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A Review on Fuzzy Logic Control Based PV Module and Bidirectional Dc-Dc Converter Design

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Abstract- **This work presents a optimize energy extraction in photovoltaic (PV) energy systems. The maximum power of the photovoltaic module will change due to changes in temperature, solar radiation and load. To maximize efficiency, the photovoltaic system uses a maximum power point tracker (MPPT) to continuously extract the most power that the solar panel can generate and then pass it on to the load. The overall structure of the MPPT system consists of a DC-DC converter (an electronic device that converts DC energy from one voltage level to another) and a controller. During changes in weather conditions, MPPT uses a tracking algorithm to find and maintain operation at the point of maximum power. Many different algorithms for MPPT have been proposed and discussed in the literature, but most of these methods have disadvantages in terms of efficiency, precision, and flexibility. Due to the non-linear behavior of the current voltage characteristics of the PV module and the non-linearity of the DC-DC converter due to switching, conventional controllers cannot provide an optimal response, especially when dealing with a wide range of shifting line parameters and transients. The purpose of this work is to design and implement a maximum power point tracker using fuzzy logic control algorithms. Fuzzy logic naturally provides an excellent controller for such nonlinear applications. This method also benefits from artificial intelligence methods that can overcome the complexity of modeling nonlinear systems. To make this work a success, Simulink designed and simulated an MPPT system consisting of photovoltaic modules, DC-DC converters, batteries, and fuzzy logic controllers. Perform the characterization of the buck, boost and buck-boost converter to find the most suitable topology for the PV system used. The integrated model of the PV module with the identified converter and battery was simulated in MATLAB to gain the necessary experience to formulate and adjust the fuzzy logic controller. The simulation results show that fuzzy logic.**

Keyword:- **PV, MPPT,Fuzzy Controller, DC-DC converter.**

I. INTRODUCTION

Power electronics has established an important position in the latest technology and has completely changed the management methods for electricity and energy. As the switching characteristics of power semiconductor devices improve and as the voltage and current rating of devices is greatly increased, the application area of electrical electronic devices is expanded. A DC-to-DC converter is an electronic current circuit that converts available DC at one voltage level to DC at another voltage level. The high frequency electronic power processor is used for DC-DC power conversion. The DC-DC converter adjusts the DC output voltage according to load and line changes. Buck, boost, buck-boost and Cuk converters are the four basic DC-DC converter topologies. Popular isolated versions of these converters are forward converters, push-pull converters and flyback converters. DC-DC converters are widely used in photovoltaic power generation, which can convert low voltage PV power to the voltage required by the load. Conventional sources of electrical energy used to generate electrical energy are not environmentally friendly and they no longer exist. The global energy crisis provides new impetus for growth and use of clean and renewable energy. Solar photovoltaic (PV) power generation is becoming increasingly important as a renewable energy source due to benefits such as no fuel costs, low maintenance costs and no noise and wear caused by moving parts. With the development of photovoltaic technology, the price of photovoltaic modules has fallen sharply. Photovoltaic-based systems are increasingly used in various applications at home and business level.

However, the nonlinear current voltage characteristics (I-V) hinder its control design to achieve maximum power extraction. To extract the maximum available power, DC-DC converters with current maximum power point tracking (MPPT) algorithms are widely used. The controller that tracks the path to the maximum power point in the PV array is called the maximum power point tracker. Due to the high cost of solar cells, it is necessary to operate the photovoltaic array at the maximum power point. To get the system running optimally, the load line must match the position of the maximum power point in the PV array. This point varies with temperature, insulation and load conditions and must be continuous

Monitored to respond to rapid changes. The two ways of operating the photovoltaic module at the maximum power point are open-loop control and closed-loop control methods. The open loop method is based on the assumption that the maximum power point voltage is a linear function of open circuit voltage. Closed loop control involves changing the input voltage around the optimum value by alternately giving the input voltage a small increment or a small increment. Then evaluate the output power output and make further small adjustments to the input voltage. This control is called mountaineering control.

Various climbing controls include the "disturbance and observe" method, the "incremental conductivity" method, and the "incremental resistance" method. MPPT can be achieved using some artificial intelligence-based tracking (e.g., fuzzy logic-based control, neural control with and without optimization techniques). For some photovoltaic applications, such as UPS, DC networks, etc., the constant output voltage must be maintained under variable load conditions, and the source voltage fluctuations must also be maintained. Various voltage regulators using DC to DC converters with different control schemes are used to improve the efficiency of the controller. Due to advances in power electronics technology and the improvement of technology, it is expected that there will be stricter requirements for accurate and reliable regulation. This leads to the need for more advanced and reliable design of controllers for DC-DC converters.

There are various analog and digital control methods for DC-DC converters, including voltage and current state control techniques. Two-way grid connected to converter and control with one current for low input voltage control. The proposed converter uses a single power conversion technique to perform bidirectional power conversion between the battery and the grid through the single power processing stage.

Energy storage systems (ESS) that use batteries are the latest focus on energy independence and flexible energy management. By storing excess energy and releasing it as needed, it reduces the overall cost of power consumption and improves the quality and efficiency of the power supply. ESS responds to changes in demand to ensure smooth changes in usage during peak times and downtime. Therefore, it is necessary to design a two-way ESS converter between the battery and the grille. In general, bidirectional converters must meet several requirements, including bidirectional power supply capacity, high efficiency, high quality power conversion, high power factor (PF) and low total harmonic distortion (THD) to interface with the power grid. It consists of a two-way DC-DC converter and a two-way DC-AC converter. In this case, these two phases correspond to the power conversion phase because each phase is served by a high frequency switch. The two-way DC-DC converter performs power conversion between low battery voltage and high DC connection voltage. A bi-directional DC AC converter is required to connect the high DC connection voltage to the mains voltage. However, the two-stage converter involves a voluminous DC connection capacitor, large shift losses and several semiconductor devices and gate drive circuits.

In addition, the efficiency of the two-stage inverter corresponds to the product of the efficiency of each stage, so that high overall efficiency is difficult to achieve. In addition, each step requires two separate controllers.

Therefore, the conventional two-stage two-way conversion involves circuit complexity, high cost and low power conversion efficiency. Single-stage two-way converter DC-AC power conversion is performed in a single power processing stage with a single controller Compared to traditional two-stage converters, it has higher efficiency, higher power density and more competitive costs. In addition, they do not require bulky DC-link capacitors. Therefore, compared to a two-stage bidirectional converter, a one-stage converter has many advantages, such as higher power conversion efficiency, improved system reliability and fewer semiconductor devices.

However, the converter only provides the step-down function, and the input battery's voltage on the one-stage converter must reach a high voltage that can cover the mains of the mains. This feature will make the switch higher and cause a large number of battery connection voltages to increase. Therefore, one-stage converters must use high-grade switches and a large number of batteries connected in series. These batteries have negative effects, such as shortening the battery life, reducing system reliability and increasing system volume / weight. In addition, they still use more semiconductor devices and gate drive circuits. To solve these problems, a two-way converter is proposed in one step. These inverters can handle low input battery voltages. However, these converters have a large amount of high-frequency battery power ripple, which increases battery capacity and impedance changes, and shortens battery life and reduces battery performance. To suppress high-frequency battery current, an electrolytic capacitor is required on the side of the battery.

II. EXISTING SYSTEM

Energy storage systems have been widely used in many applications, such as renewable energy systems, electric vehicles, uninterrupted power supply and microgrids, to offset power relations between power generation and power consumption. A bidirectional DC-DC (BDC) converter with bidirectional power conversion and transmission features is a key component that connects energy storage elements (such as batteries and supercapacitors) to various power supply systems. One side of the BDC is connected to the battery. The battery voltage is usually low, usually in the range of 12-48 V, while the other side of the BDC is connected to a high voltage bus of up to 400 V or higher to meet the inverter and AC power requirements. Therefore, for an energy storage system, a BDC with a high up / down voltage conversion ratio is desired to connect a low voltage battery to a high voltage DC bus.

In almost all circumstances, the domestic battery storage system (BESS) used to increase self-consumption of roof photovoltaic (PV) units is still economically disadvantageous to the German market, as battery prices in 2015 are assessed under the German market conditions, this is the savings of such systems can usually do not exceed the battery's investment costs within the estimated life of the system. In this work, the economic benefits of a system providing technical data based on Tesla's announcement of the power wall are evaluated. For the German market. The purpose is to make a reliable assessment of Tesla's Power Wall and estimate the conditions under which the storage system will be economically advantageous. The results also apply to other BESS homes with similar prices and technical parameters. Tesla's product is just one example, it is an example of analysis of BESS economics in photovoltaic systems for housing.

The development of DC-DC converters requires a high switching frequency PWM signal to avoid more output voltage shrinkage. In this project, the problem statement is how to develop a buck-boost converter and fuzzy logic simulation model.Compared to fossil fuels, the use of PV power plants is relatively low due to low efficiency and relatively high cost per capita. Watt. Therefore, much work still needs to be done to improve the efficiency and reliability of the photovoltaic system. The first step in understanding and discussing how to improve the efficiency of photovoltaic modules is through modeling and simulation. Having achieved good modeling and simulation of PV modules, various methods can be designed and developed to optimize system operation. Disadvantages such as low efficiency, low accuracy and slow response rate. Therefore, this study aims to find a more reliable and accurate method to obtain the required power that can be generated by the PV system under different weather conditions. This method is called fuzzy logic control based on MPPT.

The control algorithm follows the excellent method of unclear logic representation and inference, which can solve the shortcomings of existing methods.

Objectives:

- The main purpose of this research is to design and implement the maximum power point tracker for photovoltaic power supply based on fuzzy logic.
- To complete this work, an MPPT model consisting of a DC-DC converter and a fuzzy logic controller will be developed.
- To perform a characteristic analysis of the boost converter to select the topology most suitable for all components of the entire solar cell system.
- The combined model of the photovoltaic module and the selected buck-boost converter. To obtain the best design to formulate and adjust the unclear logic control algorithm used to track the maximum power
- To study the limitations of the existing Maximum Power Point (MPP) tracking algorithms used in a solar PV system, and to propose efficient algorithms for MPPT under different operating conditions.

III. PROBLEM FORMULATION

The P&O MPPT scheme is modified considering increase in solar irradiation, steady state oscillations, and load changing condition. The results of the modified scheme are compared with the existing P&O MPPT scheme, and the improvements are highlighted. The new MPPT scheme is implemented in the control circuit of a buck DC–DC converter The P&O method may give false results, i.e., when solar irradiation is increased, the conventional P&O algorithm moves in the direction of high power. It fixes the operating point, which is not maximum power point (MPP). Also, the other issue is steady state oscillations due to the nature of the P&O MPPT scheme. The limitation of the P&O method has been highlighted under increased solar irradiation condition. However, the MPPT behavior with resistive load change has not been addressed properly. These issues are addressed properly for other MPPT schemes such MPPT with fuzzy controller Therefore, for this work a fuzzy logic based MPPT algorithm has been used. Some good works based on fuzzy logic has already existed. But in most of the works an extra gain block has been added with the fuzzy system for tuning the output n this algorithm the gain block has been removed, and duty cycle has been calculated directly using rules based fuzzy system. The developed algorithm is able to track the maximum power with a convenient speed, and it shows a very dynamic response with sudden variations in environmental conditions

IV. LITERATURE SURVEY

The major limitation of the P&O MPPT method are, oscillations in the vicinity of the MPP, power loss, and degraded solar energy conversion efficiency. Also, the P&O approach tracks in the wrong direction under rapidly varying irradiance n **(Salas V et al 2005),** the P&O method has been improved by using the PV panel current (IPV) as the variable for the calculation of the duty cycle (D). To overcome the disadvantages of slow convergence and oscillation around the MPP, the use of a variable perturbation size approach was proposed in **(Liu and**

Lopes, 2004). In this approach large perturbations are applied, when the output power is far from the MPP, whereas smaller steps are adopted as the output power oscillates around the MPP. The magnitude of the variable perturbation is determined, based on the slope of the power–current curve.

The determination of this slope, however, increases the complexity and cost associated with this approach. A suitable MPPT technique has to be followed for operating a PV panel at MPP. This chosen technique has to adjust for the changing environmental conditions such as temperature and solar radiation and must be efficient enough to calculate MPP of the PV panel by reading PV voltage and current. The methods discussed in literature has number of shortcomings like high tracking error, fluctuation around the actual MPP depending on the perturbation size, inefficiency to cope with the changing climatic conditions, slow convergence etc. Therefore, there is need of developing new MPPT method considering the above discussed problems. To further improve efficiency of a PV system, a suitable voltage controller and DC-DC converter needs to be included in the MPPT of a PV system for maximum utilization of the available solar power in fast and wide range of changing environmental conditions.

XuJia et.al. (2018) When the electric car stops charging the battery, the car's driver in the car will not work. The transport system that supplies the vehicle's weapons system can be viewed. For some devices, it may have the ability to pay fast and V2G (drive to grid). This paper proposes a charge-coupled Z-source system with LCL filtering. The consolidation method based on the integrated sound system is used to reduce the current to the resonant frequency of the current output. The mathematical model of the proposed system is implemented, and the control mode on the DC and AC sides is proposed. Finally, the Z-source test domain is created during grid connection operation. Experience has proven the superiority of the system.

Chandra SekharNalamati et.al. (2018) The growing popularity of renewable energy and electricity (EV) has transformed the structure of the global energy industry. In the charge-coupled charge system for renewable energy, bidirectional AC / DC converters are used for more reliable power generation operations. This paper presents a bidirectional AC / DC converter that combines an AC-DC bidirectional converter (GBC) and a bidirectional De-Battery (BBC) battery charger. The GBC printer can facilitate bidirectional flow between the AC and DC networks, while the BBC converter can provide bidirectional power between the energy storage / EV and DC grid systems. In order to transmit power in the trunk, powerful power management technology is required. Hysteresis based power management technology is used to inject electrical energy into the container. AC-DC conversion offers asymmetric PWM strategies with minimal conversion. PSCAD tools are used in simulation to validate the proposed control algorithm.

Fatama-Tuz-Zahura et.al. (2018) The draft proposal and the current control system for mains inverter are proposed. The Controller can also be used with an energy storage system (ESS). The volume management system described in this article is based on a standard PI regulator that provides a low DC connection voltage and low response speed. The current monitoring strategies used here can improve the old shortcuts and eliminate long-term errors. Simulation is performed with MATLAB Simulink. By comparing the simulation results to the literature results, the performance of the system is optimized. The system can be used to improve the short-term response of bidirectional operators.

Meng Runquan et al. (2019) when generating a DC microgram with an AC microgrid, the bidirectional AC / DC converter (BIC) voltage associated with the AC and DC subnets must have a microgrant AC voltage with amplitude, frequency and phase The same magnitude. Therefore, the frequency, phase and amplitude of AC voltage needed for network services are known quickly and accurately. Therefore, a communication method is proposed. First, the principle of bidirectional AC / DC converter is introduced, and the problem of water loss during power relations is addressed. In the meantime, determine the BIC transmission status, and appropriate control strategies for AC / DC microgrid connectivity. Finally, the proposed control algorithm is validated by the Matlab / Simulink simulation.

Cui Yulu et.al. (2019),The two-phase two-way power supply circuit consists of two modules: inverter and rectifier. The mathematical model of the converter depends on two models. Based on this, the influence of delayed system control will be further explored. The results of the analysis are given, and the proposed control method is developed along with the Bode plot compensation. On the other hand, this control approach can eliminate the influence of delayed system optimization and improve system stability. On the other hand, the system's redesign and gradient boundaries can be improved to make it more attractive. Finally, a 5kw experimental prototype was installed to verify the error of the theoretical analyzes. The results show that in both the inverter and rectifier mode, the maximum efficiency of the converter is less than 98%. This work examines the common topological DC-DC converters, such as tweets, promotions, heart-rate converters, Cuk, Sepic, and Luo and their unique tracking techniques. The channel coordinator must maintain a constant volume regardless of any changes in the volume or load. As such, it serves as a set of control groups classified as linear and non-linear observers to control the converts to achieve systemic change. Linear regulators such as proportional (P), proportional integral (PI) and proportional integral derivative (PID) are widely used to control the transmission of active converters. However, the taste control of the transducer is not enough to cope with changes in the volume or current flow. Therefore, wireless monitoring technologies such as fuzzy logic control (FLC), neural fuzzy logic (NFLC), neural network (ANN) and algorithmic algorithm (GA) technology have been implemented to to improve fuzzy control in general. performance. Mattavelli et al. We developed the control of Buck-Boost converter and have been able to improve both the output volatility of the output volume and the sensitivity of the signal to the output voltage and output.

V. PROPOSED SYSTEM

The proposed network-connected bi-directional simple power conversion converter system with low input battery voltage. For the proposed converter, only one power processing stage is needed to perform bidirectional power flow control and meet common interface standards. The current input and output of the folded network represents the power flow and the transmitted power level. It also includes power quality on the grid side. Therefore, controlling the input and output of the folded grid current can lead to the feasibility of the proposed converter for individual power conversion.

This project designs and proposes a fuzzy controller for the Buck-boost DC-DC converter. To control the output voltage of the buck-boost converter, the controller is designed to change the converter duty cycle. The mathematical model of the buck-boost converter and the fuzzy controller is derived, and the simulation model is designed. The simulation was developed in the MATLAB simulation program. To verify the effectiveness of the simulation model, an experimental device was developed. He developed a buck-boost circuit using MOSFET as the switching element. The fuzzy logic controller that generates the PWM signal duty cycle is programmed. Simulation and experimental results show that the output voltage of the buck-boost converter can be controlled according to the value of the duty cycle to control the DC output voltage of the buck / boost converter and ensure good variable output voltage, this project proposes a fuzzy logic controller for closed-loop control of the DC-DC buck / boost converter. Figure 1 shows the block diagram of the proposed system.

The system consists of a DC-DC boost converter to maintain the DC voltage. In the voltage control circuit, the sensor detects the actual voltage (Vo) and obtains the error signal by comparing it to the reference voltage (Vref). Calculate the error change based on the current error and the previous error.

Among the proposed systems, bidirectional DC-DC converters and energy storage have become promising options for many energy-related systems, including hybrid vehicles, fuel cell vehicles, renewable energy systems and industry. The proposed converter is designed in closed loop control. Because closed loop control has advantages over open loop control. By using modern controllers, we can obtain high output voltage and high gain by controlling the breaker duty cycle. Therefore, it reduces the switching current, the frequency and the high output voltage. We can reduce heat loss, which can extend the life of the switch. It not only reduces costs. Used as input in photovoltaic panels of this design.

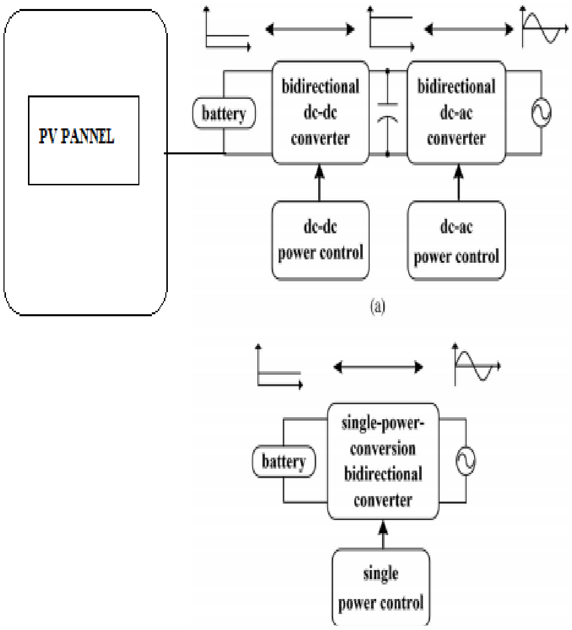

Fig 1. Block diagram of proposed model.

Improves efficiency, but also improves the performance of the system. To improve the electric power storage from renewable energy systems.

VI. CONCLUSION

This work will propose a fuzzy controller to track the maximum power point of the photovoltaic power source, and simulates it in Simulink / MATLAB. The controller is based on the basic modules of the fuzzy system, namely (fuzzification, reasoning and de-fuzzification). These blocks read ambiguous inputs and program the device process, and convert the programs into output actions respectively. In this controller, the trapezoidal shape of the input and output membership functions is proposed, and the Mamdani fuzzy inference method and centroid method are also selected as the deburring process. The entire system includes photovoltaic, booster converter, diffuse controller and modeling and simulation of the load under different irradiance changes. The results will show that the proposed fuzzy controller performs well.

REFERENCES

[1] XuJia GuomingChuai ; HaonanNiu ; Qianfan Zhang Grid Connected Power Generation Control Method for Z-Source Integrated Bidirectional Charging System 2018 International Power Electronics Conference (IPEC-Niigata 2018 -ECCE Asia) Year: 2018

[2] PandlaChinnaDastagiriGoud ; Chandra SekharNalamati ; Rajesh Gupta Grid Connected Renewable Energy Based EV Charger with Bidirectional AC/DC Converter 2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON) Year: 2018

[3] Fatama-Tuz-Zahura ; Md. Ziaur Rahman Khan Advanced Control Scheme for Bidirectional Grid-Connected Inverter 2018 10th International Conference on Electrical and Computer Engineering (ICECE) Year: 2018

[4] Jiao Jiao ; RunquanMeng ; Zheng Guan ; ChunguangRen ; Lei Wang ; Baifu Zhang Grid-connected Control Strategy for Bidirectional AC-DC Interlinking Converter in AC-DC Hybrid Microgrid 2019 IEEE 10th International Symposium on Power Electronics for Distributed Generation Systems (PEDG) Year: 2019

[5] Yulu Cui ; Yifeng Wang ; Xiaoyong Ma A Delay Compensation Control Method Based on Interleaved Dual BUCK Full Bridge Grid-connected Bidirectional Converter 2019 22nd International Conference on Electrical Machines and Systems (ICEMS) Year: 2019

[6] H. G. Langer and H. -Ch. Skudelny (1989), "DC to DC converters with bi-directional power flow and controllable voltage ratio," in Proc. IEE EPE Conf., pp. 1245–1250.

[7] Capel (1986), "A bidirectional high power cell using large signal feedback control with maximum current control for space applications," in Proc. IEEE Power Electron. Spec. Conf., pp. 684–695.

[8] K. Venkatesan (1989), "Current mode controlled bidirectional fly back converter," in Proc. IEEE Power Electron. Spec. Conf, pp. 835–842

[9] Ray (1992), "Bidirectional dc–dc power conversion using quasiresonant topology," in Proc. IEEE Power Electron. Spec. Conf., pp. 617–624.

[10] Inoue, S. & Akagi, H. (2007). A Bidirectional DC-DC converter for an Energy storage system With Galvanic Isolation. IEEE Transactions on Power Electronics, Vol. 22, No. 6, (2007), pp. 2299-2306, ISSN 0885-8993.