PV- Battery Based AC/DC Hybrid Multiport Power Routing System

[1] DR.A.SENDIL KUMAR | [2] M.KALAIMANI | [3] P.NANDHAN | [4] N.SABAPATHY
*[1] ASSISTANT PROFESSOR | [2,3,4] UG SCHOLAR *
Department of Electrical And Electronics Engineering, RAAK College Of Engineering And Technology, Puducherry, India.

ABSTRACT:

The utilization of renewable energy sources has significantly increased as a result of growing environmental concerns and the depletion of traditional energy sources. One clean and sustainable energy source that has gained popularity among them is photovoltaic (PV) systems. Batteries and other energy storage devices are necessary to offer a steady and dependable power source, though, because PV energy is sporadic. Effective power flow control and a dependable power supply are demonstrated by the test results. By reducing dependency on traditional sources and supporting clean and sustainable energy, this adaptable and scalable solution is suitable for residential, commercial, and industrial environments. An AC/DC hybrid multiport power routing system based on PV batteries is shown in this project to solve this problem. The battery bank, power routing unit, and PV array that make up the suggested system.

keywords: *PV panels, batteries, inverters, and a microcontroller-based power routing unit*.

INTRODUCTION:

Renewable energy sources share the common characteristic of being replenished naturally and sustainably. Unlike fossil fuels, which are finite and will eventually run out, renewable energy sources can continue to be harnessed indefinitely, making them a more sustainable option for meeting our energy needs. Another important characteristic of renewable energy sources is that they produce little to no greenhouse gas emissions, making them a cleaner option than fossil fuels. This is particularly important as climate change continues to pose a significant threat to the health of our planet and its inhabitants. Renewable energy sources are also becoming increasingly cost-competitive with fossil fuels. Advances in technology and economies of scale are driving down the cost of renewable energy, making it more accessible to people around the world. In recent years, there has been a significant increase in the adoption and usage of renewable energy sources, driven by a combination of factors such as technological advancements, government incentives, and public awareness of climate change. According to data from the International Energy Agency (IEA), the share of renewable energy in global power generation has increased from 18.7% in 2009 to 28.3% in 2020. Led by wind power and solar PV, more than 256 GW of capacity was added in 2020, an increase of nearly 10 percent in total installed renewable power capacity. In addition, many companies and organizations are also making commitments to transition to renewable energy, with some setting ambitious goals to become 100% powered by renewables in the near future. These developments are encouraging and suggest that the world is moving towards a more sustainable and renewable energy future. As renewable energy technology continues to advance and become more inexpensive, it is likely that these energy sources will play an increasingly important role in meeting our energy needs in a sustainable and environmentally responsible way.

RENEWABLE ENERGY:

Energy that is harvested from various sources, such as sunshine, wind, rain, and tides, and transformed into electrical power is known as renewable energy. It can be used for any purpose, and because of its benefits—such as lower maintenance costs, lower generation costs, and lower installation costs—electric cars are also using them. The main drawback of PV systems is that their power output is reliant on direct sunlight;

therefore, if a tracking system is not utilized, roughly 10–25% of the power is wasted since the cell is not always facing the sun. The power output is also reduced by atmospheric impediments like as dust, clouds, and others. An other primary concern is the concentration of output. Renewable energy is the energy that is collected from the different type of sources like sunlight, wind, rain, tides and convert that natural sources into power and can be used for all purposes and these are also used for electric vehicles due to their advantages like less maintained and the cost of generation is less and easy to install, cost of operation is also less.

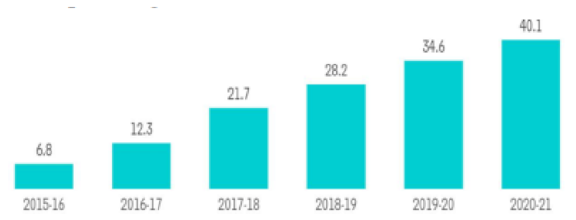


Fig.1 Solar Energy Installed Capacity in India

PV systems have the major disadvantage that the power output is dependent on direct sunlight, so about 10-25% is lost if a tracking system is not used, since the cell will not be directly facing the sun at all time. Dust, clouds, and other obstructions in the atmosphere also diminish the power output. Another main issue is the concentration of the production in the hours corresponding to main insolation, which do not usually match the peaks in demand in human activity cycles. Unless current societal patterns of consumption and electrical networks mutually adjust to this scenario, electricity still needs to be stored for later use or made up by other power sources, usually hydrocarbon.
Advances in technology and increased manufacturing scale have in any case reduced the cost, increased the reliability, and increased the efficiency of photovoltaic installations. Net metering and financial incentives, such as preferential feed in tariffs for solar-generated electricity, have supported solar PV installations in many countries.

EXISTING SYSTEM:

The existing system of using separate converters for each system in stand-alone renewable energy systems can lead to several challenges. In a typical stand-alone system, renewable energy sources such as solar PV panels, wind turbines, or hydro turbines generate DC power, which needs to be converted to AC power before it can be fed to the load. Similarly, energy storage devices like batteries and super capacitor produce DC power that needs to be converted to AC power to power the load. This requires the use of separate converters for each system, resulting in a complex and inefficient system.

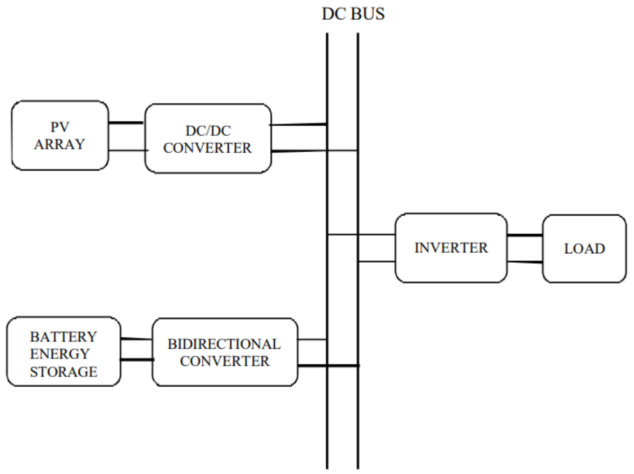


Fig.2 Block diagram of Existing system

MULTIPORT CONVERTER:

Another way of integration is by using multi-port power converters. The multiport power converter will connect all renewable energy sources and energy storage.

Some ports are bi-directional if they are connected with energy storage, while some are uni- directional if they are connected with energy source. This converter integrates photovoltaic cells, energy storage and the load. If the load is AC, an extra inverter is needed to convert the DC power into the AC power. In this multi-port DC-DC power converter, there will be fewer power devices, which means the cost of the power converter will be lower than that of the conventional one. Also, the conversion steps are minimized, resulting in higher efficiency. Due to the presence of the transformer in some circuits, electric isolation is available, which is important for safety. With the turn ratio of the transformer in certain topologies, it will be more efficient to integrate different renewable energy sources of different voltage levels. Finally, there is a central controller. The controller not only controls the individual switches, but also manages the whole system.
Fig.3 Block diagram of multiport converter

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 10 | Oct - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

PROPOSED WORK:

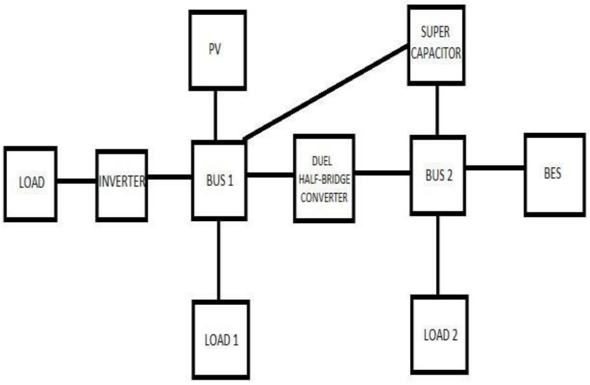


Fig .4 Block diagram of proposed system

Pv Source:

A PV (Photovoltaic) module, also known as a solar panel, is a device that converts sunlight into electrical energy. The solar cells in a PV module are made of semiconductor materials such as silicon, which have the ability to convert sunlight directly into electricity through the photovoltaic effect. When photons from sunlight strike the surface of the solar cell, they excite electrons, creating a flow of electric current. The electrical power generated by each solar cell is relatively small, so multiple cells are connected together to create a higher voltage and current output.

Super Capacitor:

Super capacitors, also known as ultra-capacitors or electrochemical capacitors, are energy storage devices with better power density and faster charge/discharge periods than standard batteries. They function by storing electrical energy in an electrostatic field formed by two opposing charged electrodes separated by an electrolyte. Power is transferred via a resonant circuit that generates high-energy pulses in dynamic wireless charging. These high-energy bursts can harm power electronics and batteries by causing voltage spikes and current surges. Super capacitors, which absorb and release energy quickly, can be utilized to smooth out these high-energy bursts, safeguarding the power electronics and batteries. In the proposed model, the super capacitors are integrated into the WPT system, and they are bidirectional, which means they can both charge and discharge.

BES (Battery Energy Storage)

Battery energy storage is a technology that allows electrical energy to be stored in rechargeable batteries for later use. It is a key component of many modern renewable energy systems, such as solar photovoltaic (PV) and wind power, as it enables the energy produced by these intermittent sources to be stored and used when needed. The battery banks are connected to power conversion systems, which allow the stored energy to be converted from DC to AC (or vice versa) for use in electrical loads or to be fed back into the grid. The conversion systems also regulate the charging and discharging of the batteries to ensure their longevity and optimal performance.

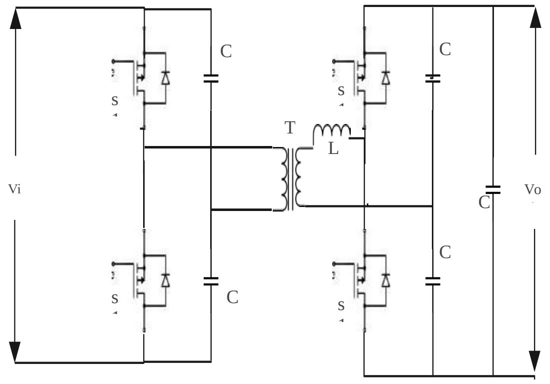


Fig.5 Block diagram of pv source

CONVERTE BI-DIRECTIONAL DUAL HALF BRIDGE:

A power electronics device known as a bidirectional dual half-bridge converter allows electricity to flow in either direction while converting electrical power bidirectionally between two different voltage levels. It is frequently utilized in many different applications, such as energy storage systems, electric cars, and renewable energy systems. In addition to providing galvanic isolation between the input and output, the bidirectional dual half-bridge converter may transfer power between two distinct voltage levels, which can be crucial for system safety and to lessen noise and interference. By modifying the pulse width modulation (PWM) frequency and the duty cycle of the switches, it may also alter the output voltage and current.

SIMULATION:

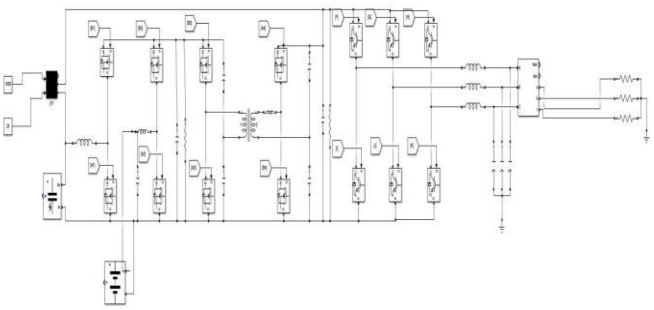
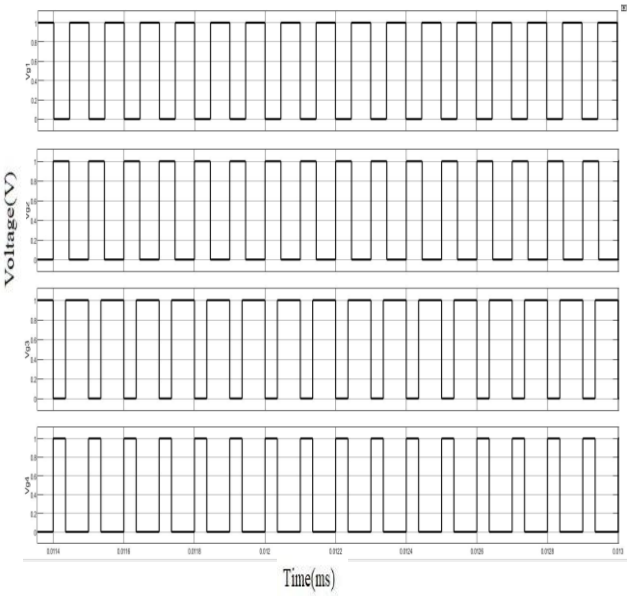


Fig.6 Simulation Circuit

OUTPUT AND RESULT :

The solar intensity is varied and the modulation index is kept constant and the duty cycle is varied to and the bus 1 voltage, bus 2 voltage and AC voltage readings are taken. The model can be created using Simulink blocks, which represent the various components of the converter, such as switches, capacitors, and inductors. The user can then specify the converter parameters, such as switching frequency and duty cycle, and simulate the converter under different load and

Fig.7 Boost converter 1 gate pulses circuit



operating conditions. It can help to optimize system performance, reduce design time and costs, and improve overall system efficiency and reliability.

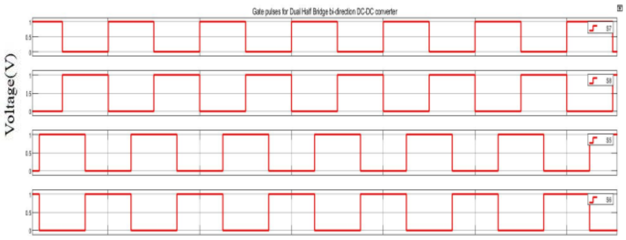


Fig. 8 Boost converter 2 gate pulses circuit

CONCLUSION:

The simulation implementation of a PV-battery based AC/DC hybrid multiport power routing system provides valuable insights into the system's performance and behavior. By utilizing simulation tools, we can analyze and optimize the system's design and performance without incurring the costs and risks associated with physical implementation.

The simulation implementation provides a cost-effective and efficient means of evaluating the system's performance and behavior before proceeding with the physical implementation. It offers a valuable tool for optimizing the system's design, identifying potential issues, and evaluating the system's feasibility.

The simulation implementation allows us to evaluate the system's efficiency, reliability, and feasibility under various operating conditions and scenarios. It also enables us to identify potential issues and limitations and devise solutions to overcome them. Benefit of Efficient renewable energy integration, Reduced reliance on conventional energy sources Minimized environmental impact, Suitable for residential, commercial, and industrial settings, Improved power supply reliability

REFERENCES :

[1] S. Falcones, R. Ayyanar, and X. Mao, ''A DC–DC multiport-converter based solid-state transformer integrating distributed generation and stor_x0002_age,'' IEEE Trans. Power Electron., vol. 28, no. 5, pp. 2192–2203, May 2013.

[2] M. S. Agamy, M. Harfman-Todorovic, A. Elasser, S. Chi, R. L. Steigerwald, J.

[3] Sabate, A. J. McCann, L. Zhang, and F. J. Mueller, ''An efficient partial power processing DC/DC converter for distributed PV architectures,'' IEEE Trans. Power Electron., vol. 29, no. 2, pp. 674–686, Feb. 2014.

[4] S. Wei, F. He, L. Yuan, Z. Zhao, T. Lu, and J. Ma, ''Design and implementation of high efficient two-stage three-phase/level isolated PV converter,'' in Proc. 18th Int. Conf. Electr. Mach. Syst. (ICEMS), Pattaya, Thailand, Oct. 2015, pp. 1649–1654.

[5] J. Xu, N. Liu, L. Yu, J. Y. Lei, and J. H. Zhang, ``Optimal allocation of energy storage system of PV microgrid for industries considering important load,'' (in Chinese), Power Syst. Protection Control, vol. 44, no. 9, pp. 29-37, 2016.

[6] E. M. Khawla, C. Dhia, and S. Lassaad, ''LVRT control strategy for three phase grid connected PV systems,'' in Proc. Int. Conf. Green Energy Convers. Syst. (GECS), Hammamet, Tunisia, Mar. 2017, pp. 1–7.

[7] M. Mao, C. Qian, and Y. Ding, ''Decentralized coordination power control for islanding microgrid based on PV/BES-VSG,'' CPSS Trans. Power Electron. Appl., vol. 3, no. 1, pp. 14–24, Mar. 2018.

[8] T. Morstyn, A. V. Savkin, B. Hredzak, and V. G. Agelidis, ''Multi-agent sliding mode control for state of charge balancing between battery energy storage systems distributed in a DC microgrid,'' IEEE Trans. Smart Grid, vol. 9, no. 5,pp. 4735–4743, Sep. 2018.

[9] J. W. Zapata, S. Kouro, G. Carrasco, H. Renaudineau, and T. A. Meynard, ''Analysis of partial power DC–DC converters for two-stage photovoltaic systems,'' IEEE J. Emerg. Sel. Topics Power Electron., vol. 7, no. 1, pp. 591–603, Mar. 2019.

[10] J. Anzola, I. Aizpuru, A. A. Romero, A. A. Loiti, R. Lopez-Erauskin, J. S. Artal- Sevil, and C. Bernal, ''Review of architectures based on partial power processing for DC–DC applications,'' IEEE Access, vol. 8, pp. 103405–103418, 2020.

[11] C. Perera, J. Salmon, and G. J. Kish, "Multiport converter with independent control of AC and DC power flows for bipolar DC distribution," IEEE Transactions on Power Electronics, vol. 36, no. 3, pp. 3473-85, 2020.

[12] S. Rostami , V. Abbasi , and M .Parastesh , " Design and implementation of a multiport converter using Z-source converter," IEEE Transactions on Industrial Electronics, vol. 68, no. 10, pp. 9731-41, 2020.

[13] M. Y. A. Khan, H. Liu, Z. Yang, and X. Yuan, "A Comprehensive Review on Grid Connected Photovoltaic Inverters, Their Modulation Techniques, and Control Strategies," Energies, vol. 13, no. 16, pp. 1- 40, 2020.

[14] M.M. Masoom, N. Kumar, and A.R. Kulkarni, "MPPT Based Grid Connected Photovoltaic System Using Flyback Converter," IEEE InternationalConferenceforInnovationinTechnology, pp.1-5,2020.

[15] Z. Deng, X. Hu, X. Lin, Y. Che, L. Xu, and W. Guo, ``Data-driven state of charge estimation for lithium-ion battery packs based on Gaussian processregression,'' Energy, vol. 205, Aug. 2020, Art. no. 118000.

[16] Muhammad Yasir Ali Khan, Haoming Liu, Naveed Ur Rehman, Design of a Multiport Bidirectional DC-DC Converter for Low Power PV Applications ," 2021 International Conference on Emerging Power Technologies (ICEPT).

[17] Levon Gevorkov, José Luis Domínguez-García, Àlber Filbà Martínez ," Modern Trends in MultiPort Converters: Isolated, Non-Isolated, and Partially Isolated ," 2022 IEEE 63th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON).

[18] C. Chen, M. Pinar, T. Stengos, "Renewable energy and CO2 emissions: New

evidence with the panel threshold model," Renewable Energy, vol. 194, 2022, pp. 117-128.

[19] D. Zhang, Q. Kong, "Green energy transition and sustainable development of energy firms: An assessment of renewable energy policy," Energy Economics, vol. 111, 2022.