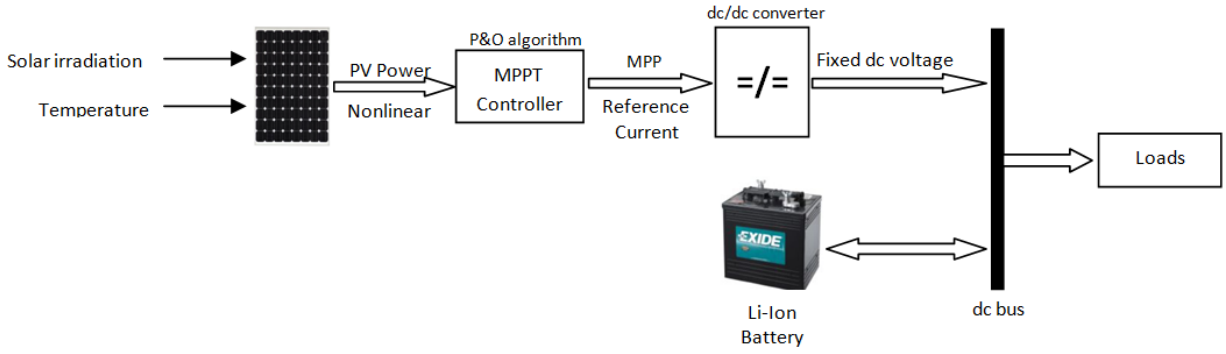

Figure 1: Block Diagram.

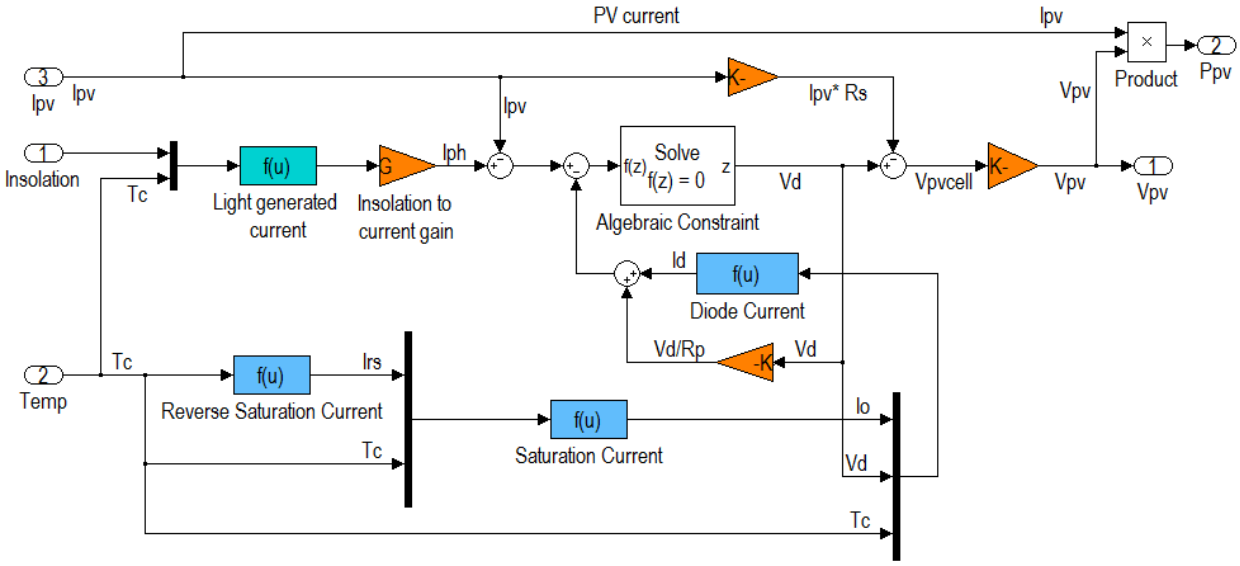

Figure 2: Simulink model of the PV system.

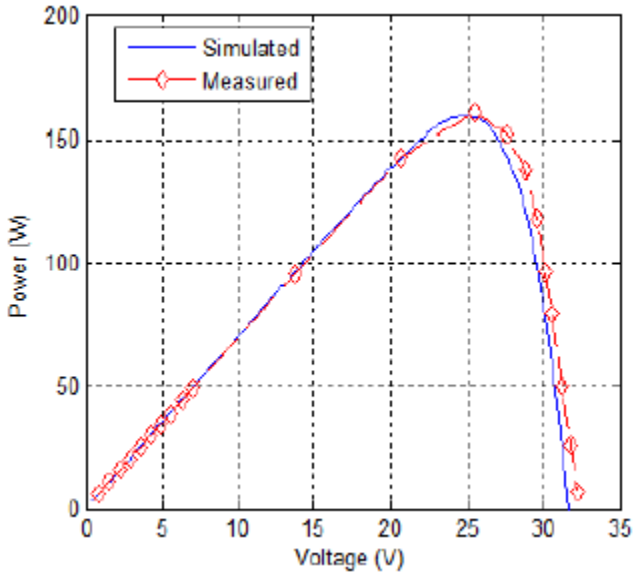

Figure 3: P-V output characteristics.

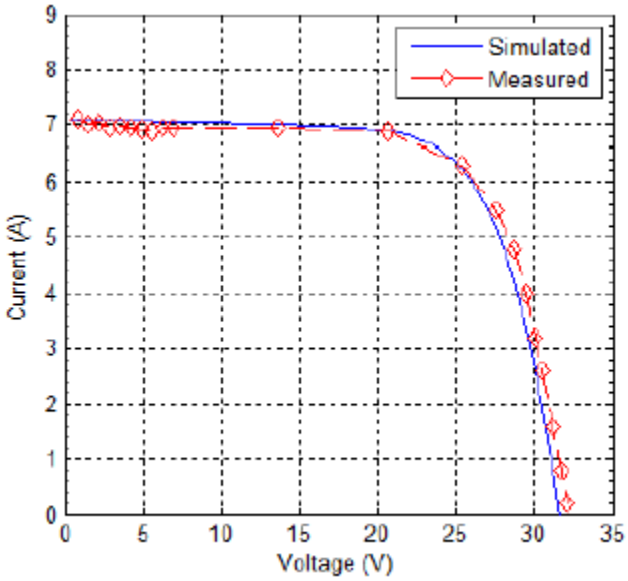

Figure 4: I-V output characteristics.

5. Conclusion

This paper presents an investigation on possible effects of high-penetrated grid-connected PV systems on power quality in distribution systems under varying solar irradiances. All information related to the modeling of PV units and solar irradiances were obtained from different solar panel producers .The results show that the active power produced by PV system causes voltage rise, voltage flicker, and power factor reduction, which may create severe problems on the system components. It can be concluded that solar power system is the most economic source of connecting renewable energy to grid station.

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