https://doi.org/10.46335/IJIES.2024.9.5.20 **e-ISSN: 2456-3463**
Vol. 9, No. 5, 2024, PP. 85-88

International Journal of Innovations in Engineering and Science, www.ijies.net

Power Quality Improvement With PV And Grid Hybrid System By Using Filter Device

Prof Dushyant khadase, Sahil Deshmukh, Aditya Chauhvan, Mohit Patle, Mitesh tamsetwar , Likesh Chaudhari

St. Vincent Pallotti College of Engineering & Technology Nagpur, Maharashtra, India

***Received on**: 5 May,2024* ***Revised on**: 24 June,2024* ***Published on**: 26 June,2024*

Abstract*— *In recent years, renewable energy sources have gained increasing significance in electrical energy production systems. Hybrid systems, which integrate two or more different energy sources, have emerged as a viable solution. This project focuses on a hybrid system combining solar energy with the main power supply, demonstrating the importance of such integrated systems over individual ones. The proposed hybrid system utilizes DC-DC boost converters tailored for photovoltaic sources, featuring a reduced number of switches. These converters efficiently convert varying DC outputs into a constant form. Additionally, a solar charge controller is employed to maximize solar energy capture. This integrated approach not only enhances power generation but also optimizes system cost. Moreover, This project uses filters to reduce harmonics in the present state and provide a stable power supply in order to enhance power quality in the hybrid system. The inclusion of such filters enhances system reliability and stability. The proposed hybrid system is currently presented in prototype hardware form, showcasing its practical implementation and feasibility. This hardware prototype serves as a tangible demonstration of the system's capabilities and potential benefits.

Keywords*— *Harmonics; Hybrid Topology; Nonlinear Load; Power Quality (PQ); Grid-Connected System, Filter etc.

I. INTRODUCTION

The increasing global demand for power necessitates the exploration of economical and reliable sources, with renewable energy proving to be a promising option. Solar energy systems are particularly crucial for addressing this demand and injecting solar power into the electric grid has become a common practice. However, this injection poses challenges to the power quality of the grid, leading to deviations from standard norms.

Solar power, while abundant, faces stability issues due to the inherent variability of sunlight. The quantity of power supplied to the system may be impacted by this volatility. In order to increase power quality, a variety of filter systems have been created.. First-generation devices such as STATCOM, SVC, and Fuzzy Logic Controller were initially used, followed by second-generation devices like UPFC and IPFC.

Compensating for fluctuations generated by renewable sources like wind turbines, battery energy storage systems (BESS) have emerged as a solution. In this project, the focus lies on utilizing filter devices to enhance power quality, thereby impacting the power factor of transmission lines.

The proliferation of nonlinear loads and renewable energy sources has introduced new challenges to electrical systems. Power electronics has emerged as a critical interface for improving power quality. The prevalence of nonlinear loads injects current harmonics into the system, leading to various issues such as equipment malfunction and voltage distortions. Custom Power Devices (CPD), including active filters, have been developed to mitigate these problems.

The advantages of both active and passive filters are combined in hybrid active energy filters, offering a complete solution to power quality issues. By leveraging both passive and active filtering techniques, hybrid filters aim to minimize the drawbacks of each while maximizing their advantages.

II. PROBLEM IDENTIFICATION

- The increasing consumption of fossil fuels is rendering the provision of electricity impossible in remote areas.
- Developed countries are increasingly turning to renewable energy as a cost-effective alternative to conventional grid supplies, especially in remote locations.
- Researchers are focusing on optimizing energy utilization and conservation methods, particularly in

https://doi.org/10.46335/IJIES.2024.9.5.20 e-ISSN: 2456-3463
Vol. 9, No. 5, 2024, PP. 82-84

the realm of electric power generation where renewable hybrid systems are being utilized.

- While individual renewable sources can generate electric power, hybrid systems offer a more reliable and consistent power supply to loads.
- With the growing demand for electricity each year, energy generation plants struggle to meet the increasing demand, resulting in frequent load shedding issues.
- Because of this, the importance of renewable energy sources has increased, and in numerous instances, many clean energy sources are needed to deliver electricity to loads or the grid.

- Multiport DC-DC converters are being proposed for hybrid applications to facilitate efficient power management.

III. OBJECTIVES

- This project primarily focuses on power quality improvement through the utilization of filter controllers in hybrid systems, elucidating their types and benefits.
- Additionally, it aims to analyze the role of control attributes in enhancing power system stability.
- A key aspect involves connecting the photovoltaic (PV) system to the DC link capacitor, fulfilling all customer requirements.
- The filter's main goal is to control voltage, with a special emphasis on power point coupling—the point at which the load is incorporated into the system.
- Finally, the project aims to identify results and discuss the applications of filter devices across various types of green energies, with a particular emphasis on solar energy.

IV. LITERATURE SURVEY

(Enjeti et al., 1992), The study "Analysis and creation of a power filter that is active to cancel harmonics in lower-voltage electric power production systems" explores active power filters' design factors with the goal of improving the quality of current in low voltage electricity power distribution systems. The use of shunt active filtering to eliminate current harmonics and improve overall reliability in the electric power transmission system is the focus of this study.

(**Adil M. Al, -Zamil.,2001),** The integration of sequence activity and shunt-active filters inside unified electrical power conditioner (UPQCs) is examined in the study "The unified energy quality conditioners: the incorporation of series active with shunt-active filters". Reactive power, negative sequencing current, harmonics, and voltage flicker/imbalance are among the problems that a UPQC aims to solve. UPQCs are primarily intended to improve power quality in industrial or power distribution networks at the time of installation. The study explores UPQCs' control strategies, focusing in particular on the movement of instantaneous proactive and reactive powers inside the UPQC.

(Singh, Bhim Al-Haddad et al., 1999), A unique control strategy for a three-phase active voltage filter (APF) is introduced in the paper "Harmonic elimination, reactive energy compensation, and load balancing for three-phase, four-wire electrical distribution systems serving non-linear loads." The suggested approach is designed to rectify system imbalance in a three-phase, four-wire electric distribution network with unbalanced non-linear loads, as well as eliminate harmonics and compensate for reactive power and neutral current. Three a one-phase IGBT-based PWM-VSI bridge that share a DC bus capacitor are used in the APF implementation.

(Bhimsingh et al., 1999), An detailed evaluation of active filter (AF) topologies, control techniques, component selection, technical and economic considerations, and how they are used in diverse circumstances is given in the work titled "A review of active filtering for energy efficiency improvements". With regard to power quality issues, it seeks to provide researchers as well as engineers with a thorough understanding of the present status of AF technology.

V. ACTIVE POWER FILTERS

- ***Active Power Filters***

By efficiently suppressing reactive power components and supply current harmonics, active power filters perform better than passive filters. To offset harmonic currents caused by nonlinear loads, they use electrical power to create certain current components. These filters are able to be connected to the nonlinear loads in a shunt configuration or in series. A three-phase parallel active power filter that is connected in parallel to the load is shown in Figure 1. The use of a three-phase shunted powered filter is the main topic of this study. Shunt active filters are quite expensive despite their efficacy, and because of the direct relationship between the rating of power and the load current that needs to be balanced, they are not appropriate for large-scale systems. [5].

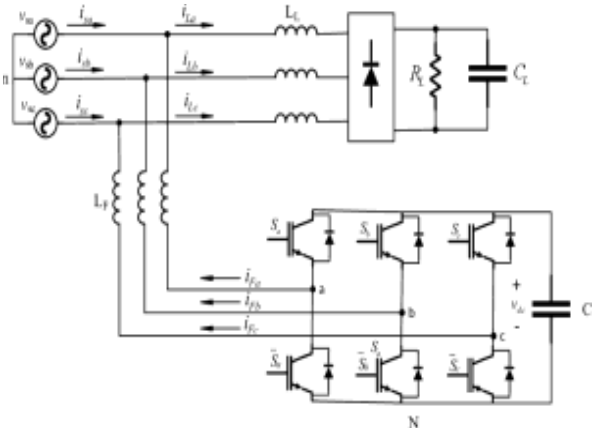

Fig.1 Three phase active power filter

https://doi.org/10.46335/IJIES.2024.9.5.20 **e-ISSN: 2456-3463**
Vol. 9, No. 5, 2024, PP. 82-84

International Journal of Innovations in Engineering and Science, www.ijies.net

- ***Configuration Of Conventional Apf***

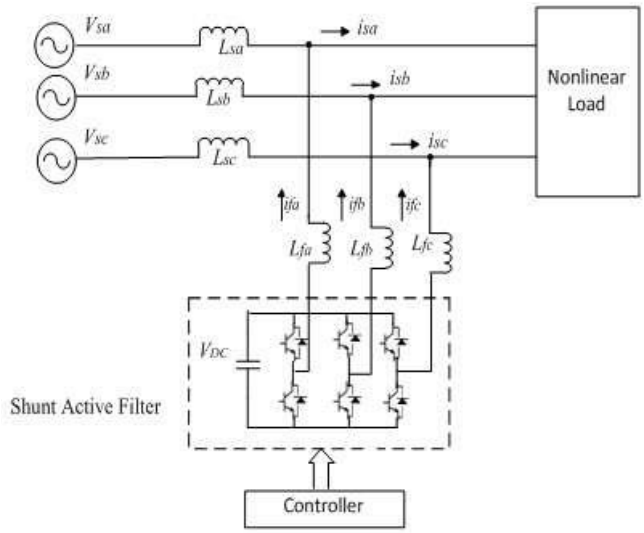

Fig.2 Setting up a traditional APF

An Active Energy Filter (APF) uses a passive component, usually an inductor set, to link the power converter's AC terminal to the utility. This device serves as a switching shock filter. Typically, APFs produce three-phase compensating currents using a current mode controller. The basic reactive component and harmonic components of the load currents make up these compensatory currents. The utility currents become sinusoidal and matched to the utility voltages as a result of the compensatory currents being injected into the electrical lines. Usually, the power converter uses a three-arm bridge design. [3]

- ***How the Hybrid Energy Filter is configured***

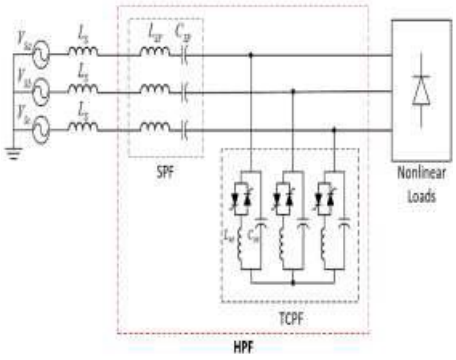

Fig.3 How the hybrid energy filter is configured

The active portion of the Power Filter (APF)'s passive components are modified in Figure 3 to create a new filter known to be the hybrid energy filter [6]–[11]. A series of inductor and capacitance set functions as a passive energy filter in this arrangement. By utilising a passive voltage filter to lower the power converter's capacity demand, the combined power filter helps the APF overcome its problems with high capacity and expense related to the power converter. The power converter used in hybrid energy filter has a three-arm bridge configuration, just as the APF. [3]

- ***Configuration Of Proposed Apf***

A series inductance and capacitor set are also included in the planned APF's passive components with the goal of lowering the power converter's needed capacity. They serve a different purpose than the hybrid power filter, though. The series inductor in the suggested APF filters the switching ripple produced by the power converter's power electronic components, and the set's capacitor provides fixed compensating reactive power. As a result, the suggested three-phase APF can need less power electrical components overall. Power system quality problems are mostly caused by the growth of nonlinear loads, which are mostly made up of semiconductor devices. [4].

VI. PROPOSED SYSTEM

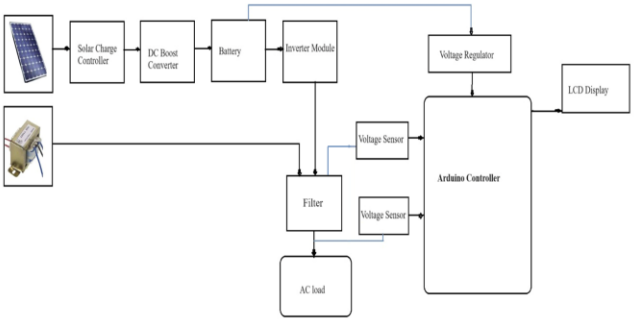

Fig. 4. Block Diagram of system

• The variable power output from the PV system results in fluctuating voltage from the inverter, accompanied by the presence of harmonics in the system.
• Implementing filter devices on the distribution side, particularly on the load side, helps in reducing harmonics and ensuring voltage stability consistently.
• Filters and other shunt-connected reactive power adjustment devices can produce and absorb reactive power to keep the system stable.
• The AC power generated by the inverter for nonlinear loads often exhibits fluctuations. Implementing filter devices is crucial for enhancing power quality and stabilizing the supply voltage.
• Solar energy is initially captured and transmitted to a solar charge controller and boost converter to augment energy. Subsequently, the energy is stored in batteries before being processed by the inverter module for AC conversion.
• The AC power then passes through filter devices before being supplied to the output load.
• voltage sensors detect input and output variations from the filter devices, transmitting signals to the Arduino Uno controller. The controller, in turn, relays these signals to an LCD display to showcase sensor readings.

VII. CONCLUSION

The significance of filter devices in enhancing power system quality is widely recognized in the global power industry. However, their integration into renewable energy plants holds particular promise. Filter devices offer essential functionalities include enhancing transient stability, offering voltage ride-through abilities, and controlling power flow—

https://doi.org/10.46335/IJIES.2024.9.5.20 **e-ISSN: 2456-3463**
Vol. 9, No. 5, 2024, PP. 82-84

International Journal of Innovations in Engineering and Science, www.ijies.net

all essential functions in hydro, wind, and solar power plants. It's crucial to remember that filters must be installed correctly before being used in certain green energy plants, taking into account elements like weather that may have an impact on plant productivity. The dependability and effectiveness of renewable energy facilities are critical to the market's capacity to absorb more renewable energy. Filter devices increase power system dependability in these systems, which in turn promotes the uptake of green energy.

REFERENCES

[1] *Zhou, Yan, and Hui Li. "Analysis and suppression of leakage current in cascaded-multilevel-inverter-based PV systems." IEEE Transactions on Power Electronics 29, no. 10 (2013): 5265-5277.*

[2] *Jain, Sachin, and Venu Sonti. "A highly efficient and reliable inverter configuration based cascaded multilevel inverter for PV systems." IEEE transactions on industrial electronics 64, no. 4 (2016): 2865-2875.*

[3] *Das, Soumya Ranjan, Prakash K. Ray, Alok K. Mishra, and Asit Mohanty. "Performance of PV integrated multilevel inverter for PQ enhancement." International Journal of Electronics (2020): 1-38.*

[4] *Chattopadhyay, Sumit K., and Chandan Chakraborty. "A new asymmetric multilevel inverter topology suitable for solar PV applications with varying irradiance." IEEE Transactions on Sustainable Energy 8, no. 4 (2017): 1496-1506.*

[5] *Rajalakshmi, Sambasivam, and Parthasarathy Rangarajan. "Investigation of modified multilevel inverter topology for PV system." Microprocessors and Microsystems 71 (2019): 102870.*

[6] *Pourfaraj, Alireza, Mohammad Monfared, and Hamed Heydari-doostabad. "Single-phase dual-mode interleaved multilevel inverter for PV applications." IEEE Transactions on Industrial Electronics 67, no. 4 (2019): 2905-2915.*

[7] *A. I. Ali, Mahmoud A. Sayed, and Essam EM Mohamed. "Modified efficient perturb and observe maximum power point tracking technique for grid-tied PV system." International Journal of Electrical Power & Energy Systems vol. 99, pp. 192-202, 2018.*

[8] *H. A. Mosalam, Ragab A. Amer, and G. A. Morsy. "Fuzzy logic control for a grid-connected PV array through Zsource- inverter using maximum constant boost control method." Ain Shams Engineering Journal vol. 9, no. 4, pp. 2931-2941, 2018.*

[9] *M. Lakshmi, and S. Hemamalini. "Decoupled control of grid connected photovoltaic system using fractional order controller." Ain Shams Engineering Journal vol. 9, no. 4, pp. 927-937, 2018.*

[10] *M. Aourir, A. Abouloifa, I. Lachkar, C. Aouadi, F. Giri, and J. M. Guerrero, "Nonlinear control and stability analysis of single stage grid-connected photovoltaic systems". International Journal of Electrical Power & Energy Systems, vol. 115, pp. 105439, 2020.*

[11] *B.G. Sujatha, and G. S. Anitha, "Enhancement of PQ in grid connected PV system using hybrid technique," Ain Shams Engineering Journal, vol. 9(4), pp. 869-81, December 2018.*

[12] *N. Prabaharan, A. Rini Ann Jerin, K. Palanisamy, and S. Umashankar, "Integration of single phase reduced switch multilevel inverter topology for grid connected photovoltaic system," Energy Procedia, vol. 138, pp. 1177-1183, October2017.*