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An Analysis of Co-Ordination Control Issues in Hybrid AC-DC Micro Grid

S.Jambulingam, Dr. D. M. Mary Synthia Regis Prabha

***Abstract*—** Power management is important roles in the electric sectors which need to handle with more concerned for achieves high efficiency. The distribution of sharing power among the multiple electric units becomes to the major issues due to its complex environment. The need of the high utility power system causes integration of multiple utility grids to share a micro generation which is called as the micro grid. Thus the micro grid comprises of multiple ac and dc grid which in turn reduces the multiple conversion of power transmission between different grids. This power flow needs to be controlled for providing the flexible and efficient environment for power management systems in real world. In this research work various power management control strategies and its flow of operation are discussed in details to achieve the user friendly environment. The analysis performed on this research concludes that the importance of the coordination control in the real world environment.

***Keywords*—** Micro grid, Coordination control, Converter station, Power management

I. INTRODUCTION

The issues of electricity sector are given as follows: a) increasing usage permission to electricity for components of population not reached by the grid, and b) finishing inflated requests from components of populations encircled by the grid. Renewable energy (RE) sources like star, wind, bio and hydro are

taken into consideration during this course each for grid fed and off grid systems. 200th saturation of RE in electricity production worldwide is measured essential within the coming year (by 2020) [1].

Power systems are undergoing considerable modification in operation necessities primarily as a result of liberation and because of large volume of distributed energy resources (DER) within the network. In several cases DERs embody completely different technologies that permit generation in small amount (micro sources) and a few of them benefit of renewable energy resources (RES) like solar, wind or hydro energy [2]. Having small sources near the load has the advantage of reducing transmission losses similarly as preventing network congestions. Once power will be totally provided by native renewable power sources, long distance high voltage transmission will be avoided.

S.Jambulingam , PHD Scholar, Dept. of EEE, Coimbatore Marine Coimbatore, Coimbatore, India. (Email: jambueee07@gmail.com)

Dr. D. M. Mary Synthia Regis Prabha , Associate.Professor, Dept. of EEE, NICHE, Nagercoil, India.

On different hand, a lot of dc loads like diode (LED) and electrical vehicles (EVs) are connected to ac power systems to avoid wasting energy and cut back carbon emission. AC small grids are planned to facilitate the association of renewable power sources to standard ac systems [3-5]. However, dc power from electrical phenomenon (PV) panels or fuel cells has got to be reborn into ac victimization dc/dc boosters and dc/ac inverters so as to attach to an ac grid. In an ac grid, embedded ac/dc and dc/dc converters are needed for varied home and workplace facilities to produce totally different dc voltages. Recently, dc grids are rising because of the event and preparation of renewable dc power sources and their inherent advantage for dc hundreds in industrial, industrial and residential applications. Multiple conversions needed in individual ac or dc grids might add extra loss to the system operation and can build the present home and workplace appliances a lot of difficult [6-8].

The hybrid micro grid grid is employed to produce reliable, prime quality electrical power in user friendly and property means. One amongst most vital feature is that the advanced structure which may facilitate the connections of assorted ac and dc generation systems, energy storage choices, and numerous ac and dc masses with the optimum plus utilization and operation potency. To attain those goals, power natural philosophy technology plays a vital role to interface completely different sources and ends up in a wise grid [9-10].

II. MICRO GRID

Micro grid will be framed as an electrical system which incorporates electricity generation, energy storage, loads that normally operate at the side of the most utility grid and may disconnect and operate autonomously further. The small grid consists of small sources with power electronic interfaces. These micro sources usually are micro turbines, PV panels, and fuel cells, bio mass, bio gas are placed at customer sites.

III. RELATED WORKS

The literature review is organized underneath many classes of discussions. This can be to supply a transparent historical summary of the main stages of development during this space.Micro grid is rising as a possible thought to appreciate this distributed installation paradigm. Integrated with renewable energy sources (RES) and different distributed generation (DG), energy storage systems (ESS) and active masses, small grids will operate in grid connected mode to

exchange power with main utility, or in islanded mode to provide native masses once the grid isn't available[12].

Because of the fast development of power physics in recent years, RES like electrical phenomenon (PV) systems and wind turbines (WT) systems have become major DG sources in small grids. However, attributable to their intermittent nature, ESS systems square measure indispensable parts in small grids that buffer the short-run unbalanced power between RES and cargo [13]. In previous works, many hybrid RES/ESS systems are developed [14], [15], whereas performance and purpose analysis of various ESS technologies applied in DG systems is summarized in [16]. However, the capability limitation of ESS is rarely thought-about in these works. Methodologies for prediction and best filler of ESS are thereby developed [17]-[19]. Though these strategies are effective to avoid the over-charge/over-discharge of ESS once the system capability is settled, the ESS must be redesigned once the overall energy generation/consumption is modified. In [20], a coordinated management strategy for PV systems and battery storage system is projected, during which the facility coordination takes into consideration each the obtainable power in RES and SoC conditions of ESS.

An energy management rule supported model prediction behavior is planned to coordinate DG and ESS units consistent with totally different decigram power conditions [21], [22], whereas a coordinated state of charge (SoC) management strategy springs in small grids management systems to stabilize the bus frequency and voltage amplitude of small grids [23].

IV. Micro Grid And Its Architecture

A micro grid could be a small-scale facility which will operate severally or in conjunction with the area's main electrical grid. Any small-scale localized station with its own power resources, generation and hundreds and determinable boundaries qualifies as a small grid. Micro grids will be meant as back-up power or to bolster the most facility during times of significant demand. The standard nature of small grids might create the most grid less prone to localized disaster. Modularity conjointly implies that small grids will be used, piece by piece, to bit by bit modernize the prevailing grid.

- *Configuration of the hybrid micro grid*

The configuration of the hybrid system is shown in Figure 1 wherever varied AC and DC sources and loads are connected to the corresponding AC and DC networks. The AC and DC links are joined along through two transformers and two four quadrant in operation three section converters. The AC bus of the hybrid grid is tied to the utility grid.

Figure 2 describes the hybrid system configuration that consists of AC and DC grid. The AC and DC grids have their corresponding sources, hundreds and energy storage components, and are interconnected by a three part device. The AC bus is connected to the utility grid through a electrical device AND circuit breaker.

In the planned system, PV arrays are linked to the DC bus through boost device to simulate DC sources. A DFIG alternative energy system is connected to AC bus to simulate AC sources. Battery with duplex DC/DC device is connected to DC bus as energy storage. A variable DC and AC load are connected to their DC and AC buses to simulate varied masses. PV modules square measure connected asynchronous and parallel.

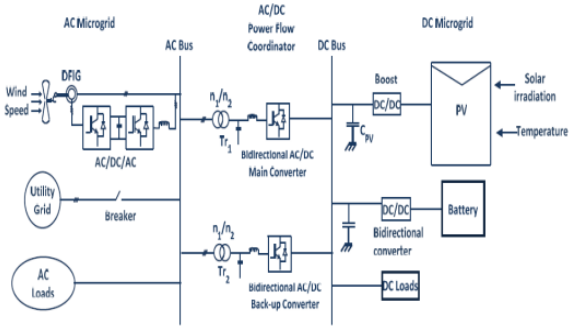

Fig 1. Hybrid AC/DC micro grid

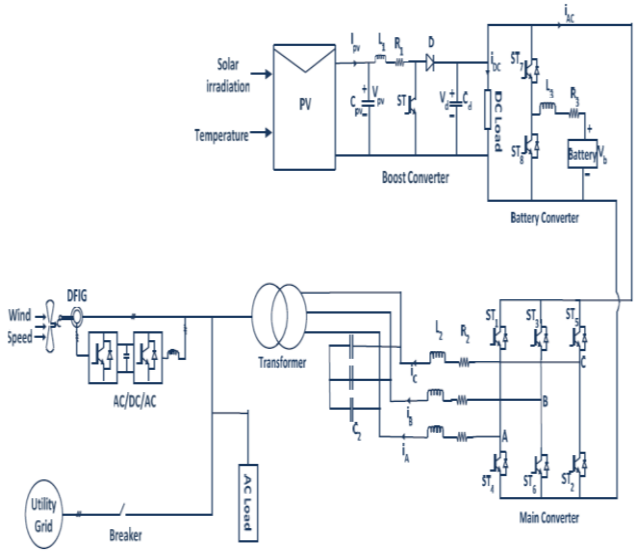

Fig 2. Representation of Hybrid Micro grid

The duplex DC/DC device is meant to keep up the stable DC bus voltage through charging or discharging the battery once the system operates within the autonomous operation mode. The three devices (boost converter, main device, and duplex converter) share a standard DC bus. An

- *Operation of grid*

The processing of hybrid grid is done in two modes which are explained detailed in the following sections

A.Grid tied mode

In this mode the converter will produce stable DC bus voltage, and needed reactive power to exchange power between AC and DC buses. Large volume of power is obtained by dominant the boost device and turbine generators. When generation of total power is a smaller amount than the full load at DC facet, the device injects power from AC to DC facet.

B.Autonomous mode

The battery plays important role for each power balance and voltage stability. DC bus voltage is maintained stable by battery convertor or boost convertor. The primary convertor is controlled to supply stable and prime quality AC bus voltage.

a. Modeling and control of converters

In the current research work five styles of converters are used for the correct coordination with utility grid which can be useful for uninterrupted and top quality power to AC and DC masses underneath variable radiation and wind speed once grid operates in grid tied mode. The management algorithms are represented within the following section.

i. Modeling and control of boost converter

The main objective of the boost converter is to trace the utmost point of the PV array by control the solar battery terminal voltage victimization the ability voltage graphical record. For the boost device the input output equations are often written as

$$V_{pv} - V_T = L_1 \frac{di_1}{dt} + R_1 i_1$$

$$I_{pv} - i_1 = C_{pv} \frac{dV_{pv}}{dt}$$

$$V_T = V_d(1 - d_1)$$

With the implementation of P&O process a reference price i.e. V^*_{pv} is calculated that in the main depends upon solar irradiation and temperature of PV array. Here for the boost convertor twin loop management is projected. Here the management objective is to produce a prime quality DC voltage with sensible dynamic response. The outer voltage loop facilitates in following of reference voltage with zero steady state error and inner current loop help in improvisation of dynamic response.

ii. Modeling and control of main converter

The role of the primary convertor is to exchange power between AC and DC bus. Here PQ management theme is employed for the management of primary convertor. The PI controller is about because the instant active current idm reference and therefore the instant reactive current i_{qm} reference are decided by reactive power compensation command.

In case of explosive DC load drop, there's power surplus at DC facet and also the primary converter is controlled to transfer power from DC to AC facet. The active power absorbed by the capacitance CT results in rising of DC-link voltage Green Mountain State.

The positive voltage error caused by social disease drop makes the magnitude of i*dm increase through the PI management.

a. Modeling and control of grid side converter

Since the machine is grid connected the grid voltage furthermore because the stator coil voltage is same, there exists a relation between the grid voltage and DC link voltage. The prime objective of the grid aspect converter is to take care of DC link voltage constant for the required action.

The voltage balance across the road is given by in following equation, wherever R and L are the road resistance and electrical phenomenon severally. With the utilization of d-q theory the 3 phase quantities are transferred to the two section quantities.

Where v_{dl} and v_{ql} are the two phase voltages found from va', vb', vc' exploiting d-q theory. Since the DC link voltage must be constant and also the power issue of the system sets to be unity, the reference values are to be set consequently.

The management theme utilizes current management loops for i_d and in with the i_q demand being derived from the dc-link voltage error through a typical PI controller. The in demand determines the displacement issue on the grid aspect of the choke.

The in demand is about to zero to ensure unit power issue. There are 2 loops for the management style, i.e. inner current loop and outer voltage loop to supply necessary management action.

Line resistance and electrical phenomenon decide the plant for the present loop, whereas DC link condenser is taken because the plant for the voltage loops.

The mathematical modelling of the machine aspect controller is given within the following equations. Beneath voltage orientation the connection between the force and therefore the d-q axis voltages, currents and fluxes may be written as follows.

b. Modeling and control of battery

The battery device could be a bidirectional DC/DC converter and also the main purpose of the battery converter is to convey assurance of stable DC link voltage. The boost converter injects current i1 (1 – d1) to the DC link. Coordination Control of the Converters

There are 5 styles of converters within the hybrid grid. Those converters need to be coordinately controlled with the utility grid to provide an uninterrupted, high potency, and top quality power to variable dc and ac masses below variable star irradiation and wind speed once the hybrid grid operates in each isolated and grid tied modes. The management algorithms for those converters are given in this section.

i. Grid Connected Mode

When the hybrid grid operates during this mode, the management objective of the boost converter is to trace the MPPT of the PV array by regulation its terminal voltage. The succeeding ac/dc/ac device of the DFIG is controlled to manage rotor aspect current to attain MPPT and to synchronize with ac grid. The energy surplus of the hybrid grid is sent to e utility system. The most devices is intended to work bi-directionally to include complementary characteristic of wind and star sources [6-7]. Power flow equations at the dc and ac links are as follows:

$$P_{pv} + P_{ac} = P_{dcL} + P_b$$

$$P_s = P_w - P_{acL} - P_{ac}$$

where real power Ppv and Pω are made by PV and WTG severally, PacL and PdcL ar real power masses connected to ac and dc buses severally, commission is that the power exchange between ac and dc links, Pb is power injection to battery, and annotation is power injection from the hybrid grid to the utility. The reference worth of the electrical device

terminal voltage is decided by the essential perturbation and observation (P&O) algorithmic rule supported star irradiation and temperature to harness the utmost power.

ii. Isolated Mode

When the hybrid grid operates within the islanding mode, the boost device and also the succeeding ac/dc/ac device of the DFIG might operate within the on-MPPT or off-MPPT supported system power balance and energy constraints. the most device acts as a voltage supply to supply a stable voltage and frequency for the ac grid and operates either in {inverter electrical converter} or converter mode for the sleek power exchange between ac and dc links.

V. CONCLUSION

In this analysis work, various converters present in the hybrid AC/DC micro grid is presented and the functionalities are discussed deeply. The main role of converters is to simplify the process of the transferring the different level load between different nodes. This power transfer needs to be controlled for the efficient control and provision of loads across different electric sectors.

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