Power quality measurement in solar Photovoltaic system using ANN controller

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Abstract: *In spite of the considerable expansion observed in the photovoltaic (PV) sector, the predominant source of energy in India continues to be fossil fuel-based power plants. One of the primary rationales behind this phenomenon is the non-dispatchability of photovoltaic (PV) energy, which implies that its generation is restricted to periods when sunlight is available. As a consequence, it is imperative for utilities to uphold dependable grid infrastructure to accommodate situations in which photovoltaic (PV) energy is unavailable, yet there exists a substantial demand, such as during the evening hours when solar irradiation diminishes but power consumption reaches its peak. Consequently, there is a significant underutilization of energy infrastructure, resulting in the inefficient allocation of resources, while concurrently perpetuating the detrimental environmental impact of fossil fuel power plants. The inherent non-dispatchability of photovoltaic (PV) systems imposes a constraint on the maximum capacity of PV installations that can be integrated into the electrical grid. One potential solution to address this limitation involves incorporating energy storage into photovoltaic (PV) systems or adjusting the timing of deferrable loads from periods of high power demand to periods of solar irradiance. The utilization of storage systems enables the charging of batteries during periods of solar irradiation, while facilitating their discharge during peak electricity demand intervals. Energy storage and load shifting enable the fulfillment of a greater number of local loads, reducing the need on energy imports from the grid and the need to export surplus photovoltaic (PV) production to the grid. The aforementioned procedure is commonly referred to as self-consumption. I apologize, but your text seems to be incomplete. Could you please provide more*

information or This study examines and contrasts the levels of self-consumption in a photovoltaic self-consumption system, specifically investigating the impact of battery-based energy storage on self-consumption. Additionally, it does a comparison between four distinct load shifting load profiles and a baseline load profile that does not involve load shifting.

Keywords: Solar, Pv, Grid, Autoselection.

1. INTRODUCTION

The market competition among energy producing and distribution corporations has led to a growing inclination towards renewable and alternative energy sources. Furthermore, in conjunction with this competitive environment, corporations are actively pursuing client expectations for power of superior quality and enhanced environmental sustainability. Moreover, given the decline of global coal reserves and the implementation of legislative measures promoting environmentally sustainable energy alternatives, there is a growing imperative to explore novel methods of energy generation. One approach that is now garnering attention in the field is Micro-Grid systems [1]-[2]. A Micro-Grid refers to a distribution network working at low voltage or medium voltage levels. It is comprised of a collection of micro sources or generators that are dispersed and energy storage equipment, and loads, all functioning as a unified and controllable system. In a microgrid (MG), it is imperative that the distributed generators has adequate capacity to accommodate the entirety, or a significant portion, of the load that is interconnected inside the microgrid. Distributed generators are strategically positioned at certain locations, typically at the distribution level in close proximity to load centers. They are utilized to provide capacity support, voltage support and regulation, as well as to reduce line losses [2]. Micro-sources or distributed generators typically comprise many advanced technologies, such as fuel cells, photovoltaic systems, and multiple types of wind turbines. The units with limited capacity are connected to power electronics and installed at the locations of consumers. Power electronics plays a crucial role in enabling the necessary control and adaptability inside the microgrid system. The integration of energy storage systems, such as batteries, flywheels, and supercapacitors, inside a microgrid configuration facilitates the storage of surplus power generated. Alternatively, this excess power can be fed back into the primary grid [3]-[4]. The implementation of micro-grids is anticipated to be an inevitable development in the future, owing to its evident benefits such as the reduction in central generation capacity, increased usage of transmission and distribution capacity, improved system security, and decreased emission of CO_2. Nevertheless, the integration of micro-grids into a conventional distribution system introduces certain intricacies in terms of control and protection.

Figure 1.1 illustrates the exponential growth of global Solar-PV installation capacity over the last twenty years, reaching a total of 237.3 GW in 2015. This signifies an increase of over three times its worldwide capacity in the year 2011[2]. The global popularity of Solar-PV systems has been attributed to various factors, including the widespread availability of solar irradiance in numerous places, the absence of moving parts in the generation system, the decreasing cost of PV panels, and the relatively cheap operation and costs related to the upkeep of these systems. Solar photovoltaic (Solar-PV) devices exhibit intermittent power generation characteristics as a result of unpredictable fluctuations in solar irradiation and temperature. From a strategic standpoint, the implementation of a Battery Energy Storage System (BESS) can effectively fulfill a significant function inside a microgrid by mitigating any discrepancies that may arise between the intermittent generation of Solar-PV and the corresponding power consumption. BESS is capable of offering ancillary services, including voltage and frequency regulation, reactive power assistance, load leveling, peak shaving, and power quality enhancement [3].

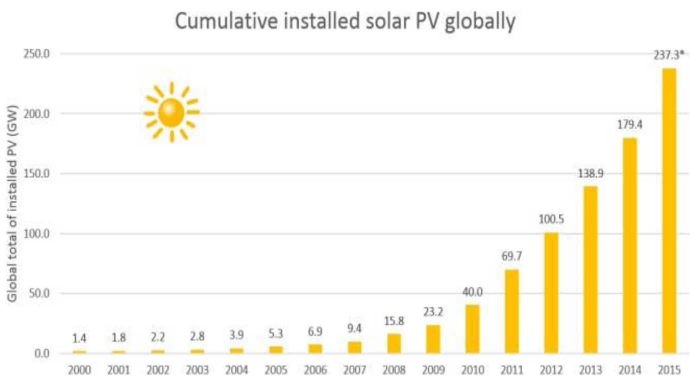


Figure 1. 1: Total installed Solar-PV around the world for the past 15 years [2].

2. LITERATURE REVIEW

G. Suresh (2018) proposed on this paper, in this study, we propose a management approach for efficient energy flow control in a lattice-connected photovoltaic (PV) battery system. The proposed method incorporates a multi-input transformer linked bidirectional DC-DC converter. The suggested device aims to meet the demand for energy storage, manage the power flow from several sources, inject excess power into the grid, and charge the battery from the grid as needed.

Ramendra Kumar et al. (2018) the implementation of a suggested hybrid power system has the potential to effectively reduce the requirements for energy storage. There is a growing interest in utilizing exchange or property power resources to efficiently and conveniently generate energy for residential applications. The PV hybrid system offers the most cost-effective solution to maintain a consistent level of Distributed Power System Performance (DPSP) when compared to standalone solar and other systems. The levelized cost of energy for PV hybrid systems with heap demands consistently remains lower than that of standalone solar PV systems.

J. Mano Priya and T. Narasimha Prasad (2018) a hybrid system incorporating a photovoltaic (PV) array, turbine, and battery storage is suggested in this study. The focus is on developing a control method for managing power flow in the hybrid system. To do this, an efficient transformer-coupled bidirectional dc-dc converter is employed. The purpose of this transformer is to establish a connection between the non-conventional electricity assets and the primary direct current (DC) bus of the device.

Rohan R. Pote and Dipti D. Patil (2017) The author proposes employing the traditional method of integrating several renewable resources and power input converters for each individual source. Nevertheless, this approach requires a greater number of converter stages, resulting in a substantial reduction in the reliability and efficiency of the system. One potential approach to tackle this problem is to introduce an energy flow management system that utilises a battery-powered grid-connected single-phase power producing DC converter..

M. Bijomerlin et al. (2017) this research presents an analysis of the effective utilization of hybrid power systems in three-phase home packages. The hybrid machine under consideration effectively regulates the flow of energy from both solar and battery sources, with the battery being charged from the grid as needed. The proposed converter incorporates a half-bridge converter to efficiently capture power from both solar panels and batteries. This is achieved through the utilization of a bidirectional greenback-improve converter for power transfer and a diode rectifier for energy extraction.

Amit Kumar Gupta et al. [54], the present study proposes a set of rules for a simplified Space Vector Pulse Width Modulation (SVPWM) technique, specifically designed for the operation of a multilayer inverter within the over modulation range. The suggested technique efficiently identifies the proximity of the reference vector and computes on-instances.

3. PROPOSED METHODOLOGY:

3.1 Grid-Connected Mode Control Strategy:

In the grid-connected mode of operation, the microgrid's voltage and frequency are determined by the utility grid. The grid serves to compensate for any power deficiency and accommodate any excess power inside the microgrid system. The control method being suggested aims to effectively manage the solar-PV units by ensuring the exchange of actual and reactive power with the microgrid. This is achieved by the utilization of the current controller within their VSC systems, while simultaneously tracking their maximum power points (MPPs). The control strategy is responsible for managing the Battery Energy Storage System (BESS) in order to meet its State of Charge (SOC) requirements, while simultaneously regulating the active and reactive power using the current controller of its Voltage Source Converter (VSC) system. The control strategy employed in the grid-connected mode has two main objectives. i) Optimising the power output of the three Solar-PV units by utilising their Maximum Power Point Tracking (MPPT) settings. ii) The goal is to control the state of charge (SOC) of the battery to a particular level that can maintain the voltage and frequency of the microgrid while it is functioning independently. The described control approach attempts to keep the Battery Energy Storage System (BESS) linked to the grid even while it is not actively being used.. This means that the BESS is neither charging nor discharging. By doing so, the number of charging/discharging cycles is reduced, leading to an extended battery life [33]

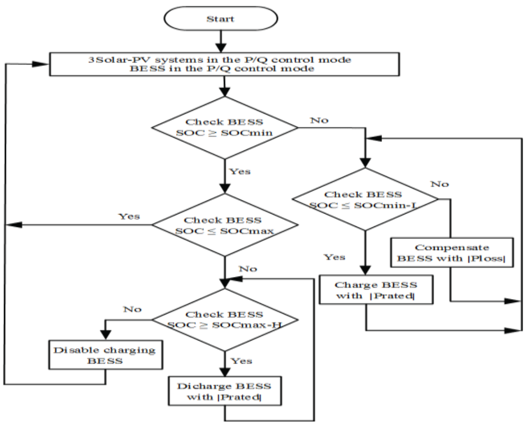


Figure 2: The proposed control strategy for the microgrid system in the grid-connected mode.

3.2 Solar-PV Unit Control

The LC of each Solar-PV unit, as depicted in Figure 3, encompasses a Maximum Power Point Tracking (MPPT) control, a DC Voltage controller, and the VSC system control. The Maximum Power Point Tracking (MPPT) system is responsible for supplying the reference direct current (DC) voltage to the DC voltage controller. The DC voltage controller is responsible for generating the reference real power (Ps_ref) that is used for controlling the VSC system. The existing controller of the Voltage Source Converter (VSC) system is responsible for regulating the VSC output power in order to align with the AC power reference derived from the DC voltage controller. This is achieved by supplying the modulation indexes required for the Sinusoidal Pulse Width Modulation (SPWM) scheme of the VSC. This thesis operates on the assumption that the Solar-PV units do not provide any reactive power support. Specifically, the reference reactive power (Qs_ref) of the Solar-PV units is set to zero by the SC.

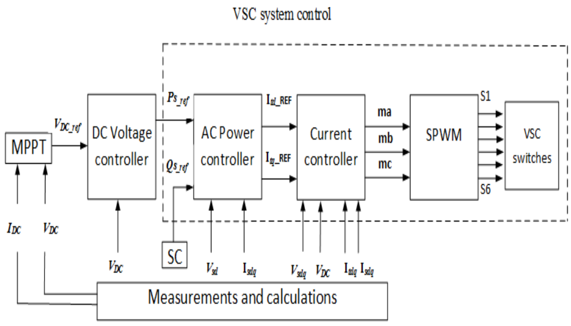


Figure 3: Schematic diagram of the control system of each Solar-PV unit.

3.3 BESS Control

Figure 4 illustrates the control framework of the Battery Energy Storage System (BESS). The LC consists of a system-on-a-chip (SOC) that incorporates logic for enforcing limitations, as well as a system control for managing the virtual storage controller (VSC). The SOC (State of Charge) constraints logic is responsible for determining the reference real power in the VSC (Voltage Source Converter) system, whereas the SC (State of Charge) determines the reference reactive power. This thesis assumes that the Battery Energy Storage System (BESS) does not provide any reactive power assistance in the grid connected mode. As a result, the System Controller (SC) sets the reference reactive power (Qs_ref) of the BESS to zero.

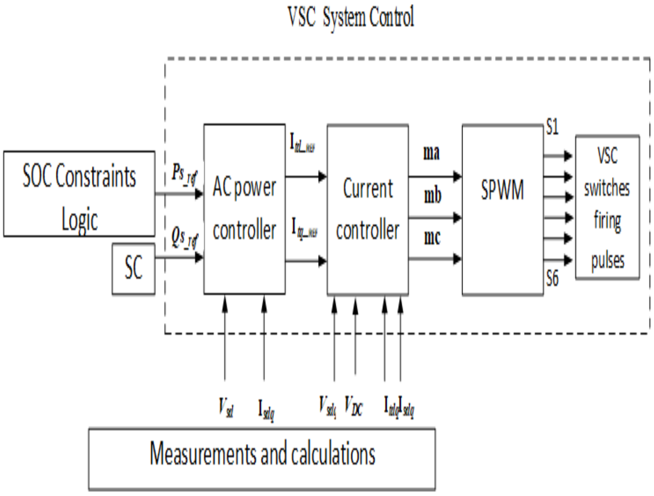


Figure 4: Schematic diagram of the control system of the BESS.

3.4 Variable Solar Irradiance

In Figure 5 (a), the real power exchange between the three Solar-PV units and the Battery Energy Storage System (BESS) with the utility grid is depicted. The output power curves of the three Solar-PV units exhibit overlap due to their operation under comparable conditions. The simulation commences with each Solar-PV unit contributing 0.4 per unit (pu) of power to the microgrid, while the utility grid provides 0.51 pu to the microgrid. Additionally, the initial state of charge (SOC) of the battery is 0.73, falling within the predetermined range of 70% to 75%. Therefore, the output power of the Battery Energy Storage System (BESS) is observed to be zero in this particular scenario, but the State of Charge (SOC) remains constant, as depicted in Figure 5 (b).

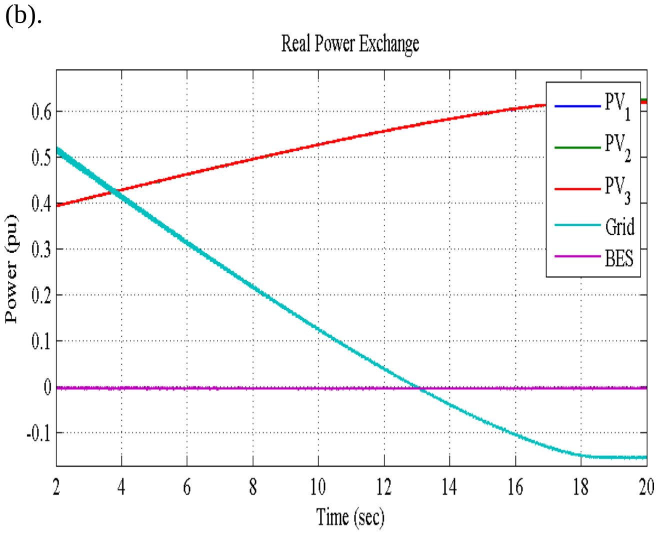
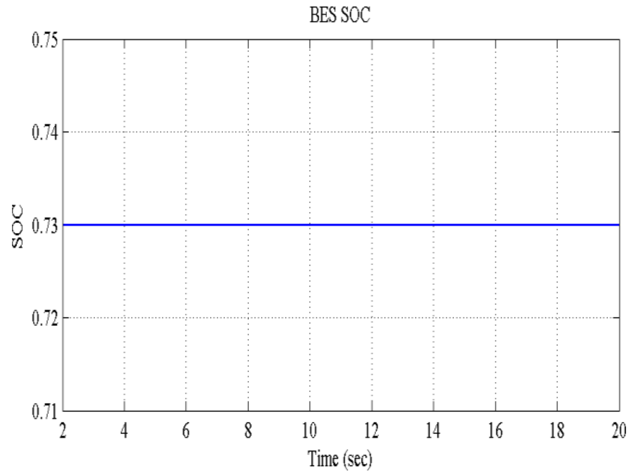


Figure 5 (a)Real power exchange between the three Solar-PV systems, the utility grid, and the BESS whenthe battery is idle (pu)

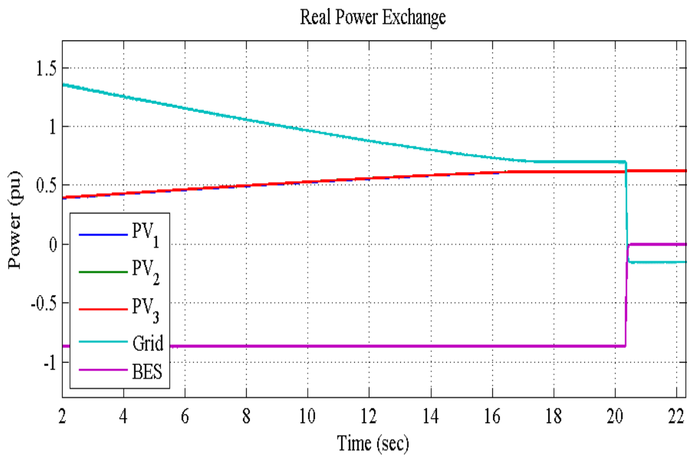
Figure 5 (b) Battery SOC is within the pre-specified range (0.73)



3.5 BESS Charging Mode

Figure 6 (a) shows the active power exchange of the three Solar-PV units and the BESS with the utility grid. In this case, the simulation starts when each Solar-PV unit supplies 0.4 pu to the microgrid system, the grid supplies 1.35 pu, and the BESS initial SOC is 0.6817 which is lower than the specified SOCmin-L(0.69). Consequently, the battery starts charging at the rated power as shown inFig. 4.12 (a) until SOC meets the lower limit at *t* = 20.4 sec and becomes constant again as shown in Figure 6 (b)

Figure 5 (a)Real power of the three Solar-PV systems, the utility grid, and the BESS when the battery isunder the charging mode (pu)



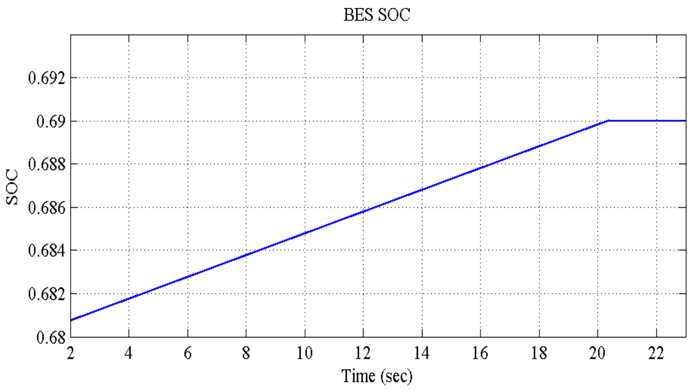


Figure 5 (b) Battery is charging under the SOC control scheme till it reaches the pre-specified range,

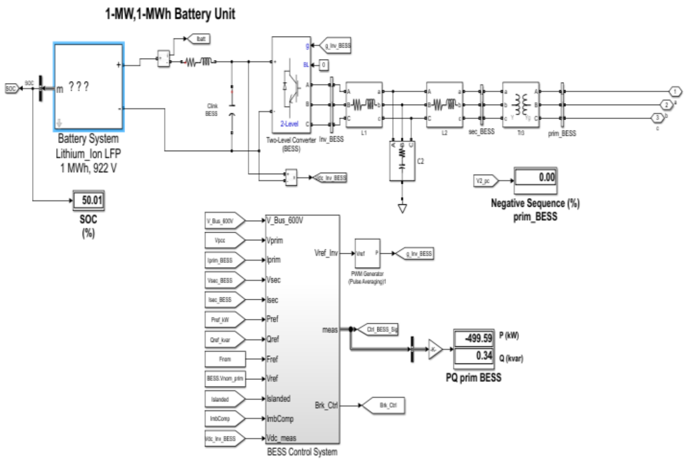


Figure 8 Battery back Unit

4. RESULT

Figure 7 Show the microgrid model of the system with 1mw solar plant , BESS controller and power grid. All the output can be seen in Scope of the system.

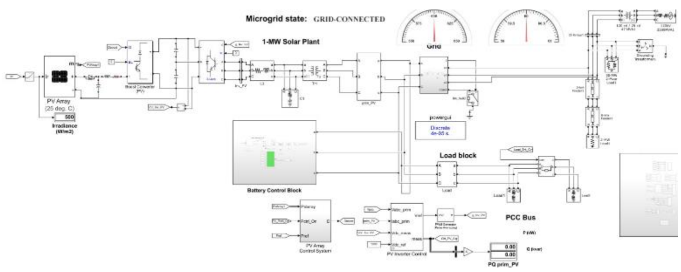


Figure 7: Simulink model of microgrid

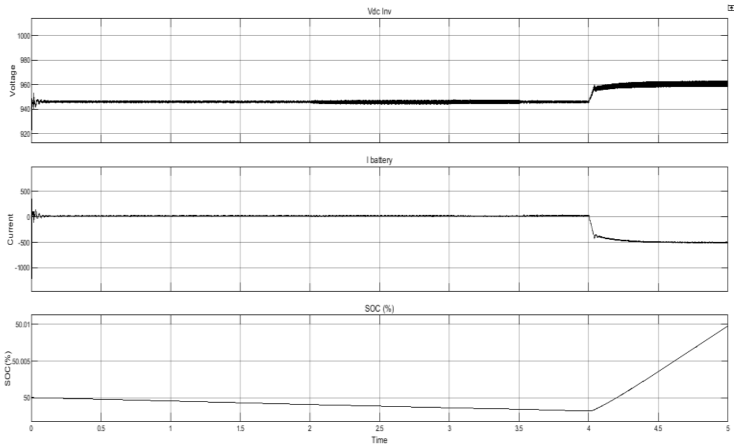


Figure 9 Voltage, current and SOC of the battery.

The voltage between the terminals of the battery is chosen as it has been represented as a controlled voltage source. Therefore, the value of EDC_B is established at 800 V, in accordance with the power range within which the converter is functioning. The VSC converter of the battery system is characterized by the inductance equivalent resistance values of $rl = 0.5\ \Omega$ and the inductance values of $ll = 5.4\ mH$. The determination of active power reference values is contingent upon the specific role of the battery and will be delineated for each simulation scenario.

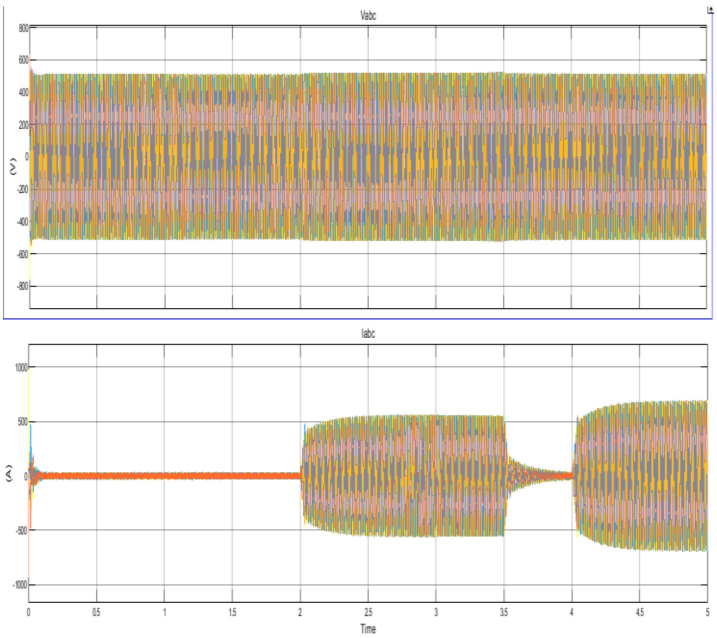


Figure 10 Voltage, current Of BESS inverter Output

Figure 11 Shows over all working of the system along with load Current remain constant . to maintain this system, compensate the error by taking current in account using from available source of the system.

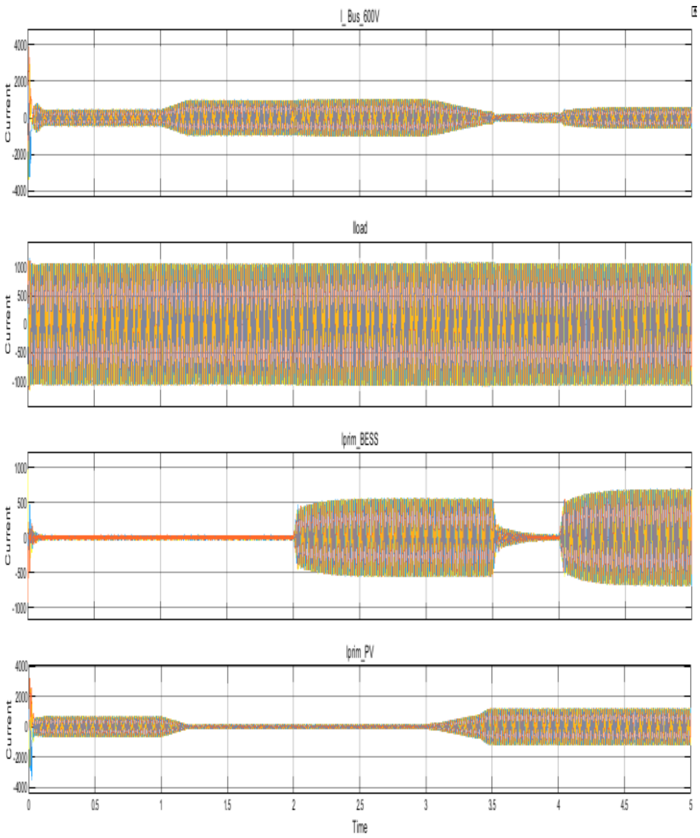


Figure 11 Current Variation of system Solar, grid, BESS to maintain load current.

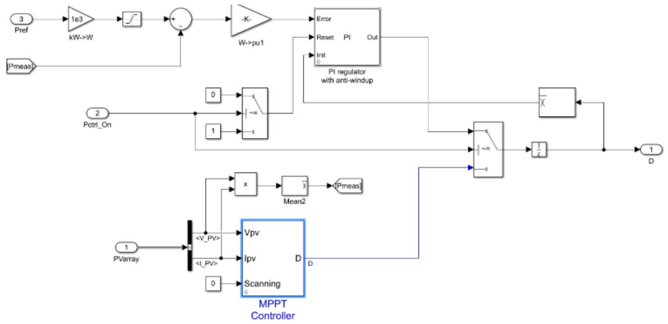


Figure 12 Adopted Pi controller

5. conclusion

This research study introduces a control strategy for a microgrid system that integrates several Solar-PV units and Battery Energy Storage Systems (BESS) while disconnected from the utility grid. The control technique enables the shift from the grid-connected operational mode to the islanded operational mode. The Battery Energy Storage System (BESS) is tasked with the duty of controlling the voltage and frequency in the isolated microgrid. Furthermore, it enables the microgrid to be reconnected to the utility grid..

REFERENCE

[1] N. Hatziargyriou, H. Asano, R. Iravani and C. Marnay, "Microgrids," in *IEEE Power and Energy Magazine*, vol. 5, no. 4, pp. 78-94, July-Aug. 2007.

[2] Global Market Outlook for Photovoltaics 2014-2018 (EPIA, 2014)& Global Market Outlook for Solar Power 2015-2019 (SSE, 2014).

[3] David Wenzhong Gao, " Energy Storage for Sustainable Microgrid," Chapter 2, *Elsevier Ltd*, 2015.

[4] N. D. Hatziargyriou and A. P. Sakis Meliopoulos, "Distributed energy sources: technical challenges," 2002 IEEE Power Engineering Society Winter Meeting. Conference Proceedings (Cat. No.02CH37309), 2002, pp. 1017-1022 vol.2.

[5] D. Olivares, A. Mehrizi-Sani, A. Etemadi, C. Canizares, R. Iravani, M. Kazerani, A. Hajimiragha,

O. Gomis-Bellmunt, M. Saeedifard, R. Palma-Behnke, G. Jimenez-Estevez, and N. Hatziargyriou, "Trends in Microgrid control," IEEE Trans. Smart Grid, vol. 5, no. 4, pp. 1905– 1919, Jul. 2014.

[6] F. Katiraei and J. R. Aguero, "Solar PV Integration Challenges," in IEEE Power and Energy Magazine, vol. 9, no. 3, pp. 62-71, May-June 2011.

[7] J. A. P. Lopes, C. L. Moreira and A. G. Madureira, "Defining control strategies for Microgrids islanded operation," in IEEE Transactions on Power Systems, vol. 21, no. 2, pp. 916-924, May 2006.

[8] X. Chen, Y. Hou, S. C. Tan, C. K. Lee and S. Y. R. Hui, "Mitigating Voltage and Frequency Fluctuation in Microgrids Using Electric Springs," in IEEE Transactions on Smart Grid, vol. 6, no. 2,pp. 508-515, March 2015.

[9] L. Xu, Z. Miao and L. Fan, "Control of a Battery system to improve operation of a microgrid," *2012 IEEE Power and Energy Society General Meeting*, San Diego, CA, 2012, pp. 1-8.

[10] I. Serban and C. Marinescu, "Control Strategy of Three-Phase Battery Energy Storage Systems for Frequency Support in Microgrids and with Uninterrupted Supply of Local Loads," in IEEE Transactions on Power Electronics, vol. 29, no. 9, pp. 5010-5020, Sept. 2014.

[11] Marc Beaudin, Hamidreza Zareipour, Anthony Schellenberglabe, William Rosehart, "Energy storage for mitigating the variability of renewable electricity sources: An updated review", *Energyfor Sustainable Development*, Volume 14, Issue 4, December 2010.

[12] S. Teleke, M. E. Baran, S. Bhattacharya and A. Q. Huang, "Rule-Based Control of Battery Energy Storage for Dispatching Intermittent Renewable Sources," in IEEE Transactions on Sustainable Energy, vol. 1, no. 3, pp. 117-124, Oct. 2010.

[13] Z. Miao, L. Xu, V. R. Disfani and L. Fan, "An SOC-Based Battery Management System for Microgrids," in IEEE Transactions on Smart Grid, vol. 5, no. 2, pp. 966-973, March 2014. doi: 10.1109/TSG.2013.2279638.

[14] Abigail Susan Hayhoe, "Impact of Irradiance Change on MPPT and Flicker Phenomenon of Solar-PV Systems," *Master's thesis, University of Toronto*, 2016.

[15] Frank Hohlbaum, Markus Braendle, and Fernando Alvarez, "Cyber Security Practical considerations for implementing IEC 62351," ABB Switzerland, frank.hohlbaum@ch.abb.com

[16] IEEE Guide for Planning DC Links Terminating at AC Locations Having Low Short-Circuit Capacities, IEEE Std 1204-1997.

[17] R. A. Kordkheili, B. Bak-Jensen, J. R-Pillai and P. Mahat, "Determining maximum photovoltaic penetration in a distribution grid considering grid operation limits," 2014 IEEE PES General Meeting
| Conference & Exposition, National Harbor, MD, 2014, pp. 1-5.

[18] IEC 60904-3:2016 RLV Redline Version Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data

[19] https://hvdc.ca/uploads/ck/files/reference_material/PSCAD_User_Guide_v4_3_1.pdf.

[20] A. Yazdani et al., "Modeling Guidelines and a Benchmark for Power System Simulation Studiesof Three-Phase Single-Stage Photovoltaic Systems," in IEEE Transactions on Power Delivery, vol. 26, no. 2, pp. 1247-1264, April 2011.

[21] Digambar M. Tagare, "Photovoltaic Energy Solar Cells and Solar Power Systems," in Electricity Power Generation: The Changing Dimensions ,1, Wiley-IEEE Press, 2011, pp.195-216 doi: 10.1002/9780470872659.ch10

[22] M. G. Villalva, J. R. Gazoli, and E. R. Filho, "Comprehensive Approach to Modeling and Simulation of Photovoltaic Arrays," in IEEE Transactions on Power Electronics, vol. 24, no. 5, pp. 1198-1208, May 2009.

[23] E. Muljadi, M. Singh, and V. Gevorgian, " PSCAD Modules Representing PV Generator, "

National Renewable Energy Laboratory, Technical Report August 2013.

[24] Ned Mohan, Tore M. Undeland, and William P. Robbins, " Power Electronics Converters, Applications, and Design," Wiley, 2003.

[25] Magdi S. Mahmoud, Fouad, M. Al-Sunni," Control and Optimization of Distributed Generation Systems, " Springer: London, UK, 2015.

[26] Kelly and Yadusky, IEEE Transactions on Power Electronics, Vol 7, No 2, April 1992, p332 in op. cit.

[27] A. Joseph and M. Shahidehpour, "Battery storage systems in electric power systems," *2006 IEEE Power Engineering Society General Meeting*, Montreal, Que., 2006, pp.8pp.-.doi: 10.1109/PES.2006.1709235

[28] Advanced Energy Center, MaRS Cleantech, Navigant Research "Future of microgrid series overview, " Ontario, Canada, 2016.

[29] http://www.renewableenergyfocus.com/view/44393/li-ion-energy-storage-takes-microgrids-to- the-next-level.

[30] X. Wang, M. Yue and E. Muljadi, "Modeling and control system design for an integrated solar generation and energy storage system with a ride-through capability," 2012 IEEE Energy ConversionCongress and Exposition (ECCE), Raleigh, NC, 2012, pp. 3727-3734.

[31] Haiying Wang, Yang Liu, Hang Fu, and Gechen Li, "Estimation of State of Charge of Batteries for Electric Vehicles," *International Journal of Control and*

Automation Vol. 6, No. 2, April, 2013

[32] X. Li, D. Hui and X. Lai, "Battery Energy Storage Station (BESS)-Based Smoothing Control of Photovoltaic (PV) and Wind Power Generation Fluctuations," in *IEEE Transactions on Sustainable Energy*, vol. 4, no. 2, pp. 464-473, April 2013.

[33] J. Groot, “State-of-health estimation of li-ion batteries: Cycle life test methods,” Chalmers Univ.Technol. Göteborg, 2012.

[34] Henryk Markiewicz and Antoni Klajn Wroclaw, "Voltage Disturbances Standard EN 50160 - Voltage Characteristics in Public Distribution Systems, " University of Technology, July 2004.

[35] R. Teodorescu, M. Liserre, and P. Rodriguez, "Grid Converters for Photovoltaic and Wind Power Systems," Jon Wiley and Sons, 2008.

[36] C. Jaen, C. Moyano, X. Santacruz, J. Pou and A. Arias, "Overview of maximum power point tracking control techniques used in photovoltaic systems," 2008 15th IEEE International Conference on Electronics, Circuits and Systems, St. Julien's, 2008, pp. 1099-1102.

[37] X. Li, H. Wen, L. Jiang, W. Xiao, Y. Du and C. Zhao, "An Improved MPPT Method for PV System with Fast-Converging Speed and Zero Oscillation," in IEEE Transactions on Industry Applications, vol. 52, no. 6, pp. 5051-5064, Nov.-Dec. 2016.

[38] D. P. Hohm and M. E. Ropp, "Comparative study of maximum power point tracking algorithms using an experimental, programmable, maximum power point tracking test bed," *Photovoltaic Specialists Conference, 2000. Conference Record of the Twenty-Eighth IEEE*, Anchorage, AK, 2000, pp. 1699-1702.

[39] Kasun Samarasekera,"Fault Ride-Through Capability of Grid Integrated Solar Power Plants,"

Master’s thesis, University of Toronto, 2015.

[40] E. Muljadi, M. Singh, and V. Gevorgian, “User Guide for PV Dynamic Model Simulation

written on PSCAD Platform, " National Renewable Energy Laboratory, Technical Report, November2014.

[41] Amirnaser Yazdani and Reza Iravani. Voltage-sourced converters in power systems: modeling, control, and applications, Chapter 8. Section 8.4.1. John Wiley & Sons, 2010.

[42] Se-Kyo Chung, "A phase tracking system for three phase utility interface inverters," in IEEE Transactions on Power Electronics, vol. 15, no. 3, pp. 431-438, May 2000.

[43] Junbiao Han, J. Prigmore, Zhenyuan Wang and S. Khushalani-Solanki, "Modeling and coordinated controller design of a Microgrid system in RTDS," 2013 IEEE Power & Energy Society General Meeting, Vancouver, BC, 2013, pp. 1-5.

[44] F. Katiraei, R. Iravani, N. Hatziargyriou and A. Dimeas, "Microgrids management," in IEEE Power and Energy Magazine, vol. 6, no. 3, pp. 54-65, May-June 2008.

[45] L. Fusheng, L. Ruisheng, and Z. Fengquan, "Microgrid Technology and Engineering Application, " Chapter 7, Academic Press 2016.

[46] A. D. Paquette and D. M. Divan, "Providing Improved Power Quality in Microgrids: Difficulties in Competing with Existing Power-Quality Solutions," in IEEE Industry Applications Magazine, vol. 20, no. 5, pp. 34-43, Sept.-Oct. 2014.

[47] L. Fusheng, L. Ruisheng, and Z. Fengquan, "Microgrid Technology and Engineering Application, " Chapter 4, Academic Press 2016.

[48] S. Adhikari and F. Li, "Coordinated V-f and P-Q Control of Solar Photovoltaic Generators with MPPT and Battery Storage in Microgrids," in IEEE Transactions on Smart Grid, vol. 5, no. 3, pp. 1270-1281, May 2014.

[49] NERC Integration of Variable Generation Task Force (IVFTF1-7) Report, "Performance of Distributed Energy Resources During and After System Disturbance Voltage and Frequency Ride-Through Requirements ", December 2013

[50] IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems, in IEEE Std 1547-2003, vol., no., pp.1-28, July 28 2003.

[51] A. H. Etemadi, E. J. Davison and R. Iravani, "A Generalized Decentralized Robust Control of Islanded Microgrids," in *IEEE Transactions on Power Systems*, vol. 29, no. 6, pp. 3102-3113, Nov. 2014.