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A Review on Renewable Energy Sources and Bidirectional DC-DC Converter

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Abstract- A critical overview of renewable energy is provided, including descriptions of renewable energy sources, technologies, assessments, comparisons and planning as well as energy technologies that facilitate renewable energy sources .Depletion of natural resources like gas, oil, coal along with environment pollution increased the popularity of the Renewable Energy Sources (RES). Power Electronic converters are utilized for conversion of power from RES to coordinate the stand-alone load and utility grid. MPPT control is also established by these converters to supply the standalone or grid-connected load despite of the RES's unpredictable nature. In order to reduce the number of switches used for integrating RES to drive loads, Multi- port converters are developed. These converters have the capability to supply more than one load simultaneously. Furthermore, more number of RESs are connected using these converters in order to drive common loads.

Keywords- PV, MPPT, Controller, DC-DC converter, Renevable Energy

I. INTRODUCTION

Photovoltaic (PV) energy has grown at an average annual rate of 60% in the last five years, surpassing one third of the cumulative wind energy installed capacity, and is quickly becoming an important part of the energy mix in some regions and power systems. This growth has also triggered the evolution of classic PV power converters from conventional single phase grid-tied inverters to more complex topologies to increase efficiency, power extraction from the modules, and reliability without impacting the cost. Solar PV energy conversion systems have had a huge growth from an accumulative total power equal to approximately 1.2 GW in 1992 to 136 GW in 2013 [1].

The factors which are responsible for this tremendous growth are cost reduction, increase in efficiency of the PV modules, the search for alternative clean energy sources, increased environmental awareness and favorable political regulations from local governments. Grid-connected PV systems account for more than 99% of the PV installed capacity compared to stand-alone systems. Storage batteries are not required in grid connected photovoltaic system since all of the power generated by the PV plant is uploaded to the grid for direct transmission, distribution, and consumption. The generated PV power reduces the use of other energy sources feeding the grid, such as hydro or fossil fuels, whose savings act as energy storage in the system, providing the same function of power regulation and backup as a battery would deliver in a stand-alone system. 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.[2]

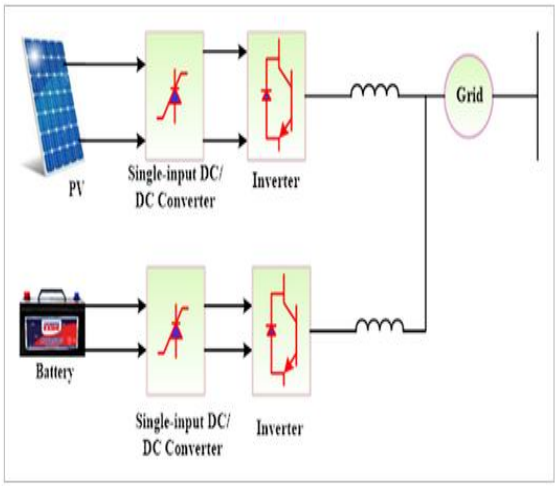

Fig.1 Traditional multi-port system

Renewable sources such as Photovoltaic (PV), Fuel cell(FC) and Wind energy gains popularity in power generation due to the technology advancements and environmental concerns. In addition, integration of hybrid power sources are increasing in recent days. By nature, intermittency and unpredictability of renewable sources and load highly demands inclusion of energy storage systems like battery, supercapacitors to meet the load requirement and also to improve the dynamic and steady state performance of the sources. Thus DC-DC converters are included to interface source, energy storing elements and load. Several unidirectional converters are proposed to realize DC-

DC power conversion and to meet necessary voltage requirement of the load. In case of systems with energy storage, two individual unidirectional converters are used to control its charging and discharging cycles. However, both charging and discharging capability can be implemented in same topology to lessen the count of power electronic components. Thus bidirectional DC-DC converter manages power flow between input source, energy storage elements and load in addition to voltage level conversion, control and increased lifetime of energy storage devices. Isolation between power circuits are preferable for safety reasons and hence to achieve DC galvanic isolation, transformers are included in the topologies. Thus intense researches are being carried out in development of new power electronic circuit topologies that interfaces solar PV, battery or supercapacitors and load with controlled power flow between these ports [1–5]. The Bidirectional DC-DC converters (BDC) are operated in Boost mode (step up mode) and Buck mode (step-down mode) that controls power flow both in forward and reverse direction. The applications of such BDCs are extended in Electic Vehicles to charge and discharge the batteries. Dual Active Bridge (DAB) BDC topologies with a source port and a load port are derived with bidirectional power flow control [6–8]. However, only two ports are controlled which leads to development of three port converter topologies to integrate multi input and multi output ports with bidirectionality achieved in one or more ports. Based on the circuit configuration with or without galvanic isolation provided by the transformer, these converters are categorized into partly/fully isolated converters and non-isolated converters respectively.[3]

II. BIDIRECTIONAL DC-DC CONVERTERS

Most of the existing BDCs are characterized by a current fed or voltage fed on one side . Based on the placement of an auxiliary energy storage, BDCs can be categorized into buck and boost type. In the buck type, energy storage is placed on the high voltage side and in the boost type on the low voltage side. To realize the double power flow in BDCs, the switch cell should carry the current in both directions.

It is usually implemented with a unidirectional semiconductor power switch such as power MOSFET or IGBT in parallel with a diode (or body diode) because the double sided current flow power switch is not available. Depending on the application, different dc-dc converters are used to modulate the input voltage. Generally, there are two basic types of BDCs, which are non-isolated and isolated .In the transformer less non-isolated power conversion systems, the boost type and the buck type dc-dc converters are commonly chosen. The high frequency transformer based system is a reasonable solution to obtain isolation between the source and the load side. Isolation is mandatory when the very high step-up or step-down ratio is required. But to improve the efficiency, size, weight and cost, the non-isolated type is much more attractive. Thus, in the high power or spacecraft power system applications where weight and size are the main concern, the transformer less type is more preferable.

Bidirectional DC/DC Converter Topologies- Bidirectional operation can be implemented in a converter with a synchronous rectifier (SR) for both isolated and non-isolated topologies. This paper only focuses on non-isolated topologies to simplify the discussion. The conclusions can also be extended to an isolated topology by adding an isolation transformer. Typical non-isolated bidirectional converters are buck, boost, and four-switch

buck-boost .It is obvious that a buck converter can run as a boost converter in the reverse direction. And a boost converter can run as a buck converter in the reverse direction. Since the four-switch buck-boost converter runs in either two-switch buck mode or two-switch boost mode, it can also easily work in reverse direction similarly to a single buck or boost converter[9-11].

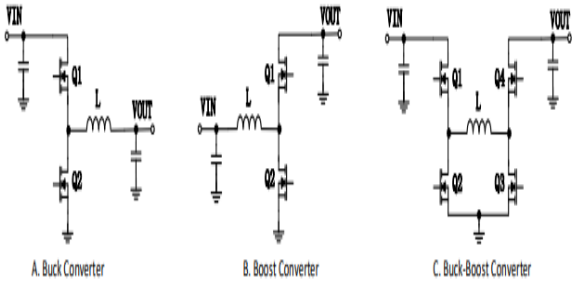

Figure 1. Bidirectional DC/DC converter topologies.

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[12-14].

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[6].

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 [7]

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.[1]

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.[2]

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.[3]

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.[4]

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.[5]

VI. CONCLUSION

The intention of this paper is to provide a detailed review of the multi-port partial isolated bidirectional DC-DC converter topologies. The present trend in interfacing renewable source with energy storage system shows

clearly an increasing demand for high performance DC-DC converters with bidirectional power transfer capability. The details of existing multi-port converter topologies interfacing renewable photovoltaic source, energy storing battery, supercapacitor and load are discussed. The charging and discharging of batteries, supercapacitors are controlled by implementing phase shift or pulse width modulated control techniques. Based on the discussions in this paper, it is clear that galvanic isolation by transformer in both partly isolated and fully isolated three port converter topologies are preferred for bidirectional power flow control of energy storage elements with higher power ratings.

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