A Review on AC DC Microgrid System

Reeka Narang[1], Varsha Sharma[2]

[1,2]Dept. of Electrical Engineering, RSR Rungta College of Engineering, Durg, C.G., India

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Abstract - Due to increase in deployment of different kinds of power generations and the grid has raised major concern with existing AC systems. Most of the micro grid with DGs and renewable energy sources operated in parallel with AC main grids. Since the majority of the power grids are presently ac type, ac micro grids are still dominant and purely dc micro grids are not expected to emerge exclusively in power grids. Therefore, dc micro grids are prone to be developed in ac types even though in subordinate[1-5]. Consequently, linking ac micro grids with dc micro grids and employing the profits of the both micro grids, has become interesting in recent studies. The idea is to merge the ac and dc micro grids through a bidirectional ac/dc converter and establishing a hybrid ac/dc micro grid in which ac or dc type energy sources and loads can flexibly integrate into the micro grids and power can smoothly flow between the two micro grids. Like other micro grids, the hybrid ac/dc micro grid can operate either in grid-connected or in islanding modes and the control system should be able to support the two operating modes as Well as transition between these modes. Therefore, a suitable control strategy to coordinate the operation of dc sources, ac sources and the IC is indispensable.

Keywords: Micro Grid, Hybrid Systems, Islanding, AC / DC Converter, AC / DC Loads.

Literature Survey

E S N Raju P et al. (2013) Micro grids are emerging as one of the promising solutions to integrate various types of distributed renewable energy sources with the utility grid. Though the existing grids are AC grids, today's electrical loads comprising of power electronic based equipments and distributed renewable energy generation make DC micro grids more attractive. However, an individual AC micro grid and DC micro grid requires multiple conversions of power at the user end for DC loads and AC loads respectively, resulting in less efficient system. Thus, hybrid AC/DC micro grid seems to be the best solution to avoid substantial energy losses in multiple conversions. However, there are several technical challenges in the implementation of hybrid AC/DC micro grid, which need to be addressed. This paper presents an overview of hybrid AC/DC micro grid and discusses the important key issues and challenges to be overcome for its practical implementation.

S.Prakesh and S.Sherine (2017) The increasing deployment of distributed generation systems in power systems hybrid AC/DC micro grid. Many micro grids are used for interlinking ac/dc converter with proper power management and control strategy. During the islanding operation of the hybrid AC/DC micro grid, the IC is intended to take the role of supplier to one micro grid and at the same time acts as a load to other micro grid and the power management system should be able to share the power demand between the existing ac and dc sources in both micro grids. This paper considers the power flow control management issues among the multiple sources dispersed throughout both ac and dc micro grids. The new method is proposed which is the decentralized power sharing method in order to eliminate the need for any communication between distribution generation or micro grids. This hybrid micro grid allows different ac or dc loads and sources should be flexibly located in order to decrease the required power conversions stages and hence the system cost and efficiency. The decentralized control operation and droop control method is used for better control strategy. The performance of the proposed power control strategy is validated for small signal stability analysis and different operating conditions, using simulation studies in MATLAB software.

Naoki AyAi et al. (2017) A DC micro grid system has been proposed as a power network that enables the introduction of a large amount of solar energy using distributed photovoltaic generation units. To test the feasibility of the system, we have developed a demonstration facility consisting of silicon photovoltaic (Si-PV) units, copper indium gallium (di)selenide photovoltaic (CIGS-PV) units, concentrator photovoltaic (CPV) units, an aerogenerator, and a redox flow battery. The redox flow battery, a key component for supply-demand adjustment in the micro grid system, successfully balanced supply and demand in the grid by its rapid charge-discharge ability even under the fluctuating condition of power generation and consumption.

Chunhua Liu et al. (2015) This paper proposes a new DC micro-grid system, which fully utilizes the renewable energy and electric vehicle for smart energy delivery. The proposed DC grid incorporates the AC supply module, standby energy module, renewable energy module, and storage energy module together, to execute the energy distribution. Hence, this grid system can offer a high quality power for the three types of loads, namely 110V AC single-phase output, 48V DC output, and 100V DC output. The control strategy of the grid system for performing smart energy delivery will be discussed in the full paper. The simulation results will be also given to verify the four operation modes of the grid system.

BRONSON RICHARD BLASI (2013) This paper discusses a brief history of electricity, specifically alternating current (AC) and direct current (DC), and how the current standard of AC distribution has been reached. DC power was first produced in 1800, but the shift to AC occurred in the 1880's with the advent of the transformer. Because the decisions for distribution were made over 100 years ago, it could be time to rethink the standards of power distribution. Compared to traditional AC distribution, DC microgrids are significantly more energy efficient when implemented with distributed generation. Distributed generation, or on-site generation from photovoltaic panels, wind turbines, fuel cells, or microturbines, is more efficient when the power is transmitted by DC. DC generation, paired with the growing DC load profile, increases energy savings by utilizing DC architecture and eliminating wasteful conversions. Energy savings would result from a lower grid strain and more efficient utilization of the utility grid. DC distribution results in a more reliable electrical service due to short transmission distances, high service reliability when paired with on-site generation, and efficient storage. Occupant safety is a perceived concern with DC microgrids due to the lack of knowledge and familiarity in regards to these systems. However, with proper regulation and design standards, building occupants never encounter voltage higher than 24VDC, which is significantly safer than existing 120VAC in the United States. DC Microgrids have several disadvantages such as higher initial cost due, in part, to unfamiliarity of the system as well as a general lack of code recognition and efficiency metric recognition leading to difficult certification and code compliance. Case studies are cited in this paper to demonstrate energy reduction possibilities due to the lack of modeling ability in current energy analysis programs and demonstrated energy savings of approximately 20%.

Dong Chen and Lie Xu (2013) Renewable power generation and the prospect of large-scale energy storage are fundamentally changing the traditional power grid. Arising challenges occur in terms of energy management, reliability, system control, etc. Microgrid, as an active subsystem of modern power grid, has revealed its promising potential in dealing with intermittent clean power generation and emerging energy storage, partially brought by electrical vehicle batteries. In this chapter, the concept of microgrid is introduced. The main focus is placed on the basic issues of control, operation, stability, and protection of DC microgrids.

Peng Wang et al. (2017) Three-phase AC power systems have been in dominant position for over hundred years due to invention of transformer and the inherent characteristic from fossil energy-driven rotating machines. However, the gradual changes of load types and distributed renewable generation (DRG) in AC local distribution systems provide food for consideration of adding DC networks. Renewable sources such as fuel cells and solar photovoltaics are DC inherent and should be connected to AC grid through DC/AC conversion techniques whereas some AC inherent renewable sources like wind generators also need DC links in their conversion systems to increase efficiency and mitigate power variation caused by intermittency and uncertainty. The disadvantage of AC grids for connection of DC inherent sources and loads as well as AC loads with DC links is that additional DC/AC or AC/DC converters are required, which may result in efficiency loss from the reverse conversion. In the other hand DC grids are resurging due to the development and deployment of renewable DC power sources and their inherent advantage for DC loads in commercial, industrial and residential applications. The number of power conversions in a DC microgrid has been significantly reduced to enhance system energy efficiency. A more likely scenario is the coexistence of both.

Peng Wang et al. (2011) This paper presents a hybrid AC/DC micro grid concept to directly integrate DC/AC renewable sources and loads to DC/AC links respectively. The hybrid grid eliminates multiple DC-AC-DC&AC-DC-AC conversions in an individual AC&DC grid. The hybrid grid increases system efficiency, eliminates the embedded AC/DC and DC/DC converters in various home, office and industry facilities which can reduce size and cost of those facilities. The basic architecture of the hybrid grid is introduced in this paper. Different operation modes of the hybrid grid are discussed. The various control algorithms are investigated and proposed to harness the maximum power from various renewable sources, to store energy

surplus during low peak loads, to eliminate unbalance problem in AC link, to maintain voltage stability and smooth power transfer between AC and DC links under various generation and load conditions. A prototype of the hybrid grid under construction is presented. Some simulation and test results are presented.

Pouria GOHARSHENASAN KHORASANI et al. (2017) Considering the advantages of DC microgrids, the extension of the conventional AC distribution grid can be implemented using a DC microgrid. This justifies the realization of a hybrid AC/DC microgrid. In the present study, a new global solution is presented to improve the power quality and to fully compensate the reactive power of an AC microgrid using DC bus capacity while introducing a new design for a hybrid AC/DC microgrid. In the new design, backto-back connections of two series and parallel converters, as well as the presentation of new controllers and simultaneous utilization of an earthing switch, are proposed. The proposed method guarantees the quality of the delivered voltage to consumers and the drawn current from the network according to the IEEE-519 and IEEE-1159 standards under different power quality problems (e.g., interruptions, sags, harmonics, and any variation in voltage/current signals from pure sinusoidal). Through the proposed design of the new hybrid AC/DC microgrid, as a new feature, the operation of the network in islanded mode can be achieved in accordance with power quality standards even in the worst load quality conditions. It should be noted that in common hybrid microgrids in islanded mode, the delivered voltage quality is proportional to the quality of the consumer's load current. Another possibility of the proposed design is the instantaneous VAR compensation of nonlinear and induction loads of consumers to keep the power factor of the distribution transformer close to unit value. Simulation results indicate that there are acceptable levels of compensation for different types of power quality problems. Total harmonic distortions and total demand distortions are below 3% in both the grid-connected and isolated modes of the hybrid AC/DC microgrid.

Enrique Rodriguez-Diaz et al (2017) This paper proposes real-time Energy Management System (EMS) for a residential hybrid ac/dc microgrid. The residential microgrid is organized in two different distribution systems. A dc distribution bus which interconnect the renewable energy sources (RES), energy storage systems (ESS) and the building's common facilities; while the apartments are supplied by an ac distribution system connected to the grid. This architecture avoids any modifications in the electrical installation that supplies energy to the apartments. A pure dc voltage supply is not yet a feasible approach for residential buildings. This architecture increases the overall efficiency of the distribution by interconnecting the RES and ESS thorough a dc distribution bus, and therefore avoiding unnecessary dc/ac conversion stages. The real-time EMS performs an 24 hours ahead optimization in order to schedule the charge/discharge of the ESS, and the energy injection/consumption from the grid. The EMS estimates the RES generation based on the weather forecasting, together with stochastic consumption modelling of the building. The EMS architectureandtheresidentialmicrogridhavebeenimplemented and tested in a laboratory scale setup. The results shown how the operational costs of the system are effectively decreased by 28%, even with non-accurate estimation of the RES generation or building parameters.

Mohammad Ali Tavakkoli et al. (2012) Complex circuitry of electronic infrastructure of compact micro-grids with multiple renewable energy sources feeding the loads using parallel operation of inverters acts as a deterrent in developing such systems. This paper deals with applicable techniques reducing the driving circuits in parallel power inverters used in micro-grid system (MGS), mainly focused on the distributed generation (DG) in islanded mode. The method introduced in this paper, gives a minimal and compressed circuitry that can be implemented very cost-effectively with simple components. DC micro-grids are proposed and researched for the good connection with DC output type sources such as photovoltaic (PV), fuel cell, and secondary battery. In this paper, the electronic infrastructure of micro-grid is expressed. Then discussed the reasons for its complexity and the possibility of reducing the elements of electronic circuits are investigated. The reason for this is in order to compact DC micro-grid system for electrification to places like villages. Digital Simulation in Matlab Simulink is used to show the effectiveness of this novel driver topology for parallel operating inverters (NDTPI).

R. Reedy et al. (2011) Conventional anti-islanding techniques used in gridtied photovoltaic (PV) systems pose many disadvantages at high levels of PV deployment. One such issue is the inability of these systems to ride-through grid disturbances. In this paper, the use of a Power Line Carrier Communications (PLCC) Permissive anti-islanding scheme is investigated as a means of safely enabling ride-through operation of grid-tied photovoltaic systems. Here potential fault scenarios are considered, along with performance, cost, and design considerations for the PLCC Permissive components, as

well as potential system configurations and methods of implementation. While PV systems are the largest (and growing) form of distributed generation (DG) generating in parallel with utility feeders, it is important to note that this technique is effective for any DG technology, whether inverter-based or rotating, including wind, hydro and fossil fueled bio-gas machines.

Conclusion

In this paper the stability of small signal stability analysis for the hybrid microgrid to analyzed. In order to reduce system equations and for the better analysis of the proposed droop controller, the dc sources and their individual droops are aggregated to form one combined dc source. This is also done for ac sources, dc and ac loads as well. Therefore the hybrid microgrid is analyzed in simplified from the perspective of IC. A decentralized control strategy based on three stage modified droop method for interfacing AC and DC microgrids. The different types of modeling are AC modeling, DC modeling and IC modeling. Using the proposed droop method, the IC is able to perform power sharing between the two microgrids in the transition from grid-connected to islanding mode as well as during the islanding operation. The simulations are verified using the MATLAB software.

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