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Grid Connected Hybrid Based Efficient Synchronous Couped Converter

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Abstract: In this paper, a control strategy for power flow management of a grid-connected hybrid based system with an efficient synchronous coupled converter is presented. The proposed system aims to satisfy the load demand, manage the power flow from different sources, inject surplus power into the grid and charge the battery from grid as and when required. A boost half-bridge converter is used to harness power from wind, while bidirectional buck-boost converter is used to harness power from PV along with battery charging/discharging control. A single-phase full-bridge bidirectional converter is used for feeding ac loads and interaction with grid. The proposed converter architecture has reduced number of power conversion stages with less component count, and reduced losses compared to existing grid-connected hybrid systems. This improves the efficiency and reliability of the system. The effectiveness of the topology and efficacy of the proposed control strategy are validated through detailed experimental studies, to demonstrate the capability of the system operation in different modes.

Keywords: Hybrid system, solar photovoltaic, wind energy, transformer coupled boost dual-half-bridge bidirectional converter, bidirectional buck-boost converter, maximum power point tracking, full bridge bidirectional converter, battery charge control.

I. INTRODUCTION

More sustainable and renewable energy sources are being integrated into power systems and power electronics to address the increasing concerns of energy costs, energy security, and greenhouse gas emissions. For these sustainable and renewable energy based power generation systems, the grid-interfacing power electronics are critical links that essentially integrate the energy source, energy storage, or even small networks (e.g. micro grids) to the main grid. As this sustainable energy integration (especially for dispersed and small capacity sources) is mostly at the distribution level, the wide adoption of grid-interfacing converters also brings unprecedented opportunities for future more active and flexible distribution systems with both AC and DC networks. To operate such a system with high penetration of sustainable and renewable energy sources, a number of power electronics technologies are essential: topology and pulse-width-modulation (PWM) of grid-interfacing power electronics, voltage/current control strategies, power flow regulation, energy management, power quality control, etc.

Depletion of fossil fuel reserves, ever increasing energy demand and concerns over climate change motivate power generation from renewable energy sources. Solar photovoltaic (PV) and wind have emerged as popular energy sources due to their eco-friendly nature and cost effectiveness. However, these sources are intermittent in nature. Hence, it is a challenge to supply stable and continuous power using these sources. This can be addressed by efficiently integrating with energy storage elements. The interesting complementary behaviour of solar insolation and wind velocity pattern coupled with the above mentioned advantages, has led to the research on their integration resulting in the hybrid PV-wind systems. The integration of multiple renewable sources, the traditional approach involves using dedicated single-input converters one for each source, which are connected to a common dc-bus [1] - [3].

However, these converters are not effectively utilized, due to the intermittent nature of the renewable sources. In addition, there are multiple power conversion stages which reduce the efficiencyof the system. Significant amount of literature exists on the integration of solar and wind energy as a hybrid energy generation system with focus mainly on its sizing and optimization [7]. In [7], the sizing of generators in a hybrid system is investigated. In this system, the sources and storage are interfaced at the dclink, through their dedicated converters. Other contributions are made on their modeling aspects and control techniques for a stand-alone hybrid energy system in [2]`.

Dynamic performance of a stand-alone hybrid PV-wind system with battery storage is analyzed in [5]. In [4], a passivity/sliding mode control is presented which controls the operation of wind energy system to complement the solar energy generating system. Not many attempts are made to optimize the circuit configuration of these systems that could reduce the cost and increase the efficiency and reliability. In [6] - [2], integrated converters for PV and wind energy systems are presented. PV-wind hybrid system, proposed by Daniel et al. [6], has a simple power topology but it is suitable for stand-alone applications. An integrated four port topology based on hybrid PV-wind system is proposed in [7]. However, despite simple topology the control scheme used is complex. In [1], to feed the dc loads, a low capacity multi-port converter for a hybrid system is presented.

II. WIND SOLAR SYSTEM

Wind power is one of the most promising clean energy sources since it can easily be captured by wind generators with high power capacity. Photovoltaic (PV) power is another promising clean energy source since it is global and can be harnessed without using rotational generators. In fact, wind power and PV power are complementary to some extent since strong winds are mostly to occur during the night time and cloudy days whereas sunny days are often calm with weak winds Hence, a wind–PV hybrid generation system can offer higher reliability to maintain continuous power output than any other individual power generation systems. wind and solar power can be considered as viable options for future electricity generation. Besides being emission-free, the energy coming from the wind and the sunrays is available at no cost. A hybrid alternative energy system can either be standalone or grid-connected. For a standalone application, the system needs to have sufficient storage capacity to handle power variations from the involved alternative energy sources.

III. BLOCK DIARAM

The output of the wind and solar given to the synchronizing unit. In tha synchronizing unit the two ouput are compared and combined by using the comparator and synchronizer. And then its output is given to the bi-directional Dc-`Dc converter. The dc output is stores in battery for charging/discharging control. Its used for the dc loads. According to the loads the inverter is used. If want to power the Ac load the output of bi-directional Dc-Dc converter output is given to the inverter. Its output is ac finally used for Ac loads.

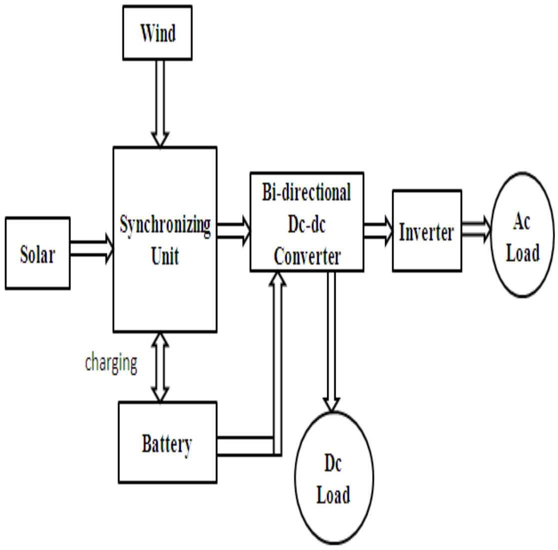

Figure 1

- ✓ MPP tracking of both the sources, battery charging control and bidirectional power flow are accomplished with six controllable switches.
- ✓ The voltage boosting capability is accomplished by connecting PV and battery in series which is further enhanced by a high frequency step-up transformer.
- ✓ Improved utilization factor of the power converter, since the use of dedicated converters for ensuring MPP operation of both the sources is eliminated.
- ✓ Galvanic isolation between input sources and the load.
- ✓ The proposed controller can operate in different modes of a grid-connected scheme ensuring proper operating mode selection and smooth transition between different possible operating modes.
- ✓ Enhancement in the battery charging efficiency as a single converter is present in the battery charging path from the PV source.

IV. SIMULATION WORK

The system consists of a synchronous coupled boost dual-half-bridge bidirectional converter fused with bidirectional buck-boost converter and a single-phase full-bridge inverter. The proposed converter has reduced number of power conversion stages with less component count and high efficiency compared to the existing grid-connected schemes. The topology is simple and needs only six power switches. The schematic diagram of the converter is depicted in fig. The boost dual-half-bridge converter has two dc-links on both sides of the high frequency transformer. Controlling the voltage of one of the dc-links, ensures controlling the voltage of the other. This makes the control strategy simple. Moreover, additional converters can be integrated with any one of the two dc-links.

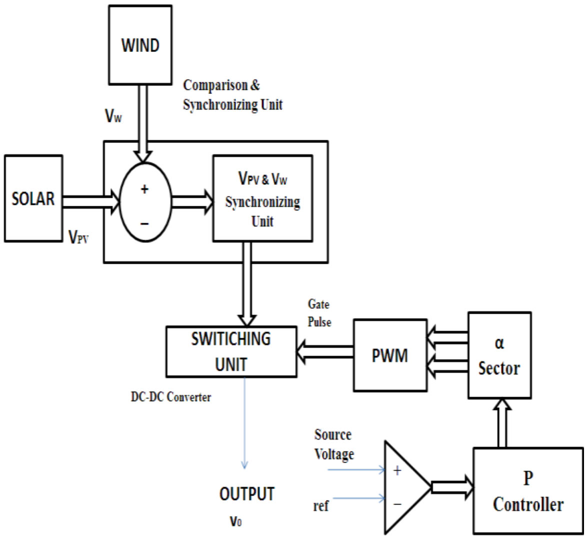

Figure 2

A bidirectional buck-boost dc-dc converter is integrated with the primary side dc-link and single-phase full bridge bidirectional converter is connected to the dc-link of the secondary side. The input of the half-bridge converter is formed by connecting the PV array in series with the battery, thereby incorporating an inherent boosting stage for the scheme. The boosting capability is further enhanced by a high frequency step-up transformer. The transformer also ensures galvanic isolation to the load from the sources and the battery. Bidirectional buck boost converter is used to harness power from PV along with battery charging/discharging control. The unique feature of this converter is that MPP tracking, battery charge control and voltage boosting are accomplished through a single converter.

Synchronous coupled boost half-bridge converter is used for harnessing power from wind and a single-phase full-bridge bidirectional converter is used for feeding ac loads and interaction with grid. The proposed converter has reduced number of power conversion stages with less component count and high efficiency compared to the existing grid-connected converters.

The power flow from wind source is controlled through a unidirectional boost half-bridge converter. For obtaining MPP effectively, smooth variation in source current is required which can be obtained using an inductor. In the proposed topology, an inductor is placed in series with the wind source which ensures continuous current and thus this inductor current can be used for maintaining MPP current. When switch T 3 is ON, the current flowing through the source inductor increases. The capacitor C1 discharges through the transformer primary and switch T 3. In secondary side capacitor C3 charges through transformer secondary and anti-parallel diode of switch T 5. When switch T 3 is turned OFF and T 4 is turned ON, initially the inductor current flows through antiparallel diode of switch T 4 and through the capacitor bank. During this interval, the current flowing through diode decreases and that flowing through transformer primary increases.

When current flowing through the inductor becomes equal to that flowing through transformer primary, the diode turns OFF. Since, T 4 is gated ON during this time, the capacitor C2 now discharges through switch T 4 and transformer primary. During the ON time of T4, anti-parallel diode of switch T6 conducts to charge the capacitor C4. The path of current flow is shoun in fig.

During the ON time of T3, the primary voltage VP=−VC1. The secondary voltage VS = nVp = −nVC1 = −VC3, or VC3 = nVC1 and voltage across primary inductor Lw is Vw. When T 3 is turned OFF and T 4 turned ON, the primary voltage VP = VC2. Secondary voltage VS = nVP = nVC2 = VC4 and voltage across primary inductor Lw is Vw −(VC1 +VC2). It can be proved that (VC1 + VC2) = Vw (1−Dw).The capacitor voltages are considered constant in steady state and they settle at VC3 = nVC1, VC4 = nVC2. Hence the output voltage is given by

$$Vdc = VC3 + VC4 = nVw(1 - Dw)$$

Further, this bidirectional buck-boost converter charges/discharges the capacitor bank C1-C2 of transformer coupled half-bridge boost converter based on the load demand. The half-bridge boost converter extracts energy from the wind source to the capacitor bank C1-C2. During battery charging mode, When switch T 1 is ON, the energy is stored in the inductor L. When switch T 1 is turned OFF and T 2 is turned ON, energy stored in L is transferred to the battery

Parameters	Values
Solar PV power	12v
Wind power	12v
Switching frequency	15HZ
Battery capacity & voltage	36v,400Ah
Output voltage	220v

Table 1

Therefore, the output voltage of the secondary side dc-link is a function of the duty cycle of the primary side converter and turns ratio of transformer. In the proposed configuration as shown, a bidirectional buck-boost converter is used for MPP tracking of PV array and battery charging/discharging control

V. CONCLUSION

A grid connected hybrid based efficient synchronous coupled converter is proposed. The proposed system produces regulated output voltage to the load from the different input sources. As the power produced by the renewable energy sources like solar and wind which are intermittent due to change in weather conditions, a storage element battery is provided.

Battery starts discharging, when the power delivered by the input sources is less than the load voltage to provide a continuous supply to the load. Instead of using individual converter for each source in hybrid system, The proposed configuration is capable of supplying un-interruptible power to ac loads, and ensures evacuation of surplus PV and wind power into the grid. The proposed configuration is capable of supplying un-interruptible power to ac loads, and ensures evacuation of surplus PV and wind power into the grid.

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REFERENCES

[1] C. Liu, K. T. Chau and X. Zhang, “An efficient wind-photovoltaic hybrid generation system using doubly excited permanent-magnet brushless machine, ”*IEEE Trans. Ind. Electron.*, vol. 57, no. 3, pp. 831-839, Mar. 2010.

[2] L. Xu, X. Ruan, C. Mao, B. Zhang, and Y. Luo,“An improved optimal sizing method for wind-solar-battery hybrid power system,” IEEE Trans. Sustainable Enery., vol. 4, no. 3, pp. 774785, Jul. 2013.

[3] B. S. Borowy and Z. M. Salameh, “Dynamic response of a stand-alone wind energy conversion system with battery energy storage to a wind gust,” IEEE Trans. Energy Convers., vol. 12, no. 1, pp. 73-78, Mar. 1997.

[4] S. Bae and A. Kwasinski, “Dynamic modeling and operation strategy for a microgrid with wind and photovoltaic resources,” IEEE Trans. Smart Grid, vol. 3, no. 4, pp. 1867-1876, Dec. 2012.

[5] C. W. Chen, C. Y. Liao, K. H. Chen and Y. M. Chen, “Modeling and controller design of a semi isolated multi input converter for a hybrid PV/wind power charger system,” IEEE Trans. Power Electron., vol. 30, no. 9, pp. 4843-4853, Sept. 2015.

[6] M. H. Nehrir, B. J. LaMeres, G. Venkataramanan, V. Gerez, and L. A. Alvarado, “An approach to evaluate the general performance of stand-alone wind/photovoltaic generating systems,” IEEE Trans. Energy Convers., vol. 15, no. 4, pp. 433-439, Dec. 2000.

[7] W. M. Lin, C. M. Hong, and C. H. Chen, “Neural network-based MPPT control of a stand-alone hybrid power generation system,” IEEE Trans. Power Electron., vol. 26, no. 12, pp. 3571-3581, Dec. 2011.