THE REVIEW OF HYBRID GRID CONNECTED INVERTER FOR RENEWABLE ENERGY GENERATION WITH POWER QUALITY CONDITIONING

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Abstract: The paper presents the review of a new type of inverter HGCI (Hybrid Coupling Grid Connected Inverter) based on power quality conditioning for active power generation. Based on the prominent features of HGCI the operational and system cost can be reduced to a great extent and the interesting thing is that it enables the transfer of active power and compensate reactive power, unbalanced power and harmonic power simultaneously.

Index Terms **– HGCI, PV, IGCI, CGCI**

I. INTRODUCTION

Around the world there is a growing attention in renewable energy. New strategies for operation and management of electricity grid for increasing number of renewable energy sources and distributed generators in order to maintain or improve the power supply reliability and quality. The modern grids are based on technologies to ensure environmental friendly energy besides serve better electricity and reliability and as for analysis the solar energy is the gift for society because of its advantages like cost effective and environmental friendliness. The solar energy is most common renewable energy and the global solar power capacity is predicted to reach 613 GW in 2020. To utilize solar renewable energy for modern grids intensive research is done on how to enhance the structure design and control methods of photovoltaic DC/AC inverters. The basic structure characteristics of different DC/AC inverter topologies can be described as:

1. Using multilevel DC/AC inverter structure with each module supported by independent PV panels as energy source.
2. Using line frequency voltage step-up transformer after the DC/AC inverter to step-up its operating voltage into the same power grid voltage level.
3. Step up the PV panel output voltage by using a DC-DC boost converter before the DC/AC inverter.
4. Connecting many PV panels in series as the DC-link energy source for the DC/AC inverter.

II. LITERATURE REVIEW

Bhuyan et al (2018) the research paper entitled “Modelling and Simulation of Hybrid Energy System Supplying 3Ø Load and its Power Quality Analysis” describes hybrid energy system (HES) used to supply the electricity to the 3Ø load as well as 1Ø load which is synchronized to the grid with the help of voltage source converter (VSC). In this paper, H2 is generated from electrolyser which takes extra PV energy and water as input elements. The complete modelling of the individual components is simulated in Matlab/Simulink

environment and also the results obtained are found to be satisfactory. Then power quality factor is verified for HES as well as 3Ø non-linear load to analyze the quality of power.

Wang et al (2017) the research paper entitled "Analysis, Control and Design of Hybrid Grid-Connected Inverter for Renewable Energy Generation with Power Quality Conditioning" describes the new type of DC/AC inverter HGCI (Hybrid coupling grid connected inverter) based on photovoltaic active power generation with power quality conditioning. The paper also presents the characteristics of HGCI compared with IGCI and CGCI that reduces the system and operational cost.

Mounika et al (2017) the research paper entitled "Modeling and Design of Hybrid Control Strategy for Power Quality Improvement in Grid Connected Renewable Energy Source" describes the need of environmental friendly and pollution free renewable energy sources. In this paper a new control strategy for 3 phase 4wire inverter is introduced for effective utilization of renewable energy source with grid.

Bouzelata et al (2015) the research paper entitled "Exploration of optimal design and performance of a hybrid wind-solar energy system" presents the new hybrid trends in power electronic for the integration of wind energy conversion system (WECS) and photovoltaic power generator which is later connected to the grid line via parallel active power filter (APF). The aim of this new hybrid configuration is to respond simultaneously to the power generation by both active power and reactive power compensation and harmonics current mitigation by active filtering capability fed by solar energy.

Srikanth and kumar (2014) the research paper entitled "Power Quality Improvement Techniques in Hybrid Systems – Are view" describes the quality constraint in power system transmission and distribution. As we now most of the energy is consumed by us means power demand is increased with unavailability of fossil fuels and the cost of generation, transmission and utilization also increases. The paper describes the need of hybrid power generation system to address the above mentioned challenges.

Khadem et al (2010) the research paper entitled "Power quality in Grid connected Renewable energy systems: Role of Custom Power Devices" presents a technical review of power quality issues associated with the renewable distribution generation systems and how CPD (custom power devices) like STATCOM, DVR and UPQC play important role in power quality improvement.

Khalid (2017) the research paper entitled "Development of Single Stage Thyristor Based Grid Connected Single Phase Inverter for Renewable Energy Systems" developed the thyristor & inductor based inverter. In conventional topology current of almost constant magnitude flows in inductor at dc side which set up constant magnitude of H in the core. At high value of H, with constant magnitude, the slope on B-H curve is small thus the effective value of inductance becomes small which is proportional to the slope on B-H curve. Therefore, inductor on dc side saturates and its effective value becomes low, thus to avoid saturation inductor of high rating is required which increases cost, size, weight and losses in the inductor. However, in proposed topology partial reset or reversal of flux in B-H loop takes place due to half-wave dc current in the inductor, therefore the effective inductance is high, thus this topology does not require inductor of high rating which reduces cost, size, weight and losses in the inductor.

Zhang et al (2012) the research paper entitled "Capacitive-coupled Grid-connected Inverter with Active Power Injection Ability" proposed the CGCI system which is capable of offering comprehensive power delivery and harmonic compensation. Compared to IGCI system, the CGCI system betterly reduces the rating of inverter without deteriorating the ability of power delivery and harmonic compensation. The reactive power adjustment module is included in the inverter control scheme, aiming at ensuring the required amount of active power injection and low inverter output voltage. When there is no active power injection requirement, the reactive power and

harmonic compensation is obtained by direct current control scheme, which detects the average load reactive power and harmonic currents, and then calculates the reference compensation current by use of single-phase instantaneous reactive power theory (IRP). When there is active power injection requirement, the CGCI operates in the mode of comprehensive active and reactive power delivery. The active power delivery is achieved by dc-link regulator, which ensures power balance of the overall inverter system, to deliver the active power generation of RES into the utility grid. The reactive power and harmonic compensation are achieved simultaneously.

III. EXISTING SYSTEM

The costly PV energy generation system does not operate almost 60% of the year if it just transfers the active power to the power grid only, which is not efficient and cost-effective. As a result, the PV generation system will work more cost-effectively if it can provide active power injection together with power quality conditioning (such as: reactive power, current harmonic, unbalanced power compensation) simultaneously. For example, the PV generation system can inject the active power and provide power quality conditioning in the daytime, while it just compensates the power quality problem at night. As the active power injection and power quality conditioning are fully supported by the inverter part only of the IGCI, this is the reason of the IGCI requires a high DC-link voltage requirement, so as high voltage rating switching devices. To reduce the required high DC-link voltage in Topology 4 and provide active power transfer and power quality conditioning functions simultaneously, the capacitive-coupling grid-connected inverters (CGCIs) are used.

IV. PROPOSED SYSTEM

The active inverter part is composed of a DC/AC voltage source inverter (VSI) with a DC-link capacitor CDC and a DC-link voltage VDC, and a small rating active inverter part is used to bear the PV active power injection, improve the performance of the TCLC part and also compensate the current harmonics. Thus, it is possible to connect less PV panels in series in comparison with the IGCI case for active power transfer and power quality conditioning. The HGCI can require low voltage rating switching devices of the active inverter part, and the cost and switching loss of the thyristor is much lower than those switching devices. Therefore, the initial cost and operational loss of the HGCI can be less than the IGCI.

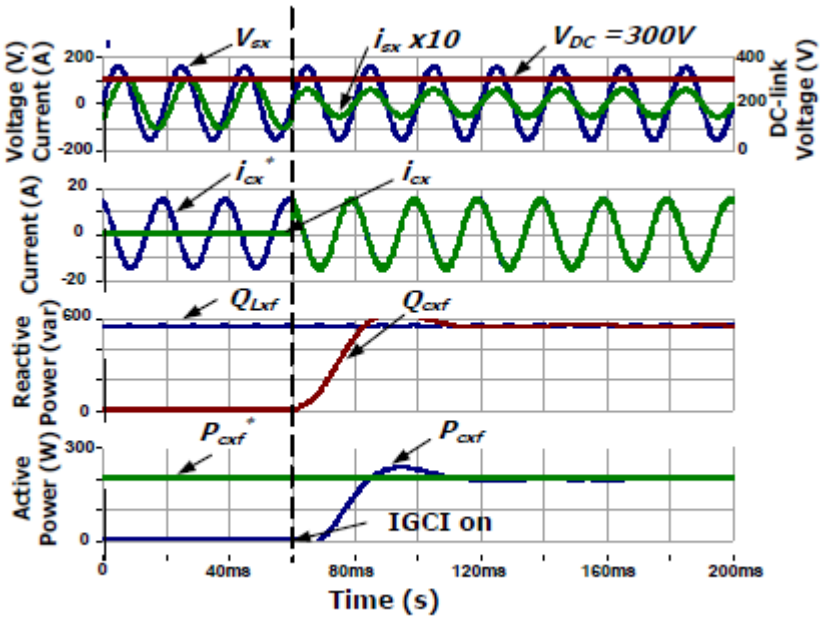
V. COMPARATIVE ANALYSIS OF LITERATURE REVIEW

Reference	Title	Technique	Research Findings
Bhuyan et al	Modelling and Simulation of Hybrid Energy System Supplying 3Ø Load and its Power Quality Analysis	VSC	Presents a hybrid energy system (HES) used to supply the electricity to the 3Ø load as well as 1Ø load which is synchronized to the grid with the help of voltage source converter
Wang et al	Analysis, Control and Design of Hybrid Grid-Connected Inverter for Renewable Energy Generation with Power Quality Conditioning	HGCI	Presents the new type of DC/AC inverter HGCI (Hybrid coupling grid connected inverter) based on photovoltaic active power generation with power quality conditioning
Mounika et al	Modelling And Design of Hybrid Control Strategy for Power Quality Improvement in Grid Connected Renewable Energy Source	3 phase 4wire inverter	Describes the need of environmental friendly and pollution free renewable energy sources.
Bouzelata et al	Exploration of optimal design and performance of a hybrid wind-solar energy system	Active Power Filter	Presents the new hybrid trends in power electronic for the integration of wind energy conversion system (WECS) and photovoltaic power generator which is connected to the grid line via parallel active power filter
Srikanth and kumar	Power quality improvement techniques in hybrid systems – a review	Hybrid Power Generation System	The paper describes the need of hybrid power generation system to address the challenges.
Khadem et al	Power quality in Grid connected Renewable energy systems: Role of Custom Power Devices	CPD	Presents a technical review of power quality issues associated with the renewable distribution generation systems and how CPD play important role in power quality improvement.
Zhang et al	Capacitive-coupled Grid-connected Inverter with Active Power Injection Ability	Instantaneous reactive power theory	Presents the role of dc-link regulator which ensures power balance of the overall inverter system to deliver active power generation of RES into utility grid.

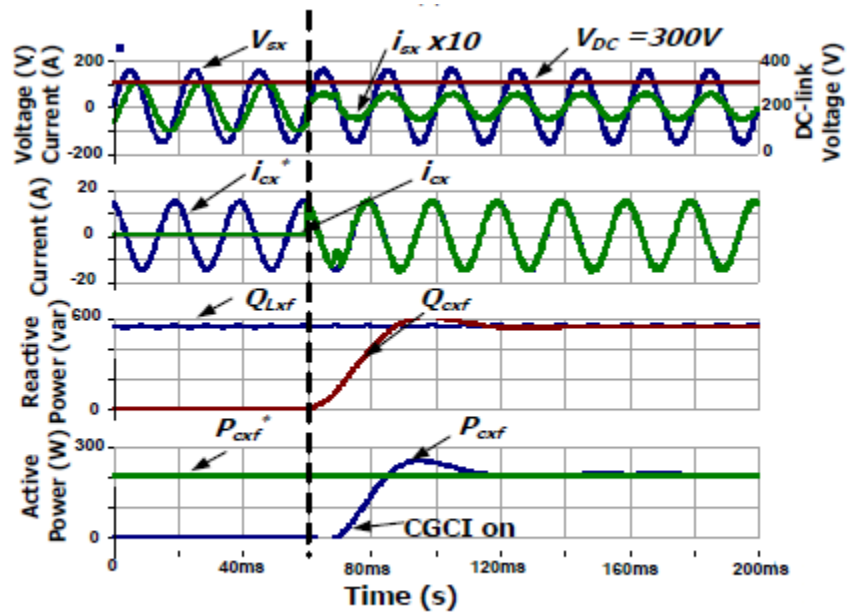
Khalid	Development of Single Stage Thyristor Based Grid Connected Single Phase Inverter for Renewable Energy Systems	B-H characteristics	For low value of inductor on dc side, proposed topology injects more power into grid with relatively low harmonics in line current, thus reduces cost, size and weight of converter.
Kumari and Garg	Power Quality Enhancement using Dynamic Voltage Restorer (DVR): An Overview	Voltage injection strategies i.e. pre-sag, phase advance, voltage tolerance, in-phase method	DVR consists of power circuit & control circuit where control system mitigates voltage sags/swells. This device is based on voltage source converter a PWM that can produce a sinusoidal voltage with any angle required of the amplitude, frequency and phase.

VI. RESULTS

The comparative results of HGCI for renewable energy generation with power quality conditioning are described below:



(a)



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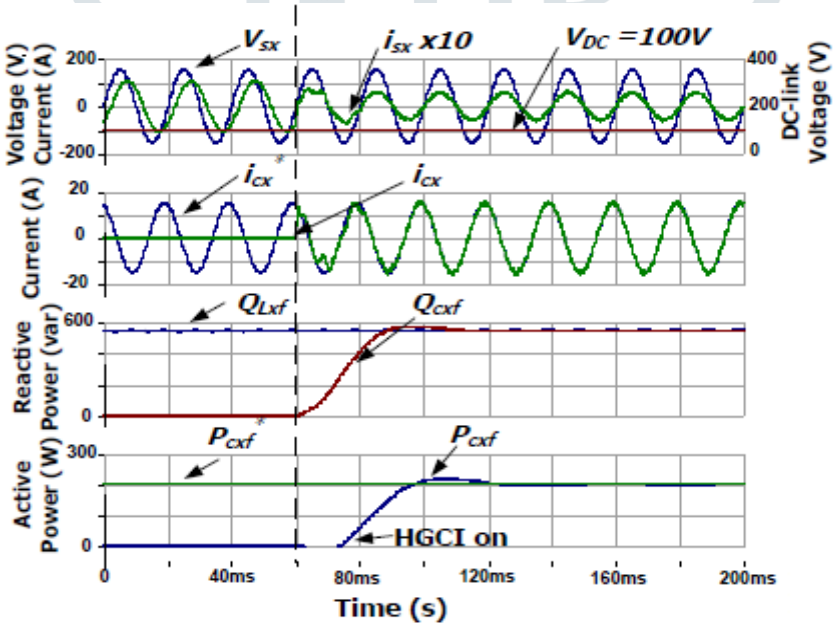

(c)

Figure 1: Simulation results for balanced linear loading compensation before and after: (a) IGCI, (b) CGCI and (c) HGCI operation [Source [2]].

	Parameters	Physical Values
System Parameters	V_{sx}, f, Ls	*110V, 50Hz,0.1mH*
IGCI	L	*5mH* (0.14p.u)
CGCI	L, C	*5mH* (0.14p.u), *80μF* (3.6p.u)
HGCI	L_c, L_{PF}, C_{PF}	*5mH* (0.14p.u), *30mH* (0.87p.u), *160μF* (1.8p.u)

Table 1: Simulation and experimental parameters for the IGCI, CGCI AND HGCI [Source [2]].

VII. CONCLUSION

The paper presents review of Hybrid Grid Connected Inverter for renewable energy generation. The paper explores the basic fundamentals of Hybrid Grid Connected Inverter and its prominent features to reduce the operational as well as system cost. The paper also describes the existing and proposed system and how to convert a proposed system into simulation model.

REFERENCES:

[1] Sujit Kumar Bhuyan, Dr. Prakash Kumar Hota, Dr. Bhagabata Panda, "Modeling and Simulation of Hybrid Energy System Supplying 3Ø Load and its Power Quality Analysis", International Journal Of Renewable Energy Research, Vol.8, No.1, March, 2018.

[2] Lei Wang, Chi-Seng Lam, Man-Chung Wong, "Analysis, Control and Design of Hybrid Grid-Connected Inverter for renewable Energy Generation with Power Quality Conditioning", IEEE, 2017.

[3] Y. N. S. Mounika, J. Ayyappa, S. N. V. Bramareswara Rao, "Modeling and Design of Hybrid Control Strategy for Power Quality Improvement in Grid Connected Renewable Energy Source", International Journal of Engineering and Advanced Technology, Volume-7 Issue-2, December 2017

[4] Yahia Bouzelata, Necmi Altin, Rachid Chenni, Erol Kurt, "Exploration of optimal design and performance of a hybrid wind-solar energy system", ELSEVIER, 2015.

[5] Y. P. Siwakoti, F. Z. Peng, F. Blaabjerg, P. C. Loh and G. E. Town, "Impedance-source networks for electric power conversion part I: a topological review," IEEE Trans. Power Electron., vol. 30, no. 2, pp. 699-716, Feb. 2015.

[6] P.G. Arul, V.K. Ramachandaramurthy, R.K. Rajkumar, "Control strategies for a hybrid renewable energy system: a review," Renewable and Sustainable Energy Reviews, vol. 42, pp. 597-608. 2015.

[7] Srikanth, Kumar, "POWER QUALITY IMPROVEMENT TECHNIQUES IN HYBRID SYSTEMS – AREVIEW", International Journal Of Engineering And Computer Science, Volume 3 Issue 4 April, 2014.

[8] X. Li, S. Dusmez, U. R. Prasanna, B. Akin and K. Rajashekara, "A new SVPWM modulated input switched multilevel converter for grid-connected PV energy generation systems," IEEE Journal Emerging and Selected Topics in Power Electronics, vol. 2, no. 4, pp. 920-930, Dec. 2014.

[9] Kahdem, Basu, Conlon, "Power Quality in Grid connected Renewable Energy systems: Role of Custom Power Devices", European Association for the Development of Renewable Energies, Environment and Power Quality, 2010.

[10] Wen-Chen Zhang, Ning-Yi Dai, Man-Chung Wong, Chi-Kong Wong, "Capacitive-coupled Grid-connected Inverter with Active Power Injection Ability" 2012 IEEE 7th International Power Electronics and Motion Control Conference - ECCE Asia June 2-5, 2012, Harbin, China.

[11] J.-S. Choi, F.-S. Kang, "Seven-level PWM inverter employing series connected capacitors paralleled to a single DC voltage source," IEEE Transactions on Industrial Electronics, vol. 62, no. 6, pp. 3448–3459, 2015.

[12] Rakesh Kumar, T. Deepa, "A New Asymmetric Multilevel Inverter with Reduced Number of Switches and Reduction of Harmonics using Sine Property," in 2016 International Conference on Circuit, Power and Computing Technologies [ICCPCT]. IEEE Explorer, 2016, pp. 1–8.

[13] Mohd Rizwan Khalid, "Development of Single Stage Thyristor Based Grid Connected Single Phase Inverter for Renewable Energy Systems", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering Vol. 5, Issue 2, February 2017.

[14] Priyanka Kumari, Vijay Kumar Garg, "Power Quality Enhancement using Dynamic Voltage Restorer (DVR): An Overview", International Journal of Scientific and Research Publications, Volume 3, Issue 8, August 2013 ISSN 2250-3153.