DESIGN AND PERFORMANCE OF 4 LEG 3 PHASE INVERTER FOR MICROGRID WITH HESS OF RES NETWORKS

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Abstract **-** Climbing need for dispersed generation based upon renewable resource resources (RES) has actually resulted in numerous problems in the procedure of energy grids. The micro-grid is an encouraging service to resolve these troubles. A specialized power storage space system might add to a far better combination of RES right into the micro-grid by smoothing the renewable energy's intermittency, boosting the top quality of the infused power as well as making it possible for added solutions like voltage and also regularity law. Nonetheless, as a result of energy/power technical restrictions, it is usually essential to make use of hybrid power storage space systems (HESS). In this paper, a second-order moving setting controller is recommended for the power circulation control of a HESS, utilizing a four-leg three-level neutral-point-clamped (4-Leg 3L-NPC) inverter as the only user interface in between the RES/HESS and also the micro-grid. A 3-D room vector inflection and also a series decomposition-based ac-side control enable the inverter to operate in out of balance lots problems while preserving a well balanced air conditioning voltage at the factor of typical combining. DC present harmonics brought on by out of balance tons and also the NPC drifting center factor voltage, along with the power department limitations, are thoroughly attended to in this paper. The performance of the recommended strategy for the HESS power circulation control is contrasted to a classic PI control system and also is confirmed via simulations making use of a 4-Leg 3L-NPC inverter.

Keywords: FPGA, HDL, Low level design, Flip flop, Xilinx, pipelined data.

I. INTRODUCTION

The conventional power systems such as hydro, thermal, nuclear, gas and large scale solar power stations are centralized and electrical energy need to be transmitted over long distances. As the power is transmitted over long distances, the overall transmission cost and transmission losses increases and the efficiency of the system reduces. Distributed Generation is emerging as an important option for the future development and restructuring of electricity infrastructure. The benefits of Distributed Generation include lower electricity costs, higher flexibility, improved power quality, higher system efficiency and greater reliability. Hence the demand of distributed generation is rising day-by-day. Increasing penetration of DG is changing management of the grid from centralized to decentralized schemes, creating several challenges that must be carefully addressed in order to keep the electrical grid's proper operation. High penetration of renewable energy can lead to stability and power quality issues due to the stochastic nature of RES, such as wind and solar energy. The microgrid concept, which can be defined as a small scale weak electrical grid that is able to operate both in connected and islanded mode, has been extensively studied as a solution for RES integration. The weak nature of a microgrid implies the use of an Energy Storage System (ESS) to increase RES penetration and insure its stability.

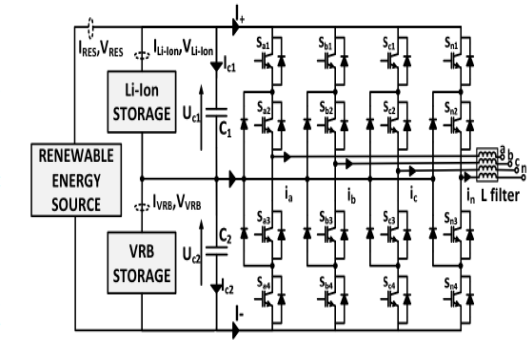

Fig.1.1. Block diagram.

II. RELATED STUDY

The micro grid concept, which can be defined as a small scale weak electrical grid that is able to operate both in connected and is-landed mode, has been extensively studied as a solution for RES integration. The weak nature of micro grid implies the use of an Energy Storage System (ESS) to increase RES penetration and insure its stability. The use of an ESS integrates constraints such as admissible bandwidth, maximum ratings, current/power maximum gradient and the number of cycles. If these constraints are not respected it can lead to a dramatic lifetime reduction of the ESS, in certain cases, to its destruction. The use of a Hybrid Energy Storage System (HESS) offers the necessary trade-off for increasing the lifetime of each ESS while also increasing the global specific energy and power of the whole system. Finally, despite a lower flexibility when compared to the

parallel topology, the 3L-NPC topology d) can be used as a single power converter able to manage the power flow of a HESS, acting as an interface between the RES and the grid. Due to the reduced voltage applied on the switches and an increased number of voltage levels, the 3L-NPC topology becomes more efficient while showing a lower current Total Harmonic Distortion (THD) than an equivalent two level inverter. Several works have been carried out on ESS hybridization using multilevel topologies, including the 3 Leg 3L-NPC. The 4-Leg 3L-NPC used as an active power filter is also extensively studied in the literature. Thanks to the 4th leg this inverter is able to produce zero sequence currents in addition to direct and negative ones. This characteristic enables compensation for the increasing number of unbalanced loads (monophasic customers, electric vehicles…) and single phase generators (small wind/PV units). In [several modulation techniques and redundant vector selection methods are used to balance the capacitor voltages in power filter application. In, the AC side predictive control of a 4 Leg 3LNPC inverter in isolated mode improves the performance and the power quality. Microgrid is a small scale, weak electrical grid that is able to operate both in connected mode and islanded mode. It is formed by integrating various sources of distributed generation, loads and storage devices. The electrical energy generated is interconnected to the microgrid at low voltages and it can operate in AC, DC or combination of both. A microgrid provides back up for the grid in case of emergencies. A microgrid allows the consumers more energy independent and more environmental friendly. The microgrid is interconnected with different types of energy storage systems to perform multiple functions such as ensuring power quality, frequency and voltage regulation, smoothing the output of renewable energy resources, providing back up power for the system and plays important role in cost optimization. The microgrid and the renewable energy resources integration may lead to number of operational challenges that are to be addressed in the design of control and protection system. The most significant challenges of microgrid are, the existing of DG units in the system at low voltages can cause bidirectional power flows that complicate the protection coordination, undesirable power flow patterns, fault current distribution and voltage control. Interaction of control systems of DG units may create local oscillations. The microgrid has a low inertia characteristic which leads to severe frequency deviations in stand-alone operation, if a suitable control mechanism is not provided. The uncertainty in microgrid due to less number of loads and high variations of renewable energy sources. MicroGrids perform dynamic control over energy sources, enabling autonomous and automatic self-healing operations. During normal or peak usage or at times of the primary power grid failure, a microgrid can operate independently of the larger grid and isolates its generation nodes and power loads from disturbance without affecting the larger grid's integrity. MicroGrids interoperate with existing power systems, information systems, and network infrastructure and are capable of feeding power back to the larger grid during times of grid failure or power outages.

III. AN OVERVIEW OF PROPOSED SYSTEM

The use of a 4-Leg 3L-NPC power converter topology to interface a RES with a HESS (formed by a VRB and a Li-Ion battery) in a microgrid context has been investigated. A new model of the structural limits is presented and implemented to exploit the entire capability of the 4-Leg 3L-NPC converter to insure a maximum power division between the two ESS. The power flow management of a HESS Composed of a Li-Ion battery and a Vanadium Redox Battery (VRB) is investigated in a microgrid context. The 4 Leg 3LNPC inverter has been chosen to interface the HESS with the microgrid due to its low THD, high efficiency and its ability to manage unbalanced AC loads through the 4th leg. The objective is to prove that by adding the fourth leg to a 3LNPC converter and using a new DC side control strategy it is possible to reach both fast and efficient DC power sharing between the two esss and the RES, and at the same time improves the AC side power quality. The main contribution lies in the DC power flow controller which allows HESS power flow control and DC current harmonics suppression. The new model for 4-Leg 3L-NPC structural limits proposed is assessed. A non-linear 2-SMC scheme has been designed and tuned to control the zero sequence injection in the modulating signals in order to control the power flow of the HESS. The proposed DC side control strategy is based on the Second Order Sliding Mode Control for its accuracy and robustness regarding some particular uncertainties. It aims to control the power flow of the HESS according to grid needs.

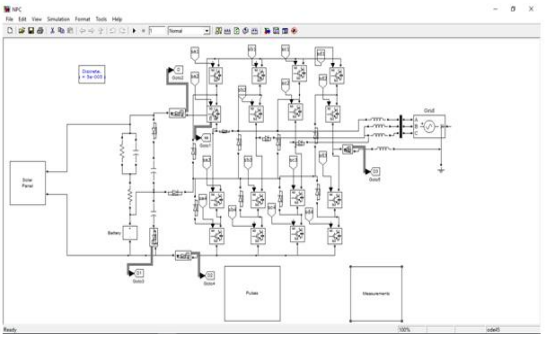

Fig.3.1. Simulation circuit.

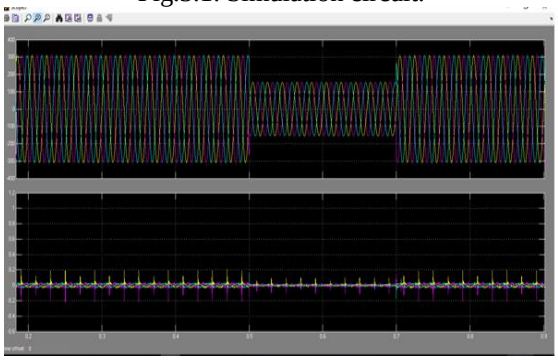

Fig.3.2. three phase voltage across the grid side.

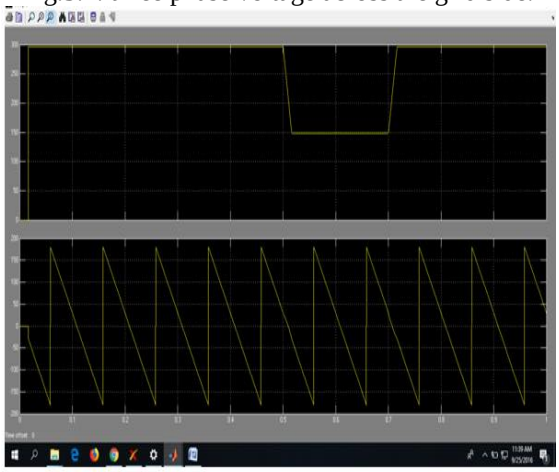

Fig.3.3. Voltage values.

IV. CONCLUSION

In this project, the use of a 4-Leg 3L-NPC power converter topology to interface a RES with a HESS (formed by a VRB and a Li-Ion battery) in a micro grid context had been investigated. A new model of the structural limits is presented and implemented to exploit the entire capability of the 4-Leg 3L-NPC converter to insure a maximum power division between the two ESS. A nonlinear 2-SMC scheme has been designed and tuned to control the zero sequence injection in the modulating signals in order to control the power flow of the HESS. Furthermore, the fourth leg of the converter allows the unbalanced load issue to be addressed, and, thus, enable active power filter capabilities. The investigation of the limits of the topology showed a power exchange capability among the HESS. Simulation and experimental results proved the capacity of the proposed control strategy to manage a HESS in order to improve the power quality and stability as well as to control the renewable energy injected into a micro grid.

V. REFERENCES

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