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Micro Grid Operational Issues And Challenges In Smart Grid Scenario While Heterogeneous Micro Level Generations Are Predominant

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Abstract*.: Micro Grid operations are more dependent on and vulnerable to intermittent renewable energy sources (RES) integration along with other emerging trends like Plug in Electric Vehicles (PEVs) and advanced Energy Storage Systems (ESSs). With the advent of Smart Grid technologies, the micro grid operations are becoming more realistic and promising without much delays and inaccuracies in control actions. In this paper, we mainly focused on Micro Grid Energy Management System (EMS), synchronization, V and f control. A comprehensive review has been carried out to list out the current issues and challenges in a Smart Grid technology aided Micro Grid. The major issues in Micro Grid are mainly concerned with integration of intermittent distribution generation and while running in island mode of operation, the issues like V and f correction are more critical. Micro grid community helps in power sharing and stability cooperation among all micro grids, but at the same it should be capable of identifying when to isolate in case of any micro grid blackout. The role of power electronic converters in controlling the grid parameters while interfacing DGs are discussed through available literature.

Key Words: Micro Grid, MG central control (MGCC), Grid Synchronization, V and f control, Interfacing of DGs, Micro Grid EMS.

I. INTRODUCTION

The Micro Grid can be defined as an active distribution network which can be operated with or without main grid assistance depending on local generation and load level. Distribution automation [1,2] brought so many changes in the legacy network with the incorporation of DGs, PEVs, ESSs, and Smart meters. Renewable Energy Sources like solar and wind are becoming the more prominent cleaner energy sources all over the world [3]. The intermittent nature of these creates problems in the distribution network. Though there exists so many forecasting tools for wind and solar power generation, still the power generation from these RESs is said to be unpredictable as weather conditions are uncertain in nature.The ever increasing energy demand needs a new and heterogeneous interoperable system. The micro grid which is considered to be a mini grid which is of self sustainable nature is an encouragement to the power utility.

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Concept of Micro grid was established on the basis of distribution generation and distributed energy storages coordination. To enjoy the fruits of micro grid deployments, there has to be certain standards should be followed, without which micro grid operations con not be realized in real time. The micro grid that can be either in isolated/off-grid/island mode or in on-grid/grid connected/parallel mode has two different topology structures in which parallel mode of operation is said to be easy going one. Any way there need be perfect synchronism that needs to be maintained before get the transition from island mode to parallel mode of operation. The advent of smart grid technologies [4-6] in power sector has brought so many changes in existing techniques and algorithms that are used for grid micro grid synchronization.

The Information and communication technologies ICT) along with other automation entities like smart meters, remote terminal units(RTUs) and intelligent electronic devices(IEDs) have laid a new path for research in electric power management and utilization. As a consequence, there are new challenges and issues raised in all the areas of power grid starting from home energy management to the generation point. Apart from energy demand crises, the globe is now facing a big problem with greenhouse gases releasing from power generation and transportation. According to U.S Energy Information Administration (eia), it has been projected that coal remains in its old share(around 40%) in electricity generation even though so many other ways of electricity generation have been introduced with remarkable fraction in world energy production[7].

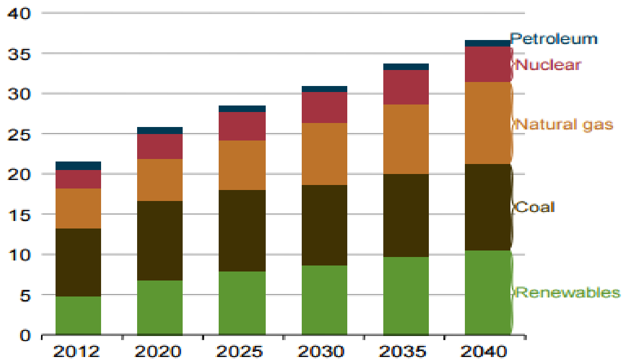

Fig.1.1 World electricity generation percentage by fuel.

RES is having its annual growth of 2.9% which is remarkable and it is expected to continue increasing(see Fig.1.1) up to 2040 and further(wind and solar PV are having more growth rate).CO_2 emissions due to electricity generation and transportation stood in first and second places respectively.

These concerns of environment protection along with increasing energy demand welcome new ways of cleaner power generation. Out of all ways of renewable energy generations, wind and solar PV generations are playing major roles. The micro grid thus can be treated as a mini cleaner energy province as it is basically integrated with RES and another DGs/RES.
The micro grid modes of operations are so identified in such a way that the local DGs in coordination with ESSs could serve the load demand without drawing power from main grid. In the case of island mode, the electric network/micro grid has to be more strict in terms of monitoring and controlling actions. Most of the problems like frequency variations, protection and optimal energy management will take care by main grid in parallel mode of operation. The intermittent nature RES integration in to the micro grid creates issues like energy management and generation forecasting. Fig. 2.1 shows a micro grid layout with heterogeneous entities: ESSs, DGs/RESs, Plug-in-Electric Vehicles (PEV), Load centers and control centers. The concept of integrating heterogeneous entities helps in improving grid efficiency, demand side management (flat load profile) and economic benefits. Micro grid deployments all over the world has set the new flat form for marketing power which will encourage individual customers in local power generation[8].

Sharing of power in micro grid is considered to be the prime task in order to maintain the system stability. The organization of this paper is as follows: The section II is dedicated to explain smart grid role in micro grid atomization and smart control. Section III describes the island mode operation and it's challenges followed by V and f control in section IV and energy management system for micro grid in section V. The control strategies for power sharing in island mode has been discussed in section VI and finally The grid synchronization issue was discussed in last section.

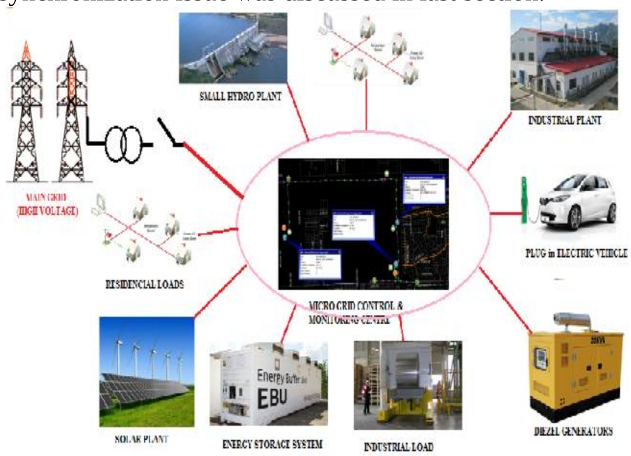

Fig. 2.1 Micro grid layout with heterogeneous entities(left), Micro Grid Community(right).

II. SMART MICRO GRID

In recent years, there is a appreciable proliferation of smart grid deployments all over the world. The advancements in technologies in information and communication areas lead the grid more sustainable and reliable utility. In view of increasing energy deficiency and increasing CO2 emissions because of energy production, the RES became a preferable solution. Along with RES the concept of Smart Grid lead the grid to have i components integrated into the legacy grid. Among the various components in the now-a-days grid, PEV, advanced energy storage systems (ESS), micro turbines, solar and wind generation, smart metering infrastructure are the key role players in energy management at the distribution side.

The DGs integration and ESSs lead to the concept of micro grid[9,10]. Micro grid is an autonomous distribution system in which the local generation along with ESS can run the entire load. Smart Micro Grid can be considered as an integration of heterogeneous entities with ICT and Smart metering infrastructure [11-13]. The Fig.2.1 shows the model of micro grid along with the control centers and data flow. The two-way communications among the different components of Micro grid helps in sophisticated control and monitoring. Smart Home provides additional flexibility over the demand side management and load forecasting. In a broad sense, the Smart Grid technologies can bring so many advancements in controlling of Micro Grids. In Fig.2.1 the PCC is the point of common coupling through which the main grid service can be utilized in case of power generation inadequacy in the Micro Grid. Depending on the energy availability and load variations, Micro grid can be operated in two modes: 1. Island mode, 2. On-grid mode. In island mode of operation, the local generation along with the ESS will supply the load demand. In case of any failures or deficiency in generation, the PCC will get to ON position which in turn connects the main grid to the micro grid. The major differences between Micro Grid operations and main grid operations are shown in the Table.1.

Table- I: Differences between Micro Grid operations and main grid operations

Micro Grid	Main Grid(Distribution)
Local generation along with ESS can feed the load	Power will be supplied by Grid
Frequency correction should be done by local control	Grid will take care of frequency variations
Variable network configuration(Island/on-grid)	Conventional distribution network
Island mode detection need to be identified	No Island mode operation
Coordination of Micro Grids is possible	Main grid will have tie lines to connect neighbor area
Synchronization need to be attained among all DGs	Grid synchronization will be done at Generation side
During grid failure Micro grid can still supply power	Utility cannot supply power during grid failures

Micro grid as it is a very complex network having variable topology with transitions from one mode to another there are so many challenges and issues in its operation, which are listed below:

- DGs synchronization.
- f - correction.
- V - correction.
- Island detection.
- Protection.

- Optimal energy management.
- DGs placement.
- Reverse power flow.
- ICT aided Micro Grid.

To address the above issues, instead of conventional control, the communication aided control and monitoring will be the best opportunity for effective and reliable micro grid operations. These smart grid entities makes the micro grid more efficient in terms of all aspects: energy sharing among DGs, adaptive protection, V and f control and smart way of island detection.

This paper the control strategies of power sharing has been discussed clearly along with other issues in island mode of operation. ICT, anyhow is needed investments on new communication and smart metering infrastructure. The smart grid layouts and standardizations are yet in their preliminary stages and the smart grid implementations were started with available standardizations. Supervisory control and data acquisition(SCADA), which depends on the data from centralized communication is not up to the mark because of data inadequacy and hence SCADA is limited for partial control[14].

State estimation plays vital role in control and monitoring of any electric network. The data from all the RTUs. IEDs, PMUs, smart meters and other meters will be collected by data centers and then the data will be processed to avoid wrong measurements and unwanted data in order to estimate the state of the network. This process is called as state estimation where the voltage magnitude along with it's angle describes the state of the electric network. In ref. [15], the authors have discussed the effectiveness of state estimation with the PMU's and RTU's data used in SCADA systems. Of communications for data transfer in electric networks, one wired another one being wireless. (power line communications) PLC [16,17] and digital subscriber lines(DSL)[18].

The PLC is having its best advantage as it uses the existing power line as the medium and hence it is a preferable choice for cost effective communication. DSL are another level of quality communication as the data is transferred in digital form with no disturbance, whereas the PLC is facing problems with interference.

Two way There exist The communication topologies for effectiveness and reliability, are classified according to their application and the latency requirements. Broadly speaking, there are three topologies namely: Home area network(HAN), Local/building/industrial area network(LAN/BAN/IAN) and Wide area network(WAN).The proliferation of wireless communication technologies, the higher band width and reliable data transfer is an additional advantage for smart grid deployments where the latency place a vital role[19,20].

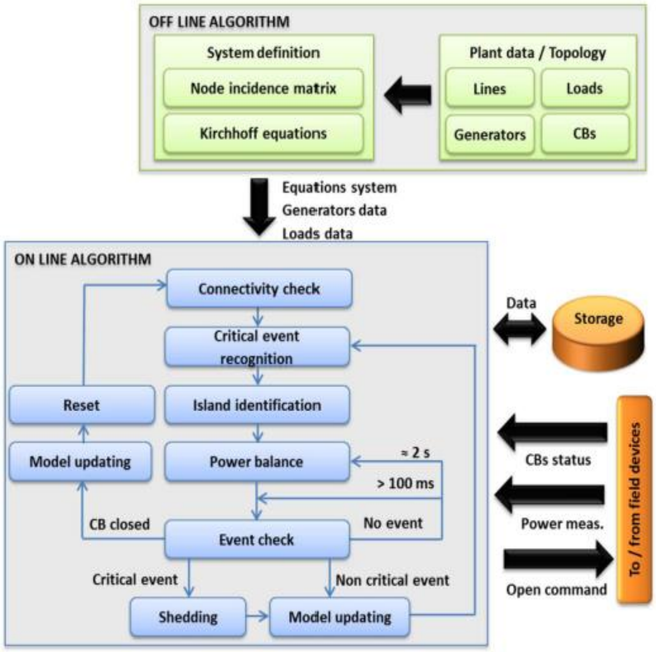

Fig.2.2. Island detection based on online data and network parameters.

A. *Island Mode Detection*

Micro Grid operations are very crucial when it is operating in island mode because the grid stability entirely depends on how the loads/generators are scheduled. Network changes its topology when it turns from on grid/parallel mode to island mode. There should be change in control actions and quick scheduling of generators/loads to maintain the stable operation. The major issues that arise due to mode changing are, protection criteria, reverse power flow, network topological changes and V and f control. The main objectives of island detection process are: to recognize the major critical events, to see which nodes are in and which nodes are out of each island and finally to calculate amount power to be shed in order to maintain the frequency.

Detection of island mode is very necessary to implement voltage and frequency corrections in micro grid. When it is decided to run in island mode of operation there must be balance in between load and generation. If any imbalance occurs in power, it can be seen as frequency deviation and hence there should be an effective control logic which will take care of load/generation shedding. The traditional methods which uses predefined shedding settings for few loads/generators works with frequency relays to shed the particular load or generator through the circuit breaker opening or closing. But these traditional methods have disadvantages as there are fixed settings for shedding and also time taking process. Fig. 2.2depicts an example that explains algorithmic way of island detection, where it runs two algorithms (one is online and another one is offline). Off line algorithm is for network topology identification and it needs data from circuit breakers, generators, loads and lines. Once the topology has been recognized, the online algorithm can start running.

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On line algorithm needs data from generators, loads, ESSs and impedance data of network. It also needs the generation constraints and other economical constraints.

Depending on critical event identification, the shedding of either generator or load will be decided by the online algorithm. In the literature so many works have been described with different protection schemes embedded in distribution generators to identify the island mode[18-21].In each critical event occurrence, there should be instantaneous logics to be generated in order to make the decisions of which generators are to be kept isolated or added. Most of the island detection algorithms works with Boolean algebra logics. Paolo Pinceti and Maurizio Vanti in their work have proposed a new algorithm for island mode detection which uses topological data and doesn't requires data from network parameters[25].Guo et al. proposed an algorithm based on wide area measurements and synchronized data to send the tripping signals to respective loads or generators in order make the load and inertia balance[26].

B. V and f control

Micro Grid, when it is operating in its grid connected mode, the voltage and frequency variations will be taken care by main grid. But during the Island mode, the dynamics in micro grid causes large variations in both voltage and frequency which need to be corrected by proper control strategies. Intermittent nature of RESs like solar and wind and along with other uncertainties like PEV, and unexpected loads are the major sources of frequency and voltage variations in micro grid. The solar and wind generations cannot be considered as sources of control for the frequency deviations as these sources are purely weather dependant and mostly unpredictable. It is more difficult to maintain V and f in their marginal limits when the micro grid operates in Island mode. The ESSs in coordination with other DGs like Diesel Generators can be a better solution for corrections in V and f deviations because of their quick response.

Micro Grids can be operated in coordination with neighboring Micro Grids to share the power in adverse situations[27,28]. The frequency correction is considered to be a major concern in micro grid operations mainly in Islanding mode, as the frequency violations leads to Micro grid block and hence then spreads to other Micro grids which are operating in coordination. There can be two different layers of control functionalities for micro grids namely: primary, secondary.

Primary or local control will look after the local area of minimum coverage and implements necessary actions that can be done at the local level. Secondary control will be in two ways, either decentralized or centralized control. Decentralized control facilitates interaction among the various units in order to gather data and to send the control signal[29,30]. Decentralized control is more suitable when the micro grid is operating in grid connected mode. Micro Grid Central Controller (MGCC) is an autonomous control center which will have control over very remote terminal unit. The MGCC collects the data from all the meters and Intelligent Electronic Devices (IEDs) and processes to send the control signals to appropriate units.

Within less time, the frequency deviations should be seen[31-32]. In support to this, the islanding of micro grid in the system is done with reference to many methods were proposed. The uncertainties seen in the micro grid were flexible resolved by H^{∞} and μ- synthesis which is a potent frequency control technique [33]. Assumption of virtual synchronous generators working is interfaced in a converter with droop control technique [34]. The micro grid islanding with respect to voltage and frequency controls at the time of contingencies [35] with cost effectiveness to real grid operations [36], along decentralization control scheme were different control methods (PCC of DGS) proposed [37]. Even with PCC of DGS, fast acting ESS systems with DGS are used in terms of load steady state operation of micro grid, communication delays are considered with certain latency was stated on control method [38].

Due to the advancements in ESSs at distribution side, it has become more flexible to either absorb from or deliver power to the grid. The low inertia nature of micro grid is a major concern to and voltages maintaining the frequency in their marginal limits. The ESSs can be a better source for frequency and voltage correction with effective control mechanism [40,41]. Single ESS micro grid is easier to control V and f in which the storage system acts as a variable source of frequency/voltage and also the ESS can be considered to mimic as a synchronous generator. Multiple ESSs operating in parallel in a micro grid creates complexity in control. ESS can be regulated by adjusting their voltage angle and magnitude in order to meet the required active and reactive powers in the micro grid.

Droop controlling method has grabbed lot of attention in recent years [42], and it provides feasibility with plug and play the sources in micro grid[43].The droop control method generally works with assumption that the transmission line is inductive nature, however the low and medium kevel lines will have resistance domination and inductance is not a considerable parameter on comparison and hence traditional method of droop control is mostly not suitable [44].Virtual impedance provided by converters has been proposed by in [45-47] which gives an improvement in droop control in resistance dominative low/medium voltage micro grids.

III. MICRO GRID EMS

Reliable and economical micro grid requires a strategically programmed energy management system (EMS). The main objective of EMS is optimal scheduling of generation among all active DGs and ESSs with consideration of all possible constraints. In the communication aided smart micro grid, dealing with the issues pertaining to energy management became very realistic. EMS of micro grid should take care of below mentioned issues:

- Optimal Generation
- Inertia and load balance
- Power flow congestion
- Flat load profile
- Maximum utilization of cheaper and cleaner power.
- Customer friendly power supply.
- Exact forecasting of generation and demand.

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Energy management in micro grid is a multi-objective problem which is in nonlinear nature with so many constraints. EMS requires data from all the DGs and ESS, and from all the loads that are connected. And also EMS needs forecasting data both from RESs and loads in order to achieve best optimization.ICT provides adequate real time data with negligible latencies in data transfer which makes the EMS more efficient in taking decisions for load/generator shedding or scheduling.

There are different methods proposed in literature for this multi objective nonlinear optimization problem that includes: Rolling Horizon Strategy [48], mixed integer programming[49], using PSO, Neural networks, genetic algorithms[50].

These methods require high computational capabilities at the control center of the micro grid. EMS through ESS control will be a better choice for efficient management of micro grid[51].Another major problem with micro grid EMS is with intermittent nature RESs like wind and solar. The fixed frame of control strategies doesn't work well for this case because of poor forecasting nature. As the generation from most of the RESs goes in uncertain manner, it is more difficult to model the EMS and requires adaptive control strategies like time scale adaptive method proposed by LI et al., in which author used neural network-based forecasting for online setting of controls[52].

The Fig.3.1 shows MCCC layout with another two levels of controls namely: primary/local and secondary. The Decentralization of controlling has been considered to improve the accuracy in control and to reduce complexity of control circuitry. In Fig. 3.1, it is depicted that the way overall control will carry out by the MGCC in coordination with local and secondary levels of controls.

The major drawbacks with the methodologies or algorithms done in literature are: didn't consider all the constraints, forecasting information not considered and neglected network topological impact(assuming that all generators are connected to single bus) and power flow .An effective survey was done by the authors in ref. [53] in which the EMS issues and benefits are reviewed clearly.

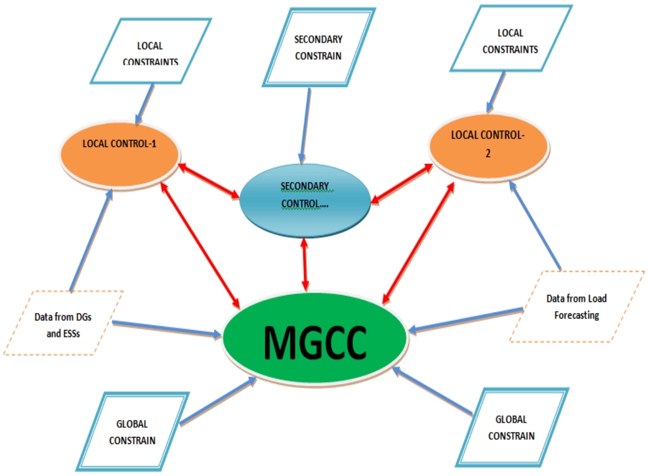

Fig. 3.1. An Energy Management System for Islanded micro grid operation.

In [54], proposed a distributed EMS for micro grids in which optimization has been done for at local controller in conjunction with MGCC. Distributed control over the whole micro grid has several advantages as it is very easy to deal with complex networks with heterogeneous components. Authors in [55] have proposed a multilevel control scheme for micro grid which is a multi agent system based control (MAS) in which decentralization in terms of local controllers has been preferred at maximum extent.MAS can be considered as best one for sophisticated control of micro grid, and different control strategies of MAS has been proposed by researchers [56-58]. Along with economic generation, the demand side management (DSM) which helps in scheduling loads makes the EMS more prominent in maintaining micro grid market in profit. Mojica-Nava et al. described an EMS that uses population game theory and considers two main objectives: optimal DGs scheduling and DMS[59].

IV. ROLE OF POWER ELECTRONICS IN MICRO GRID CONTROL

Mostly the DGs within the micro grid are heterogeneous and hence possess so many issues in power sharing and other operational coordination. Most or all of the DGs will connected to the distribution grid through the power electronic converter's/inverter's interface. The control actions in the islanded micro grid can be initiated through these converters(DC/AC or AC/AC), through which the power sharing, synchronization, voltage fluctuations, power-load balancing and other control actions will be done. The main role of these interfacing converters is to match the demanded active and reactive powers to active and reactive power generations. The Fig. 4.1 depicts the parallel operated inverter interfaced DGs and in an islanded micro grid.

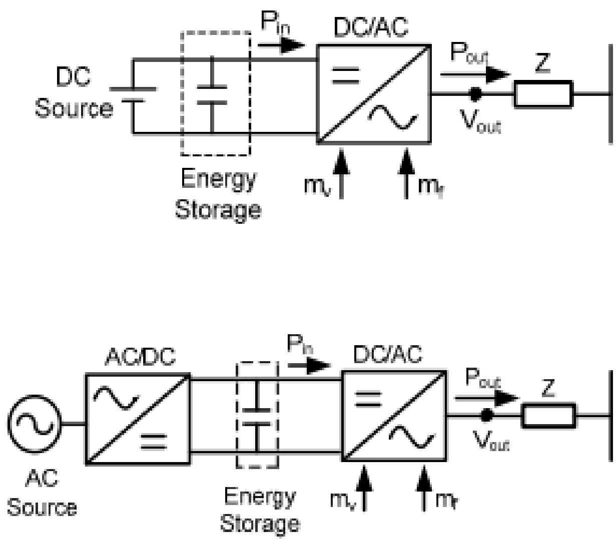

Fig. 4.1. Micro grid with converter interfaced DG units (DC type DG-at top; AC type DG-at bottom).

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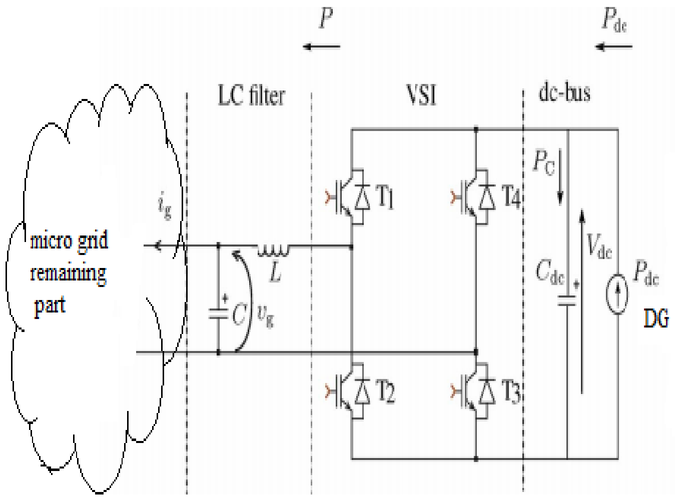

Fig. 4.2. Micro grid representation in Generation perspective.

There are so many control techniques that are adopted for the control of theses converters proposed in the literature. The main aspects of micro grid controller are: power sharing among DGs optimally, voltage and system stability, active and reactive power balance, automatic island detection, compensate dynamic voltage requirements, addition of micro sources and micro grid synchronization. Basically two types of DGs are available out of which one is of DC type another one is AC type. Both of them need converters to interface with the micro grid as shown in the Fig. 4.2. The DC link voltage is used to monitor the power fluctuations on the grid and hence the monitoring of DC link voltage gives hint for control actions to be initiated in order to compensate the system dynamics.

The whole micro grid control scheme can be visualized in three levels of control layers: primary, secondary and tertiary. The roles of each control layer have been depicted in the Fig. 4.3. The tertiary control, which will hold the entire operational aspects of micro grid, will be more effective with the smart grid technological cooperation which is ICT.

The reason is that, the communication and information technologies helps in speed up the operation and adequate data helps in speed up the accurate control process. The secondary control is like a back up for the primary control layer and the primary control will look after the generation control and scheduling, frequency and voltage correction at generators level, reverse power flow etc. On the other hand, these control schemes are varied from centralized control to decentralized control:

Centralized control and decentralized control. The different types of power sharing control strategies are reviewed in depth in ref. [60] for islanded AC micro grids. Virtual inductance based control scheme was proposed in ref. [61], where the authors used the voltage drop across impedance along with local loading of the DG to execute the power sharing operation.

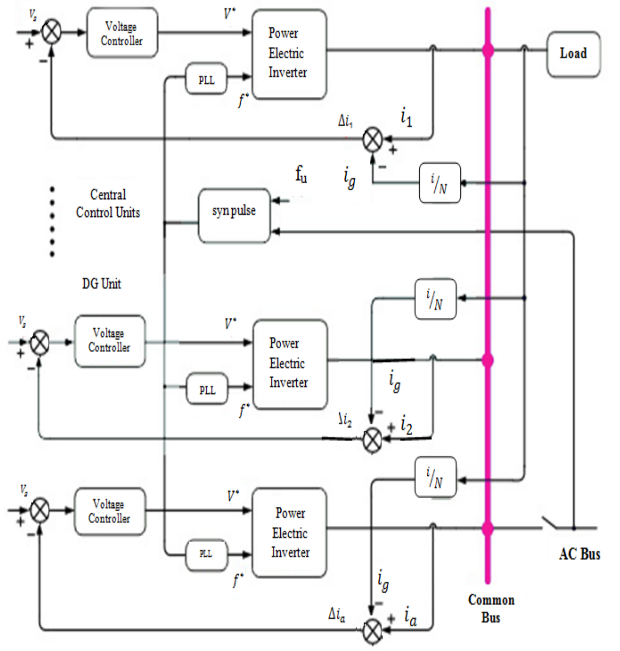

Fig. 4.3. Concentrated control scheme for micro grid operations.

There are some reviews published on this micro grid control strategies in the literature [62-64]. Authors in ref. [65], have presented an hierarchical control strategies for islanded micro grid with three layered structure. J.W. Simpson Porco et al, have proposed a new algorithm for islanded micro grid synchronization and sharing among the DGs without violating the system operational constraints and droop control has been adopted [66].Wireless control scheme was adopted with virtual impedance measurement for active power sharing [67].An autonomous DC link voltage-based control scheme was explained in ref. [68], in which the grid voltage fluctuations are recognized with the DC link voltage variations. These types of droop control methodologies require no communication among the DG sets hence are said to be cost effective. As this paper is mainly concerned about smart grid related issues and challenges in micro grid operations, the communication-based control schemes are discussed and the conventional droop control strategies are not concentrated.

V. MICRO BRID CONTROL

A. Communication based Control

Control strategies based on conventional droop control methods works without any communication assistance. With abundant data and quick transmission leads to effective and accurate control over the micro grid power sharing and mitigating fluctuations. The communication-based control strategies can be divided in two three categories depending on the interoperability among the micro grid entities: Centralized control. Master-slave control and Distributed/Decentralized control. Anyhow the communication protocols need extra investment. These control schemes need reliable communication channels without which no control actions can be initiated.

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B. Concentrated control

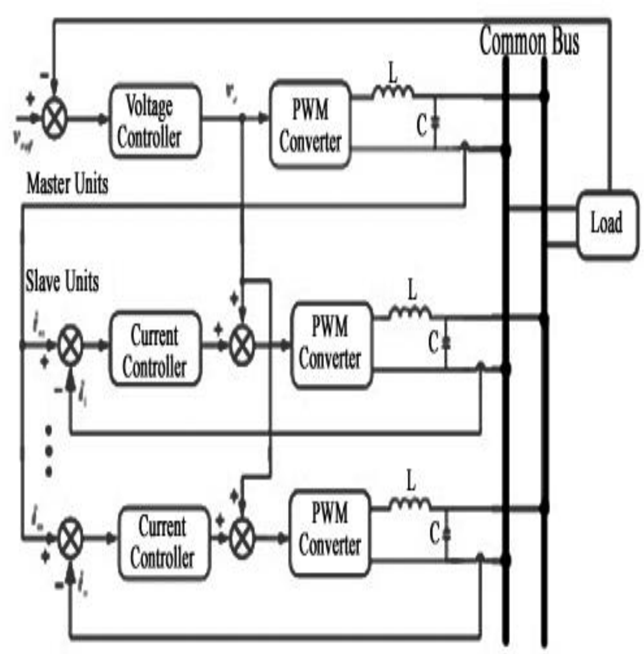

Fig. 5.1. Master-Slave control scheme for micro grid operations.

This scheme is very effective in power sharing to obtain the global optimization in power among all the generations and storage units. And it is possible to execute these control actions during both the steady state and transient states. It is difficult to expand the system further with new micro generations as these changes affect the central control scheme. And moreover, high band width communication is needed to transfer all the loading current references to each generation and storage unit. This centralized control scheme requires synchronized data from all the ends in order to ensure the autonomous control and power sharing. In the Fig. 5.1, the control mechanism has been illustrated. Each converter will get a reference current signal from the load current measurements. The whole load thus can be surpassed to all the generating units optimally. With the help of phased locked loop, will look after the variations in frequency and also phase angle. The main aim is to achieve equal current distribution among all the inverter modules. Hence this concentrated or central control, method is in need of effective and reliable communications without which there would not be perfect synchronization among the all modules.

C. Mater-Slave control

Unlike the concentrated control, the master-slave control is designed to operate with reference to one of the inverter modules that are operating in parallel. The parallel connected modules will receive the control current reference from the master units and acts accordingly [62-65]. At the starting time of island operation, any one module can be considered as reference or master while remaining being operated with the reference current signal sent by master module. As shown in the figure. 5.2, the master module is responsible for controlling the voltages at all the modules by sending individual current references. Inverters are synchronized with the master module and hence PLL is not needed in this case. The disadvantage is that whenever master controller fails, entire system will fail to operate.

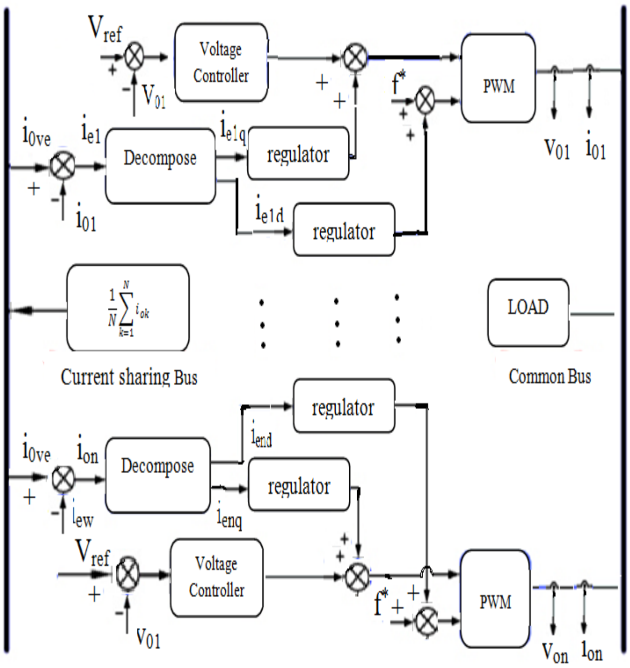

Fig.5.2. Distributed control scheme for micro grid operations.

While talking about disadvantages of this control, one should mention about failing of master module and also about the adverse effect of transients on master module as it is uncontrolled one. During transients the uncontrolled master inverter may experience peak over currents which causes system failure. The remedy or the substitute for current master is the main interest of researchers these days. Authors in ref [69], have proposed a redundant master-slave control strategy using rotating priority window to decide new master. Master-slave control was applied to inverters in which real and reactive power sharing buses are used to identify the master inverter with high power delivery[70].Communication assisted master-slave control was discussed in [71] where the community of micro grids also considered to improve the efficiency in power sharing. The adoptability of master-slave control allows plug-and-play of new DG's integration into the micro grid.

D. Distributed control

In this type, there is no need of central control or monitoring but each individual inverter module will have its own control circuitry. All it needed is one average current sharing bus and voltage reference for synchronization. Current controlled loop is used for tracking the average current in all the inverter modules. The reference current is then spited into two parts, one is active component and another one being reactive component. These decomposed components are used to control the frequency and amplitude of the voltage. The main advantage in this control is that it need no global information. A fully distributed control for AC island grids was proposed in [72], where no external information sharing is needed and the power sharing was considered the incremental fuel costs. The importance of distributed control and its advantages are discussed in ref. [73].

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An average instantaneous current sharing scheme was proposed in ref. [74] which is aimed to improve the redundancy of the system.

On comparison with droop control methods proposed in the literature, it is more convenient and cost effective. And it needs very less band width for data transfer as the information needed is available with adjacent modules. However, this control scheme requires interconnection among the inverters for the reference signal sharing and hence it creates the complexity in the network. If the DGs are located far away the interconnection is an issue. But with the smart grid deployments, the communication protocols help a lot in sophisticated control over the all remote entities in the micro grid.

E. Grid Synchronization

Along with the numerous advantages of micro grid formations, there are so many issues that are pertaining to both technical and economic issues pulling down the micro grid deployments. Grid synchronization, reverse power flow, protection and stability are the major issues in the micro grid. Once the islanded micro grid started undergoing the wide variations in frequency and stability, necessary control must be done in order to get into stable operation.

If self-healing is not don in permissible time duration, sever consequences will be takes place which in turn causes micro grid black-out.

It will continue to the other micro grids which are operating in coordination. A perfect synchronization need to be done before closing PCC.

Thale And Agarwal have proposed an advanced grid synchronization method by using communication technologies of smart grid. In their work, before making smooth transfer from island mode to grid mode, each and every DG was set to get in synchronism with main grid voltage magnitude and angle at a specified frequency[75].Lot of researchers have came up with different types of synchronization techniques by considering phase imbalance, harmonics and frequency deviation. These techniques are not so popular as they are developed with consideration of distorted voltage and also requires complex control circuits. In [76], traditional PLL based synchronization technique has been proposed which uses instantaneous three phase voltages oh the main grid.

VI. CONCLUSION

Micro grid issues and challenges are discussed in this paper along with their existing solutions in the literature. Mainly DGs synchronization and V and f control are discussed, which are very deciding parameters of micro grid stability. Along with these stability issues there are other issues like protection of micro grid, reverse power flow, optimal placement of DGs etc., which are not covered in depth in this paper. The role of power electronic converters in controlling of grid parameters also discussed. The communication-based control strategies are also discussed for effective power sharing among the DGs in the micro grid. Anyhow the conventional droop control strategies are not discussed in this paper. Energy Management System is said to be heart of Micro grid through which the whole power balance is maintained and it is also responsible for micro grid stability.EMS is also discussed in this paper with the existing literature. The main factor that influences the operation of Micro Grid is integration of intermittent DGs which are RESs like solar and wind sources. Smart Grid technologies deployment leads to a new paradigm of control strategies with more accuracy and reliability as abundant real time data is available along with advanced communication protocols. With these Smart Grid technologies implementations, it is expected to have more challenges in the micro grid operations in near future.

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