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Design ofsingle stage single phase reconfigurableinverter for a solar powered hybrid AC/DC home

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Abstract:*This paper offerings a new active/reactive powerclosed-loop control system for a hybrid renewable energy generation system used for single-phase residential/commercial applications. This project recommended a reconfigurable single phase inverter topology for a hybrid AC/DC solar poweredhome. This inverter own a single phase single stage topology and the main benefit of this converter isthat it can perform DC/DC, DC/AC and grid tie operation, thus decreases loss, cost, size of the converter. Thishybrid AC/DC home has appliances of both AC and DC types. This type of home assistances to reduce the powerloss by circumventingneedless double stages of power conversion and progresses the harmonic profile byisolating DC type loads to DC supply side and rest of AC side.*

Keywords-DC to DC, Power Conversion, DC Type loads

I. INTRODUCTION

Nowadays, humans bear in mind renewable electricity resources to be a viable mainstream source of strength generation. In the perfect case, a residential residence need to be self-sustainable and even aid the utility grid when wanted. The essential trouble in figuring out this scheme is the intermittent nature of renewable electricity resources [1]-[3]. Therefore, reliability is the primary difficulty for harvesting renewable power in the future. Energy storage systems offer a awesome strategy to supplement the intermittent nature of renewable strength structures [4]-[6]. In particular, energy storage inside the form of batteries in electric powered vehicles (EVs) can effectively support the integration of the intermittent renewable power assets into allotted generations (DGs) [7]-[10]. With the exponential increase of EVs, the batteries in EVs can offer great strength storage capability for DGs. Besides strength storage, EVs can provide reactive power compensation (VAR compensation), load balancing, modern-day harmonic filtering and several other ancillary contributions [11]-[12]. Considering the aforementioned competencies, EVs and electricity storage gadgets will be an inevitable a part of smart grids [13]-[18]. Fig.1 suggests a typical association of a hybrid renewable strength generation system (HREGS). According to this figure, a wind energy conversion system (WECS), a sun inverter and an strength garage unit are covered in the HREGS. These three additives carry out smart energy management. Only for the duration of days is the sun inverter generating energy, whereas the wind power era is extra said for the duration of nights. Using smart electricity control, consisting of peak shaving or energy shifting, the greater electricity may be stored inside the strength garage unit and be launched whilst it is required [19]-[20].

From the aforementioned discussion, the significance of the electricity storage unit is very glaring so that it will complement an intermittent HREGS. The consciousness of this paper is the active and reactive power control of the power storage unit used in a residential scale HREGS. A unmarried-segment bi-directional AC/DC converter is the important thing component of an strength garage unit. If an EV is used as the strength garage unit in this structure, the AC/DC converter is blanketed inside the on-board charger. The bidirectional AC/DC converter can successfully manage the active and reactive energy among the grid and the battery in addition to acting other ancillary services. The control of the AC/DC converter is of incredible significance to the integration of the electricity storage unit into the HREGS.In single-phase structures, the real-time manipulate of lively/reactive electricity is difficult due to the presence of energy ripple [21]-[23].

Conventionally, the energetic/reactive power manipulate in AC/DC converters is carried out either in a stationary reference frame or a synchronous reference body (synchronous with the grid voltage).

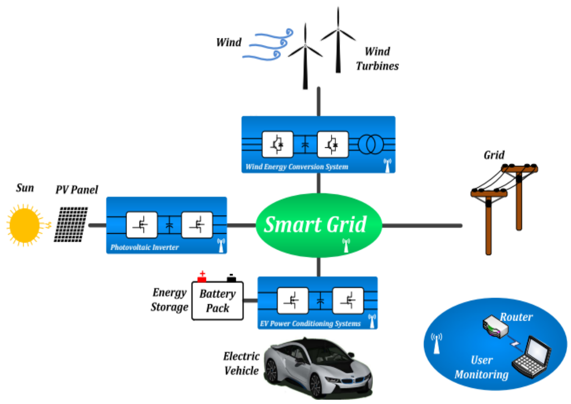

Fig. 1.Hybrid renewable energy generation system for residential/commercial applications.

Real-time calculations of the energetic and reactive electricity for the remarks manipulate machine in a single-section machine requires low bandwidth filtering due to the double frequency power ripple. Herein lies the problem with the conventional control gadget. Thus, this paper affords a singular hybrid observer, that is capable of eliminate the want for filtering the double frequency ripple in the instantaneous strength signal, resulting in a fast response in the active/reactive power closed-loop manipulate device.

II. PROPOSED CONTROL SCHEME

The experimental system proposed in this thesis is a stand-alone type without backup batteries; thesystem is very simple and consists of a single PV or DC module, and battery and hybrid converter. The sizeof the system is intended to be small; therefore it could be built in the lab in the future. The system including the subsystems will be simulated to verify the functionalities.Due to growing of nonlinear modern household equipment and new technologies in houses, which needed toimprove productivity and comfort ability, are main source of generating harmonics current in distributionfeeder and that adversely affecting the power quality, power losses along with creating a significantchallenge for electrical engineers. Modern household loads have different characteristics compared to loadspresent in earlier stage. However, harmonic mitigation and/or its minimizations are big challenges indistribution system. Many literatures works have been reported to address aforementioned problems asfollows. Harmonic mitigation in the distribution system using solar inverter by virtual harmonic dampingimpedance PV-Battery storage system is used to control the voltage stability in distribution system.

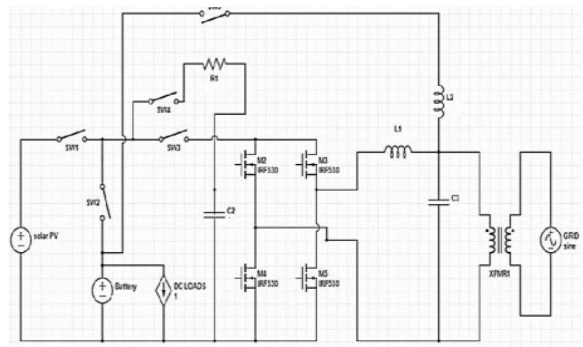

Fig.3 circuit diagram

Thecontrol of solar powered grid connected inverter for electric vehicle charging has proposed the DC microgrid and shown its advantages and challenges of making a complete DC home micro grid. Further, this paperhas analyzed by considering all buildings in 2050, 80 % of buildings are already built. So, focus is more onimproving the efficiency of existing buildings than making a new complete DC home. The efficiency ofresidential building when it is converted into DC house over the conventional AC distribution house.The circuit diagram of reconfigurable solar inverter is given in the Fig.1. Though it will reduce the noof power conversion stages but mechanical switches and cable requirement are more for this topology. Themodes of operations of the proposed single phase single stage converter are given. In addition,different operations modes are given in Figs

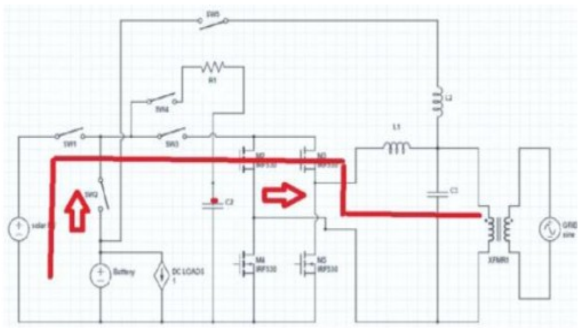

Fig.3 Mode1 operation

Mode-1 (PV to Grid): The mode of operation as shown in Fig is directly connects PV to the Grid. MPPT controller is used toextract maximum power from the solar panel. Inverter controller is used to synchronize with grid andtransfer active power to the grid.

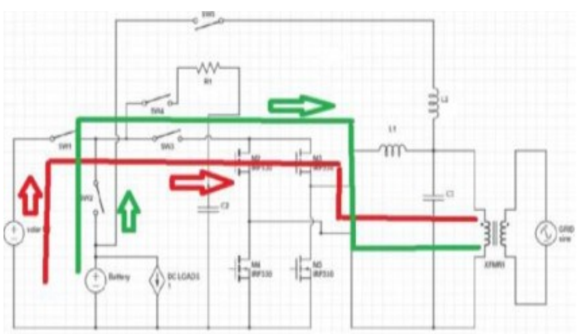

Fig.4 Mode 2 operation

Mode-2 (PV-Battery to Grid): In Fig the mode of operation is to supplying power to the grid from both solar PV and battery. This modeoperates when there is a shortage of power from the solar PV due to external conditions, e.g., weather etc.One of the drawbacks of this connection is that the battery voltage and PV voltage should always bematching each other. Since battery voltage is stiff, MPPT controller cannot be used for this configuration.

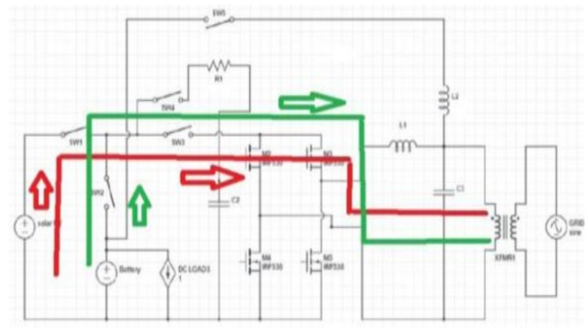

Fig.5 Mode 3 operation

Mode-3 (PV to Battery charging)

Figure 4 shows DC/DC operation of the proposed topology where battery is charged by a chopperaction of the converter. The extra inductor is optional to reduce ripple in the charging current further. When there is an excess energy available, the battery is charged for the night time usage.

III. SIMULATION RESULTS

An investigationalexample of an AC/DC converter has been applied in order to estimate the performance of the proposed active/reactive power control method.

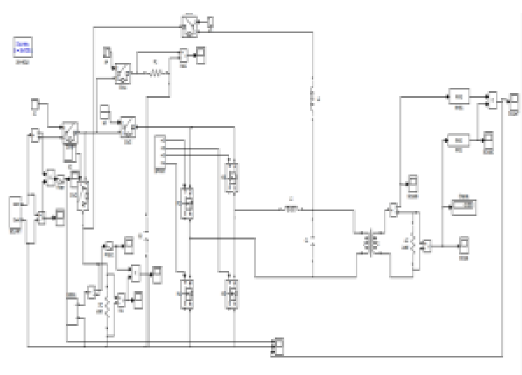

Fig.6 simulink block

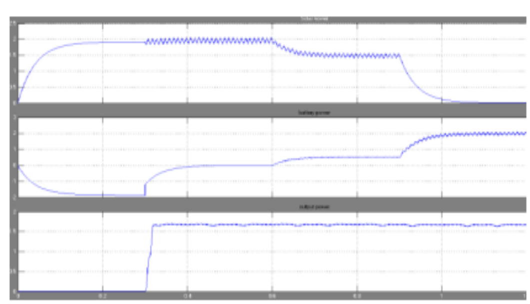

Fig.7 simulation output

IV. CONCLUSION

The foremostideas of this topology is that a single phase single conversion of AC power to DC and vice versa isemployed, which amended the efficiency, reduces volume and enhances the reliability. The hardwareenactment validates that the recommended converter topology would be cooperative to diminishsubstantialamount of harmonics in the residential feeders of the future Smart Grid. Nonetheless, here only solar PV isconsidered as source of power, this topology could be equally appropriate to wind, fuel cells etc.

REFERENCES

[1] Liserre, M.; Sauter, T.; Hung, J.Y., ”Future Energy Systems: IntegratingRenewable Energy Sources into the Smart Power Grid Through Industrial Electronics,” Industrial Electronics Magazine, IEEE , vol.4, no.1,pp.18,37, March 2010.

[2] Bose, B.K., ”Global Energy Scenario and Impact of Power Electronicsin 21st Century,” Industrial Electronics, IEEE Transactions on , vol.60,no.7, pp.2638,2651, July 2013.

[3] Blaabjerg, F.; Zhe Chen; Kjaer, S.B., ”Power electronics as efficientinterface in dispersed power generation systems,” Power Electronics,IEEE Transactions on , vol.19, no.5, pp.1184,1194, Sept. 2004.

[4] Jamehbozorg, A.; Radman, G., ”Small Signal Analysis of Power SystemsWith Wind and Energy Storage Units,” Power Systems, IEEE Transactions on , vol.30, no.1, pp.298,305, Jan. 2015.

[5] Vargas, L.S.; Bustos-Turu, G.; Larrain, F., ”Wind Power Curtailment andEnergy Storage in Transmission Congestion Management ConsideringPower Plants Ramp Rates,” Power Systems, IEEE Transactions on ,vol.PP, no.99, pp.1,9, 2015.

[6] Quanyuan Jiang; Yuzhong Gong; Haijiao Wang, ”A Battery EnergyStorage System Dual-Layer Control Strategy for Mitigating Wind FarmFluctuations,” Power Systems, IEEE Transactions on , vol.28, no.3,pp.3263,3273, Aug. 2013.

[7] Derakhshandeh, S.Y.; Masoum, A.S.; Deilami, S.; Masoum, M.A.S.;HamedaniGolshan, M.E., ”Coordination of Generation Scheduling withPEVs Charging in Industrial Microgrids,” Power Systems, IEEE Transactions on , vol.28, no.3, pp.3451,3461, Aug. 2013.

[8] Yilmaz, M.; Krein, P.T., ”Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and HybridVehicles,” Power Electronics, IEEE Transactions on , vol.28, no.5,pp.2151,2169, May 2013.

[9] R. Sioshansi and P. Denholm, ”Emissions Impacts and Benefits of PlugIn Hybrid Electric Vehicles and Vehicle-to-Grid Services,” EnvironmentalScience & Technology, vol. 43, no. 4, pp. 1199-204, Feb. 2009.

[10] C. Thomas, ”Fuel Cell and Battery Electric Vehicles Compared,” International Journal of Hydrogen Energy, p. 262512, 2009.

[11] M. Yilmaz and P. T. Krein, ”Review of the Impact of Vehicle-toGrid Technologies on Distribution Systems and Utility Interfaces,” IEEETransactions on Power Electronics, vol. 28, no. 12, pp. 5673-5689, Dec.2013.

[12] Mischinger, S.; Hennings, W.; Strunz, K., ”Integration of surplus windenergy by controlled charging of electric vehicles,” Innovative SmartGrid Technologies (ISGT Europe), 2012 3rd IEEE PES InternationalConference and Exhibition on , vol., no., pp.1,7, 14-17 Oct. 2012.

[13] Kramer, B.; Chakraborty, S.; Kroposki, B., ”A review of plug-in vehiclesand vehicle-to-grid capability,” Industrial Electronics, 2008. IECON 2008.34th Annual Conference of IEEE , vol., no., pp.2278,2283, 10-13 Nov.2008

[14] Kisacikoglu, M.C.; Ozpineci, B.; Tolbert, L.M.; Wang, F., ”Singlephase inverter design for V2G

reactive power compensation," AppliedPower Electronics Conference and Exposition (APEC), 2011 TwentySixth Annual IEEE , vol., no., pp.808,814, 6-11 March 2011.

[15] Da Qian Xu; Joos, G.; Levesque, M.; Maier, M., "Integrated V2G, G2V,and Renewable Energy Sources Coordination Over a Converged FiberWireless Broadband Access Network," Smart Grid, IEEE Transactions on, vol.4, no.3, pp.1381,1390, Sept. 2013.

[16] Yilmaz, M.; Krein, P.T., "Review of the Impact of Vehicle-to-GridTechnologies on Distribution Systems and Utility Interfaces," PowerElectronics, IEEE Transactions on , vol.28, no.12, pp.5673,5689, Dec.2013.

[17] Mitra, P.; Venayagamoorthy, G.K., "Wide area control for improvingstability of a power system with plug-in electric vehicles," Generation,Transmission & Distribution, IET , vol.4, no.10, pp.1151,1163, October2010.

[18] Galus, Matthias D.; Waraich, R.A.; Noembrini, F.; Steurs, K.; Georges,G.; Boulouchos, K.; Axhausen, K.W.; Andersson, G., "Integrating PowerSystems, Transport Systems and Vehicle Technology for Electric MobilityImpact Assessment and Efficient Control," Smart Grid, IEEE Transactionson , vol.3, no.2, pp.934,949, June 2012.

[19] Molderink, A.; Bakker, V.; Bosman, M.G.C.; Hurink, J.L.; Smit, G.J.M.,"Management and Control of Domestic Smart Grid Technology," SmartGrid, IEEE Transactions on , vol.1, no.2, pp.109,119, Sept. 2010.

[20] Fang, Xi; Misra, Satyajayant; Xue, Guoliang; Yang, Dejun, "Smart GridThe New and Improved Power Grid: A Survey," Communications Surveys& Tutorials, IEEE , vol.14, no.4, pp.944,980, Fourth Quarter 2012.

[21] Blaabjerg, F.; Teodorescu, R.; Liserre, M.; Timbus, A.V., "Overviewof Control and Grid Synchronization for Distributed Power GenerationSystems," Industrial Electronics, IEEE Transactions on , vol.53, no.5,pp.1398,1409, Oct. 2006.

[22] Guerrero, J.M.; Lijun Hang; Uceda, J., "Control of Distributed Uninterruptible Power Supply Systems," Industrial Electronics, IEEE Transactions on , vol.55, no.8, pp.2845,2859, Aug. 2008

[23] YaosuoXue; Liuchen Chang; SrenBaekhjKjaer; Bordonau, J.; Shimizu,T., "Topologies of single-phase inverters for small distributed powergenerators: an overview," Power Electronics, IEEE Transactions on ,vol.19, no.5, pp.1305,1314, Sept. 2004