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Islanding Operation with Solar Hybrid System and Grid Tied PV System

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Abstract:- Buildings can get electricity from solar hybrid systems that combine photovoltaic and battery storage, both on and off the grid technolgy. Grid-tied photovoltaic systems are integrated to improve unintegrated operation. It is forbidden for many hybri on/off grid grid inverters to charge the battery when the system is off grid to prevent the inverters associated with grid from receiving excessive electricity. A smart meter and a solar irradiance sensor are combined in this work. The system can be analzied to with battery conncted solar hybrid system for different operating modes considering grid. Islanding between grid-tied and hybrid solar PV systems is done using MATLAB software.

Keywords*:* - VSI Islanding , Photovoltaic , Generation.

1. Introduction

The emphasis on Distributed Generation (DG) for getting profit to electric utilities and customers is still growing. A distributed generator (DG) is a small-scale electric power source that is connected to the customer side meter or the point of consumption in a distribution network (DN). Larger-scale availability of various electrical power sources makes them appropriate for on-site generation in structures. Renewable eneArgy sources include small-scale wind turbines and solar photovoltaic (PV) panels, which are especially well-suited for building integration. Larger buildings may also have combined heat and power (CHP) systems installed. Many different power sources are appropriate, which makes them acceptable for the generation in buildings. A variety of renewable energy sources, such as photovoltaic panels, are ideal for integration into buildings. Benefits of PV system integration include reduced electricity costs and enhanced power quality. PV panel and battery storage system are both parts of the solar hybrid system. When there is an electrical outage, the solar hybrid system keeps the building powered continuously. Large-scale solar hybrid systems with PV arrays include separate connections to the electrical system and a power converter. However, a small portion of a solar hybrid system with a PV array and battery storage is connected to the main grid via a solar hybrid grid converter. This inverter is utilized when the grid is on or off. Maintaining a steady power source is one of the challenges of islanding operations.

This paper focuses on islanding operation of solar hybrid system and grid tied PV system. The paper is organized as, Section I-Introduction, Section II-System Description, Section III-Test System and Result Analysis and Section IV-Conclusion.

2. Objectives

In contrast to the solar hybrid on/off grid inverter alone, this project provides a specific power curtailment controller that allows the grid-tied PV inverter to support power generation during islanding operations. The grid-tied PV inverter;s output power is regulated to avoid excessive PV feeding by the utilization of data from the solar irradiance sensor and smart meter. The purpose of this study is to show how well a purpose-built power-limiting controller performs in supplying more power from a grid-tied photovoltaic inverter, perhaps reducing the need to discharge battery power. Therefore, in the event of a loss from the main grid, this tactic might aid inkeeping the supply of electricity going.

Methods

3. 1. Grid Tied PV Inverter and Solar Hybrid On-Off Grid Inverter

A DC/DC converter on the PV panel's side catches the most solar energy as determined by the Maximum Power Point Tracking (MPPT) technique. Here Fig. 1 displays the setups of the solar hybrid on/off grid inverter and grid-tied PV inverter. A battery-side DC/DC converter is included in solar hybrid on/off grid inverters to regulate the charging and discharging of energy storage. The grid-side DC/AC inverter may convert DC electricity from PV arrays or batteries to AC power during grid-connected operation. It uses the grid interface control to synchronies with the distribution system. The grid-side inverter of a solar hybrid system can take power from the main grid to charge the battery in addition to supplying power to the network. The anti islanding protection of a conventional grid-tied PV inverter forces it to disconnect in the case of a loss of grid power. In order to provide system voltage and frequency references during islanding operation, the solar hybrid on/off grid inverter is attached and then switches from grid-following mode to grid-forming mode. Droop control techniques, which are based on decentralized control are used to regulate the active and reactive power of solar hybrid on/off grid inverters.

$$P = -\frac{(f - f_0)}{K_P}$$

and

$$Q = -\frac{(V - V_0)}{K_Q} \quad (1)$$

The above formula can be used to express the frequency-droop and voltage-droop characteristics: P and Q represent the active and reactive powers generated by the inverter, K_P and K_Q represent the droop gains, and f_0 and V_0 represent the reference frequency and voltage. The PV array will power the load first and then charge the battery when the solar hybrid on/off grid inverter is operating in the off-grid mode. The solar hybrid on/off grid inverter must be able to deliver load before the grid-tied inverter can resynchronize with the isolated system. It must, however, make sure that the additional inverter's supporting power won't result in an excessive injection into the system, which would create sudden variations in the voltage and frequency of the system.

3. 2. Power Curtialment Controller

A specific power curtailment controller is implemented to stop grid-tied PV inverters from exceeding their power during islanding operation. It is the control in real time. It necessitates merging data from the solar hybrid on/off grid inverter's PV output and load consumption. Furthermore, a high resolution power meter is used to measure the load consumption, and a pyranometer is used to measure solar irradiance, which is used to estimate the PV output of a solar hybrid on/off grid inverter. As shown in Fig. 2, the real-time data is correspondingly transmitted over the communication system to the power curtailment controller, which uses it to determine the appropriate PV output of the grid-tied inverter. The PV output prediction $P^{predict}_{PV}$, at time t can be expressed as follows:

$$P_{PV}^{predict}(t) = \eta \frac{I_{tr}(t)}{1000} P_{dc0} \quad (2)$$

Where, I_{tr} represents solar irradiation (W/m^2). The DC-to-AC derate factor is the PV array's DC rating. The PV outputs of solar hybrid systems and grid-tied PV systems can be predicted using (2) and expressed in terms of

$P^{predict}_{PV,\ hybrid}$ and $P^{predict}_{PV,\ grid\text{-}tied}$ respectively, if the size of the PV array for each system is known. Only when the load usage, or P_{LOAD}, exceeds the $P^{predicted}_{PV,\ hybrid}$, will PV power be supplied to the system once the grid-tied inverter has had time to re-synchronize with the island electricity system.

$$\Delta P(t) = P_{LOAD}(t) - P_{PV,hybrid}^{predict}(t) \tag{3}$$

$$P_{LOAD}(t) > P_{PV,hybrid}^{predict}(t), then$$

$$P_{pv,grid-tied}(t) = \begin{cases} \Delta P & if\ \Delta P < P_{PV,grid-tied}^{predict} \\ P_{PV,grid-tied}^{predict} & else \end{cases} \tag{4}$$

Otherwise

$$P_{PV,grid-tied}(t) = 0 \tag{5}$$

Since the prediction error and certain power losses, like line loss, are not included in (2) to (5), a small amount of battery power may be needed to secure the power balancing mechanism. As a result, the grid-tied inverter's PV power set-point, or PPV, grid-tied, is considered to be real operation. Using computer simulation in the DIgSILENT *Power Factory* environment, the suggested power curtailment algorithm's performance is evaluated. A grid-tied PV inverter and a solar hybrid on/off grid inverter comprise the test system, which is a building.

3. Results

The experimental building that has been examined shown in Fig. 2 and is connected to a three-phase 416V, 50Hz distribution network. This installation has a 5 kW grid-tied PV system and a kW/5 kWh solar hybrid system installed. In both systems, a gel-type battery powers the 5 kVA inverter. Fig. 3 shows, the daily load demand characteristic. Fig.4 shows the 5 kW PV system's power generation and 24-hour solar irradiance, which were determined using equation(2).

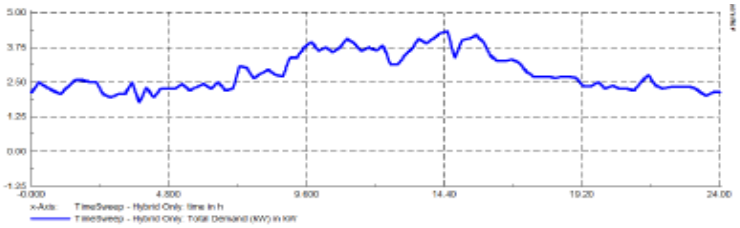
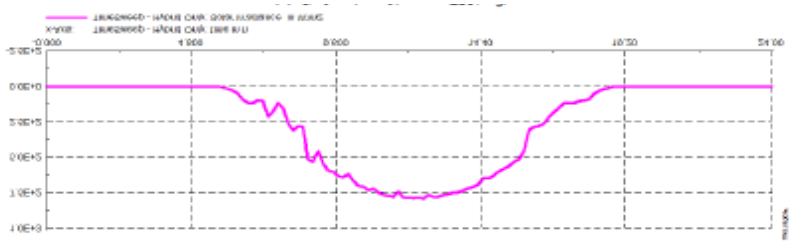
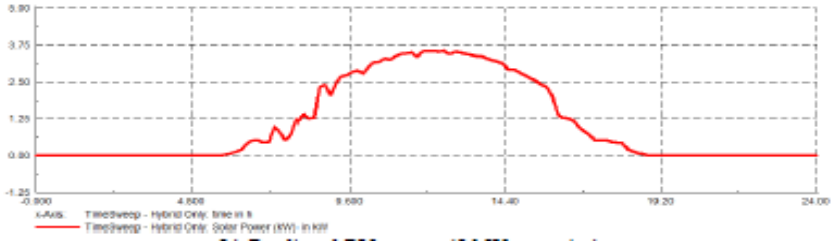


Fig. 4.1.. Daily load profile



(a) Solar irradiance (W/m2)



b) Predicted PV power (5 kW capacity).

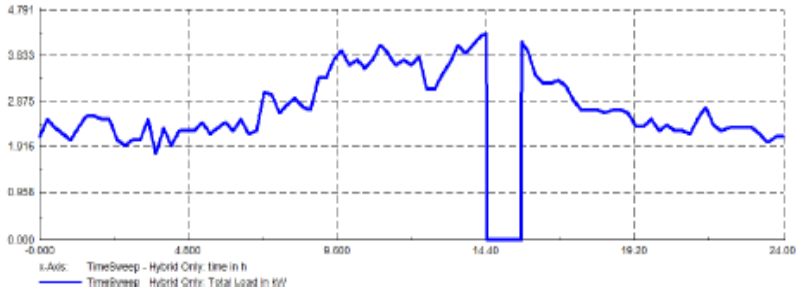
Fig. 4 .2. Daily solar irradiance and predicted power generated by 5 kW PV system.

Case 1: The Grid-Tied PV System is Not Included In Islanding Operation

In this case, during the event of a loss of grid voltage, only the solar hybrid on/off grid inverter maintains the supply of electricity. Fig. 5. Shows, the voltage at the PCC and provided load. Standalone solar hybrid on/off grid inverter have to look after power sharing and control mechanism in system. So that system will operate with stability.

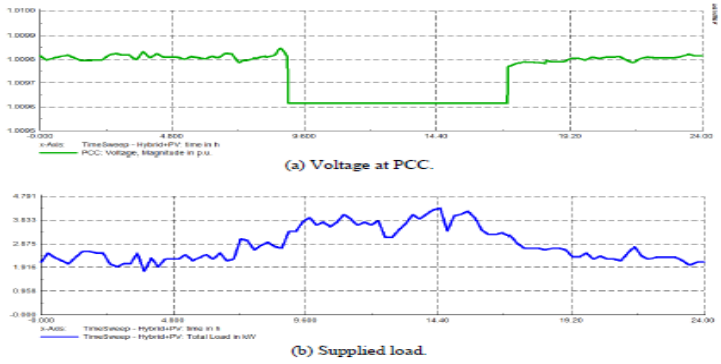
Case 2: The Grid-Tied PV System with Power Curtailment Control is Included in Islanding Operation

Fig. 6 (a) and (b) shows how the grid-tied PV system supports enhanced power limit control during islanding operation. It is discovered that improving the building's uninterrupted operation can be achieved by integrating a solar hybrid on/off grid inverter with a grid-tied PV inverter for islanding purposes. In this test, the islanding operation can sustainably supply electricity despite the limited quantity of power provided by the battery.



(b) Supplied load.

Fig.4.3 . Voltage at PCC and supplied load in Case 1.



(a) Voltage at PCC.

(b) Supplied load.

Fig. 4.4. Voltage at PCC and supplied load in Case 2

Attempting to automatically modify the power set-point in the power limiting function present in many commercial grids, the suggested power curtailment controller connected PV inverters, to maintain a balance between PV generation and load demand while the system is off the grid.

4. Discussion

Based on simulation results, the study found that the grid-tied PV inverter that collaborates with the solar hybrid to prevent exceeding PV generation during islanding operation is enabled by the smart meter and solar irradiance sensor, which is a power curtailment controller.

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