International Journal of Computational Science and Engineering Research
ISSN: 3107 -8605 (Online) , http://www.ijcser.com/
Regular Issue , Vol.1, Issue. 2 (April – June) , 2024 , Pages: 42 - 45
Received: 25 April 2024 ; *Accepted:* 03 May 2024; *Published:* 30 May 2024
https://doi.org/10.63328/IJCSER-V1RI2P8
Original Paper : Applied Research – Compare and Contrast Research Paper

Simulation Model of Isolated Solar Roof Top System for Home and LV Grid

P Siva Prasad [1]*, K Aparna [2], C Gayathri [3], A Komala [4], V Lokesh Reddy [5], P Balaji Reddy [6]

[1-6] Department of EEE, Aditya College of Engineering , Madanapalle, Andhra Pradesh, India

* *Corresponding Author : P Siva Prasad ;sivaprasadpokala328@gmail.com*

Abstract: An important advancement in the building's integrated centralized generation inside the LVDC grid is the rooftop photovoltaic system, which is mounted on contemporary timber roofing. As opposed to traditional rooftop PV modules, which often call for fixed cable connections between the PV array, the power converters, and the loads on the building, the clear advantages of the suggested PV-IWPT system eliminate the need for a complex wall wiring design and streamline the installation process through eliminating the actual physical cable connections, which are primarily made possible by the IWPT technique between the building's interior and rooftop. A series IWPT converter powered by the PV panel—s and immediately loaded by the LVDC grid makes up this effective PV-IWPT system. Finally, we analyze theoretically and verify experimentally by simulation the proposed PV-IWPT system in a 500-W under different irradiance conditions

Keywords: IWPT, LVDC Grid, Wireless, PV Panels , Inductive, MPPT.

1. Introduction

Nowadays, due to the rapid growth of the energy demand, the reliance on the renewable energy sources (RESs) increases progressively in the distribution power systems, as well as relieving severe environmental pollutions. Therefore, RESs play a significant role in complementing the high energy-density but environmental friendless non-renewable energy sources. Clean electricity can come from the distributed RESs, including photovoltaic energy, wind energy, biogas energy, etc. Among the aforementioned RESs, the improvement of PV technology distinguishes itself leading to its wide utilization due to the abundance of solar irradiation. Meanwhile, since the majority of the electronic devices exclusively operate on DC power and a number of distributed RESs produce energy in DC, the recent wide application of a low voltage DC (LVDC) grid allows the interconnection of the main power bus with the loads and the various energy sources.

The rooftop PV system is a significant development solution of the building integrated centralized generation in the LVDC grid, installed in modern timber-roofs. Compared with the conventional rooftop PV modules that usually require fixed cable connections among the PV array, the power converters and the building's loads, the obvious merits of the proposed PV-IWPT system omit the complicated wiring design of the wall and simplify the installation steps by getting rid of the physical cable connections between the rooftop and the building inside, which are mainly provided by IWPT technique

1.1. *Microgrid and Photo Voltaic System*

DG has become more popular as concerns about energy security and climate change have grown. growing public awareness of the need to reduce carbon emissions as a result of the electrical market's sufficient liberalization. A tiny transmission and distribution network that efficiently utilizes distributed energy resources is the basis of the micro grid concept.

1.2. *Types of Microgrid*

1.2.1. *AC/ DC MICRO GRID*

A new paradigm for defining the distributed generating operation is provided by this concept. The micro grid can be viewed as a regulated power system cell for utility purposes. The micro grid can be designed by the client to fulfill their unique needs, such improving local dependability, voltage sag correction, reduced feeder losses, support for local voltages, and enhanced efficiency through waste heat recovery programs. If micro generation and loads are properly and intelligently coordinated, the micro grid or distribution

ISSN: 3107 - 8605 (Online) , http://www.ijcser.com/ , Vol. 1, Issue 2, 2024, https://doi.org/10.63328/IJCSER-V1RI2P8

network subsystem will cause less interference to the utility network than conventional micro generation.

1.2.2. DC MICRO GRID

Direct DC is used in many of the emerging distributed energy resources, such as fuel cells, stationary and mobile batteries, and photovoltaic (PV) generation. Furthermore, a lot of high-efficiency loads are direct DC. Figure 2.1 depicts the DC micro grid system's layout. When a micro grid uses a DC bus instead of an AC bus, many of the power conversion stages that are necessary could be avoided, which could result in increased energy efficiency and more cost-effective operation.

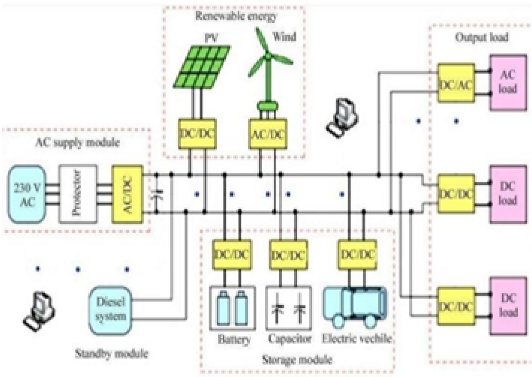

Figure. 1 DC Micro Grid Architecture

Benefits of DC Micro grid include the following

Expand the deployment of dispersed photovoltaic systems. Integrate the junction between a commercial grid and DC bus that connects PV units and accumulators to reduce energy dissipation and facility costs arising from AC/DC conversion. Even when commercial grids are blacked out, power should still be supplied to loads via conventional distribution lines (not exclusive lines for emergencies).

2. AC Micro Grid

All loads and DERs in an AC micro grid are linked to a single AC bus. Figure 3 displays the AC and DC micro grid block diagram.1 DC generating units and energy storage will be connected to the AC bus using DC-to-AC inverters; additionally, DC loads will be supplied by AC-to-DC rectifiers.

In order to mimic DC sources, PV arrays are linked to the DC bus in the project via boost converters. To mimic AC sources, a DFIG wind generation system is coupled to an AC bus. As a means of storing energy, a battery with a bidirectional DC/DC converter is attached to the DC bus. To mimic different loads, a variable DC and AC load is connected to their respective DC and AC buses. PV modules have a series connection. and parallel. As solar radiation level and ambient temperature changes the output power of the solar panel alters. A capacitor is inserted to the PV terminal to reduce high frequency variations in the output voltage of the PV. When the system operates in autonomous mode, the bidirectional DC/DC converter is intended to maintain a steady DC bus voltage by charging or draining the battery. There is a shared DC bus among the three converters (boost, main, and bidirectional). Double fed induction is the foundation of a wind power system.

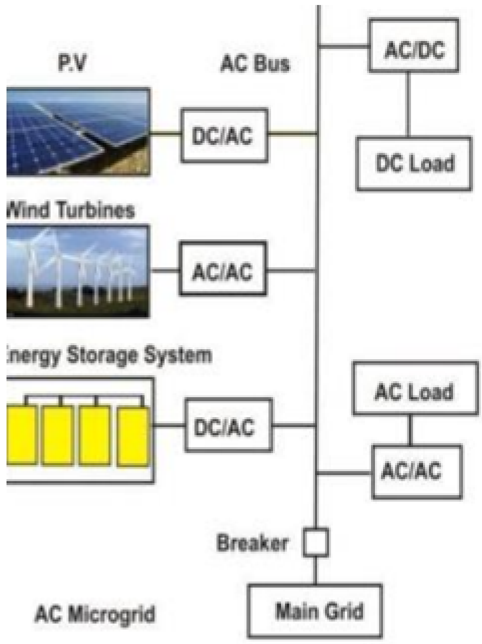

Figure.2 AC Micro Grid Architecture

2.1. Various MPPT Techniques

Extreme seeking control the P&O algorithm requires few mathematical calculations which makes the implementation of this algorithm fairly simple compared to other techniques. For this reason, P&O method is heavily used in renewable energy systems.

(a) Incremental conductance
(b) Fractional open circuit voltage
(c) Fuzzy logic based MPPT
(d) Neural networks

2.2. Low- Voltage DC Grid

A typical low-voltage DC grid is a localized distribution network designed to efficiently manage and distribute direct current (DC) electricity at relatively low voltages, typically below 1000 volts. These grids are increasingly gaining attention

At its core, a low-voltage DC grid consists of various components such as generators or renewable energy sources (e.g., solar panels, wind turbines), energy storage systems (e.g., batteries), power

ISSN: 3107 - 8605 (Online) , http://www.ijcser.com/ , Vol. 1, Issue 2, 2024, https://doi.org/10.63328/IJCSER-V1RI2P8

converters, and loads (e.g., lighting, appliances, electronic devices). Unlike traditional alternating current (AC) grids,

which require conversion from AC to DC for many modern electronic devices, low voltage DC grids eliminate the need for this conversion, resulting in reduced energy losses and increased system efficiency. Power flow within a low-voltage DC grid is typically bidirectional, allowing for energy to be both consumed from and supplied to the grid. This flexibility enables the integration of distributed energy resources (DERs) and facilitates energy exchange between different parts of the grid, promoting resilience and stability.

Moreover, low-voltage DC grids offer opportunities for smart control and monitoring systems, enabling real-time optimization of energy flows, load balancing, and fault detection. Advanced technologies such as power electronics, digital communication, and intelligent control algorithms play a crucial role in maximizing the performance and reliability of these grids.

renewable energy sources and improving overall energy efficiency. However, challenges such as standardization, interoperability, and regulatory frameworks need to be addressed to realize the full potential of low-voltage DC grids and ensure their widespread adoption in various applications

3. Implementation

Implementing the PV-IWPT system with MPPT control at the transmitter side and MEPT control at the receiver side in MATLAB involves several steps. Here's a high-level overview of how you can approach the implementation:

3.1. Modeling the PV Array and MPPT Control

Model the behavior of the PV array using MATLAB's Simulink or scripting capabilities. You can use PV array models available in MATLAB's Sim Power Systems toolbox or create custom models based on your specific requirements. Implement the MPPT control algorithm (e.g., Perturb and Observe, Incremental Conductance) using MATLAB scripts or Simulink blocks. Utilize control design tools and simulation capabilities to optimize the MPPT algorithm's performance under varying environmental conditions.

3.2. Modeling the IWPT System

Model the transmitter and receiver coils, along with the wireless power transfer link, using Simulink or MATLAB scripting. Incorporate appropriate circuit elements to represent the inductive coupling between the coils and simulate the wireless power transfer process

3.3. Modeling the MEPT Control at the Receiver Side

Develop a model for the receiver-side circuitry, including rectification, regulation, and stabilization stages, using Simulink or MATLAB scripting. Implement the MEPT control algorithm to rectify and regulate the induced AC voltage from the receiver coil, ensuring a stable DC output voltage for the load or battery system.

3.4. Integration and Simulation

Integrate the models of the PV array, MPPT control, IWPT system, and MEPT control into a comprehensive simulation setup using Simulink or MATLAB scripts. Run simulations to evaluate the performance of the PV-IWPT system under various operating conditions, including changes in sunlight intensity, temperature, load requirements, and wireless power transfer distance.

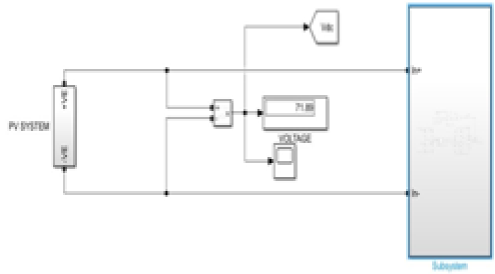

Figure. 1 Simulation Circuit

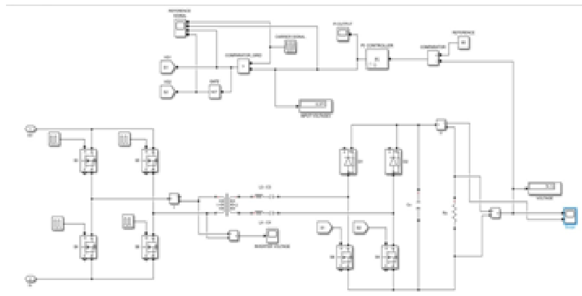

Figure. 2 Subsystem Simulation

4. Results

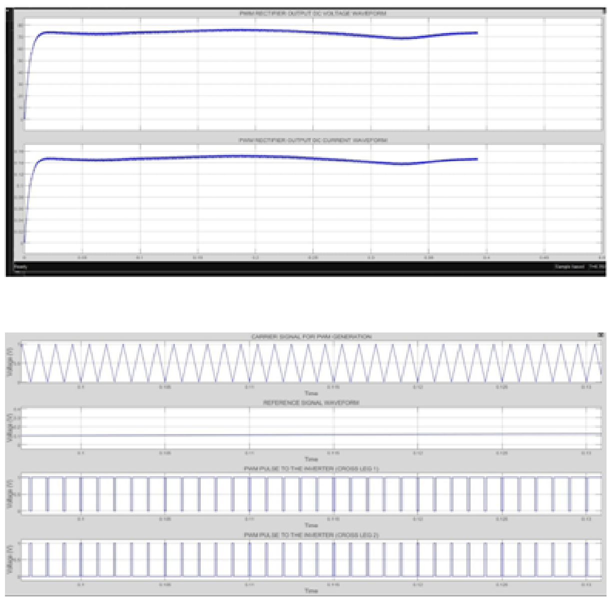

Figure.3 Rectifier Output and PWM Carrier and reference signal

ISSN: 3107 - 8605 (Online) , http://www.ijcser.com/ , Vol. 1, Issue 2, 2024, https://doi.org/10.63328/IJCSER-V1RI2P8

4.1. Applications

Off-Grid Power Supply: The PV-IWPT system is ideal for providing off-grid power supply to remote locations, off-grid communities, and rural areas where access to electricity is limited. It can power essential devices, communication systems, and lighting without relying on centralized grids.

Electric Vehicle Charging: The system can be used for wireless charging of electric vehicles (EVs) in residential, commercial, or public charging stations. It offers convenience, flexibility, and scalability in EV charging infrastructure deployment, supporting the transition to electric mobility.

Consumer Electronics Charging: The PV-IWPT system can wirelessly charge consumer electronics devices such as smartphones, tablets, wearables, and IoT sensors. It eliminates the need for physical connectors and simplifies the charging process for end-users.

Industrial Automation: In industrial applications, the system can power machinery, sensors, and robotic systems wirelessly, enhancing flexibility, safety, and efficiency in industrial automation and manufacturing processes

5. Conclusion and Future Scope

The PV-IWPT (Photovoltaic-Inductive Wireless Power Transfer) system with MPPT control at the transmitter side and MEPT control at the receiver side presents a promising solution for efficient wireless power transfer from photovoltaic arrays to loads or battery systems. By integrating PV technology with wireless power transfer, the system offers several advantages, including efficient power transfer, wireless operation, renewable energy integration, scalability, environmental benefits, reliability, and resilience. Its diverse applications span off-grid power supply, electric vehicle charging, consumer electronics charging, industrial automation, emergency response, disaster recovery, and grid-tied renewable energy systems.

Efficiency Optimization: Continued research into improving the efficiency of the PV-IWPT system through advancements in MPPT and MEPT control algorithms, coil design, and system integration techniques.

Scalability and Modularity: Development of scalable and modular PV-IWPT solutions to address a wide range of power requirements and application scenarios, including small-scale consumer electronics charging to large-scale grid-tied renewable energy systems.

Integration with Emerging Technologies: Exploration of synergies between the PV-IWPT system and emerging technologies such as Internet of Things (IoT), artificial intelligence (AI), and blockchain to enable smarter, more interconnected energy ecosystems.

References

[1]. M S. Willium, "Biological Sciences," *International Journal of Scientific Research in Computer Science and Engineering*, Vol.31, Issue 4, pp.123-141, 2012.

[2]. R. Solanki, "Principle of Data Mining," McGraw-Hill Publication, India, pp. 386-398, 1998.

[3]. M. Mohammad, "Performance Impact of Addressing Modes on Encryption Algorithms," *In the Proceedings of the 2001 IEEE International Conference on Computer Design (ICCD 2001)*, Indore, USA, pp.542-545, 2001.

[4]. S.K. Sharma, "Performance Analysis of Reactive and Proactive Routing Protocols for Mobile Ad-hoc N/W," *World Academics Journal of Engineering Sciences*, Vol.1, No 5, pp.1-4, 2013.

[5]. S.L.Mewada, "Exploration of Efficient Symmetric AES Algorithm," *Journal of Physics and Chemistry of Matierials*, Vol.4, Issue 11, pp.111-117, 2015.

[6]. A. Mardin, T. Anwar, B. Anwer, "Image Compression: Combination of Discrete Transformation and Matrix Reduction," *International Journal of Scientific Research Biological Sciences*, Vol.5, No 1, pp.1-6, 2017.

[7]. H.R. Singh, "Randomly Generated Algorithms and Dynamic Connections," *International Journal of Scientific Research in Biological Sciences*, Vol.2, Issue 1, pp.231-238, 2014.

[8]. B. Bollipo, S. Mikkili, and P. K. Bonthagorla, ''Hybrid, optimal, intelli gent and classical PV MPPT techniques: A review,'' CSEE J. Power Energy Syst., vol. 7, no. 1, pp. 9–33, Jan. 2021

Author's Profile

Authoor-1 Earned his B. Tech., degree from Aditya College of Engineering, Madanapalle affiliated to Jawaharlal Nehru Technological University Anantapur in the year 2024.His area of interest are Solar Power and Power Electronics.

Authoor-2 Earned her B. Tech., degree from Aditya College of Engineering, Madanapalle affiliated to Jawaharlal Nehru Technological University Anantapur in the year 2024.Her area of interest are Power Electronics applications in renewable systems.