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IMPORTANCE, ISSUES AND CONTROL OF MICROGRID

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Abstract:
Utilization of distributed energy resources and power stability related problems are becoming of most importance in the pursuit for a more sustainable power system. Microgrids (MGs) could contribute significantly to both issues and may play an important role in the new decentralized paradigm of power systems, microgrid with distributed generation is playing an essential role in fulfilling this increasing demand of power. Microgrid comprises of distributed generators, batteries, connected loads and electronic interfaces. In the current scenario distributed power generation which consists of a diesel generator with renewable are widely used. Microgrid with Solar is the most commonly used renewable power source of power generation in distributed generation.
Motivation/Background: This paper reviews the Importance of microgrid its advantages over conventional grid, Issues, control and energy management aspects of microgrid have been reviewed.
Method: Give a short account of the most important methods used in your investigation.
Results: Various elements in the microgridsposses potential to coordinate with other element using a hierarchical architecture and suitable communication system with the controllers connected with each of the element
Conclusions: The modern microgrids with renewable interconnections possess high potential to meet the growing demand of power.

Keywords: *Microgrid; Control; Renewable.*

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1. Introduction

Power generated in the local area is commonly used in microgrid with various generators and electrical load for a local area it provides viable solution for villages and remote areas, where the grid connectivity is not proper and cost of electricity per Kwh generated by diesel generator is very high and also the fuel is nonrenewable, therefore there is a requirement to switch from diesel generator to renewable energy sources like solar Photo Voltaic (PV)[1,2].

2. Importance of Microgridmaterials and Methods

- Power supply does not get affected with other grid failure as it is not dependent on other grid. Beneficial in case of natural disaster or manmade disaster.
- Local cost of distribution is less as compared to the transmission cost of the transmission lines installation as well as line losses cost.
- With the increasing demand of power, microgrid costs less as compared to transmission and distribution power systems.
- It utilize renewable energy and emits almost zero harmful gases, thus beneficial for our atmosphere.
- Power delivered by the microgrid is good in quality and also reliable as compared to conventional power systems.
- As the power produced locally cost of cost per unit of electricity is less.
- In overall for a long term project it is not only producing low cost green electricity but also utilizing local natural resources as well as opening job opportunities for local people. Thus resulting in the overall development of a local area society.

3. Issues in Microgrid

Microgrid offers various advantages over conventional grid and with the use of renewable systems, its issues also increases. Renewable energy sources provides a clean and green energy, with low cost per watt generation and also. As there are various advantages of using renewable energy sources but the main disadvantage is that it lags with the synchronous generator inertia [3, 5]. This may lead to serious instability in voltage and frequency in the system which can further result into grid failure if the load demand is not met at the particular time instantly. The above mentioned issues are need to be considered before establishing any microgrid, some issues and challenges in distributed microgrid are as follows:

- As the power supplied to the main grid can be injected as renewable energy sources produces DC power that need power electronic devices and power converters for connecting mail grid with microgrid and renewable sources. These power electronics devices injects various harmonics to the main grid resulting in degradation of power quality. Some active filter connected converters have helped in mitigating the harmonics but at the same time it also increases the cost of the overall system.
- Frequency and voltage variation caused by variation in the demand and supply due to lag in the system inertia.
- Fault protection is one of the issue when renewable sources are connected microgrid as every element need to be protected with internal faults as well as external faults.

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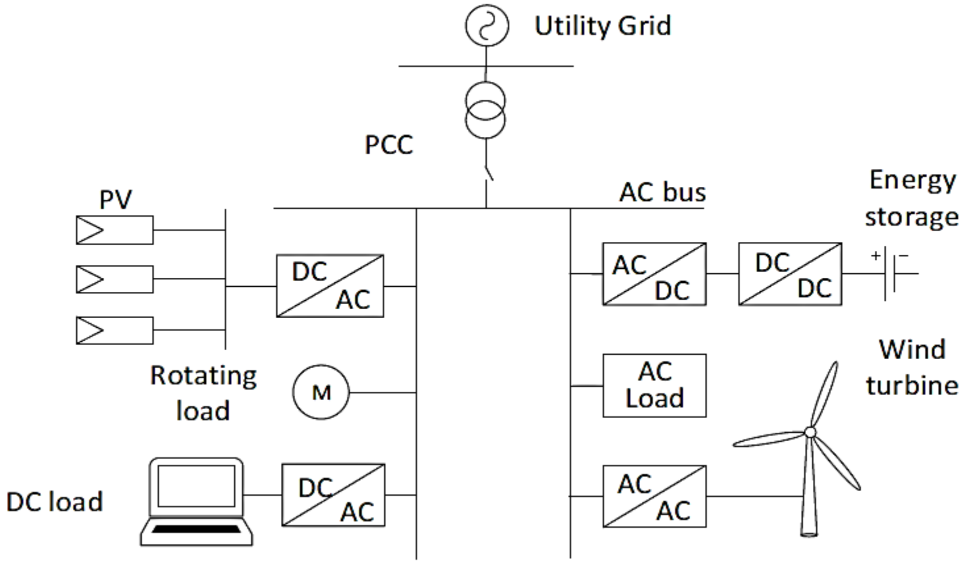

Figure 1: AC architecture of microgrid

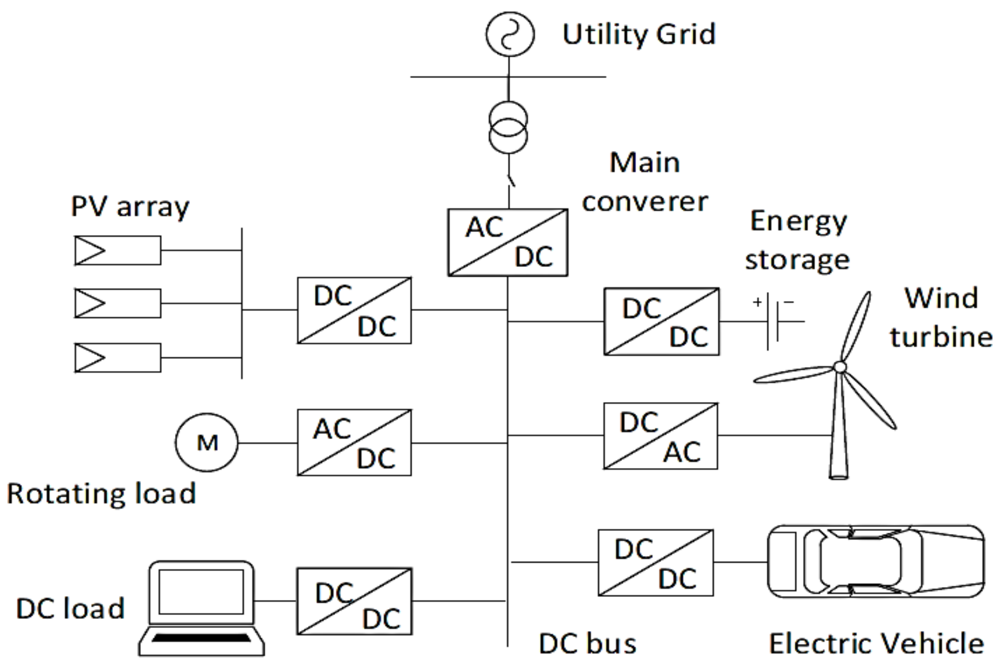

Figure 2: DC architecture of microgrid

4. Microgrid Control

In a microgrid active and reactive power need to be controlled this can be explained as follows:
DC current control: It is one of the important control in microgrid, In DC current control the P reference generates the current reference which which ultimately results in working of converter it acts as current controlled voltage source.

PQ control: In PQ control mode the reactive power (Q) and active power (P) output from the converter are controlled by controlling the quadrature axis and direct axis current of the converter output.

Voltage source Inverter control: In this type of control the converter operates as Voltage Source Inverter (VSI) imitating the action of a synchronous generator. The droop characteristic is used for finding the Q and P reference.

The microgrid can be operated in Islanded mode or in grid connected mode. In grid connected mode surplus power by the microgrid can be injected to the main public grid, and power can be drawn from the need when required, In Islanded mode of operation, microgrid is disconnected from the main grid, and power generated by the microgrid can only be utilized within the grid and there will be no external exchange of power with the main grid. But in islanded mode stability is the major issue. In the absence of synchronous machines the converters have to emulate the droop characteristics and ensure frequency stability. Then Voltage Sources Inverter control scheme is suited for this. There are two main control strategies under islanded mode of operation [10-12]

Two main control strategies under islanded mode of operation [10-12]
- Single Master Operation (SMO) is where one converter connected to source or storage element will operate in VSI mode. This converter will therefore set a voltage and frequency reference for the grid. The other converters will work in PQ control mode.
- Multi Master Mode (MMO) in this mode more than one converter will work in VSI mode setting the voltage and frequency reference while others work in the PQ control mode.

Control levels can be classified as four categories (a) Centralized control. (b) Decentralized control. (c) Distributed control. (d) Hierarchical control. Decentralized control is based on local control of microgrid.

Decentralized control can be explained using Fig. 3(b) this type of control does not require any information from other controllers and each controller is responsible for its own system and data collection is done separately. Decentralized control does not require any real time data communication. Droop control is one of the example of decentralized control. It can achieve power sharing between Diesel generators without any communication, but its accuracy is restricted by system control and its configuration and depends upon its electrical parameters. The main challenge of a fully distributed control is the coordination among distributed units achieve either control or optimization of the system, which basically require a good communication system for its appropriate function.

A hierarchical control system is explained in Fig.3 (d), most commonly used in microgrid. Functions can be fed at two levels at central level and at local levels, Hierarchical control is therefore becoming a standardized configuration in Microgrids.

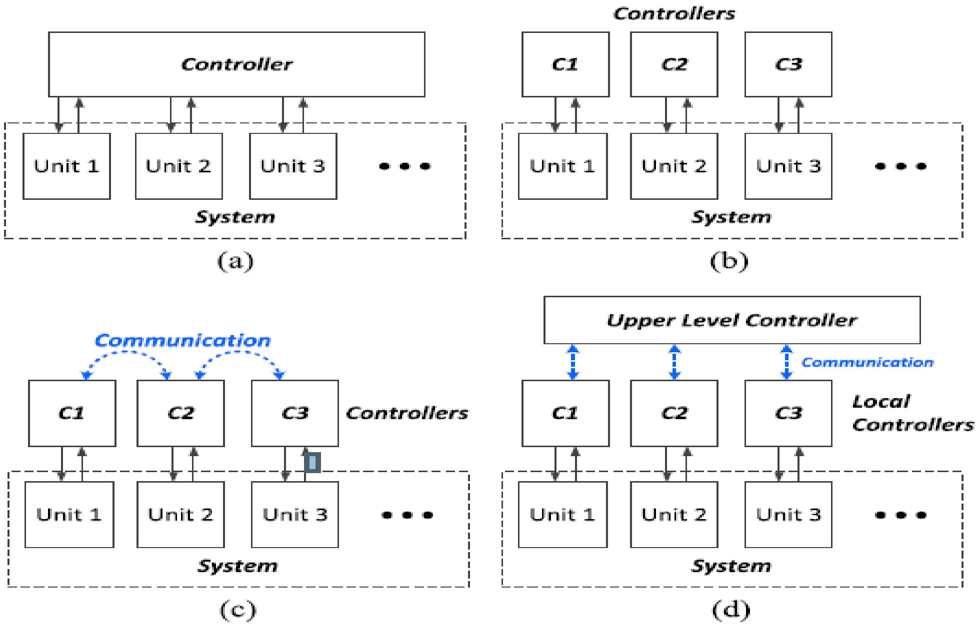

Figure 3: Basic Control Structures a) Centralized. b) Decentralized. c) Distributed. d) Hierarchical

5. Energy Management Aspects of Microgrid

In the microgrid application scenario, one of the challenging tasks is reducing large energy imbalances due to the uncertainty in power supply from intermittent renewable energy source based distributed generators (DGs) and the dynamic nature of electricity consumption. Fortunately, advances in information and communication technologies (ICT) along with more and more heterogeneous flexible loads, such as plug-in electric vehicles (PEVs), thermostatically controlled loads (TCLs) and distributed energy storage (DES), enable a great opportunity to develop the demand response (DR) and demand side management (DSM) in smart grid applications. These technologies provide a lot of energy management approaches to ensure that the power demand can be rescheduled according to the power supply from utilities or local microgrids through directly or indirectly load control strategy [14-16].

Table1: Energy Management

Type	**Pros**	**Cons**
Centralized control	• Easy to implement • Easy to maintenance in the case of single point failure	• Computational burden • Not easy to expand (so it is not suitable for smart grids) • Single point of failure (highly unstable) • Requires a high level of connectivity
Decentralized control	• Local information only • No need for a comprehensive two-way high-speed communication	Absence of communication links between agents restricts performance Moderate scalability

	• Without leaders, system still includes Some control island-area • Parallel computation	
Distributed control	• Easy to expand (high scalability) • Low computational cost (parallel computation) • Avoids single point of failure • Suitable for large-scale systems • Not affected by changes in system Topology. • practical solution for plug-and-play characteristic of smart grid	• Needs synchronization • May be time-consuming for local agents to reach consensus • Convergence rates may be affected by the communication network topology • Needs a two-way communication infrastructure • Cost to upgrade on the existing control and communication infrastructure

In the last few years, there have been more and more retailers and utilities investing in DR programs, utilizing changes in end-users' power demand as one of the methods to increase power demand elasticity. Usually, most demand response actions may be either responses to changes in the electricity prices over time, or incentives from utilities that result in peak shaving or even the relief of congested networks incentive agreement. With the development of networked microgrids, those incentives also include local power supply situations and relevant generation forecast. Generally, there are two demand response mechanisms, namely incentive-based and price-based. Each DR mechanism comprises a number of DR alternatives that can be adopted, which are shown in Table.2.

Table 2: Different demand response mechanism

DR program	**Time of Use**	**Critical Peak Pricing**	**Real Time Pricing (RTP)**	**Direct Load Control**	**Bidding**	**Emergency**	**Interruptible**
Rule	Non-dispatchable	Both	Non-dispatchable	Dispatchable	Dispatchable	Dispatchable	Dispatchable
Response type	Customer side	Customer side	Customer side	Utility side	Customer side	Utility side	Customer side
Advantages	Low price rate during off peak, user can shift load with min.	Customer response for a short time period to get discount offers.	The customer can minimize the cost with respect to price change in a day, month	The utility offers good discount for limited load reduction or shifting.	The utility offers good discount for limited load reductio	Customer can get credit or discount rate for the short response.	Customers respond for a short period to get discount rates.

					n or shifting.		
Disadvantages	One price rate for all customers' consumption levels,	The customer should shift or curtail home resource for certain time.	Customers need to instantaneously respond to minimize bill cost.	The customer should give the utility company a level of authority to shift or curtail certain load in order to balance	The customer should shift or curtail home resource for certain time.	The customer should shift or curtail home resource for certain time.	The customer should shift or curtail home resource for certain time.

6. Conclusion

In this review paper this can be concluded that elements connected to the low voltage side posses the capability to setup its small grid and can manage it in the better way. Various elements in the microgridsposses potential to coordinate with other element using a hierarchical architecture and suitable communication system with the controllers connected with each of the element. The major challenge in micro-grids is the implementation of a robust control capable of operating in the islanded mode and the grid connected mode. The modern microgrids with renewable interconnections possess high potential to bring renewable, demand response system, distributed energy storage systems, controllable loads and communication infrastructure and many other new technologies into one main stream for supplying the demand for the local area and also supply surplus power to the main grid, helpful to meet the variation in the demand with high quality power.

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