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Review on the Future Grid -Microgrid

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***Abstract* - The Microgrid concept using renewable energy sources is a building block towards the future energy networks for long-term viable solution of energy needs . Many microgrid developments carried out in several countries, because microgrid offers many advantages, including better power quality and more environmentally friendly. Microgrid development concern in technology generation, microgrid architecture, power electronics, control systems and protection systems. This paper provides a review on Microgrid system across the world.**

Keywords: - Microgrid; Distributed Generation (DG); Distributed Energy Resources (DER); Point of Common Coupling (PCC)

I. INTRODUCTION

Due to rising concern of climate change and energy security, Distributed Generation (DG) has gained popularity. Increasing concern of public awareness in reducing the carbon emission and due to sufficient liberalization of electricity market, there is the rise in the use of Distributed generation. This concept in turn create the concept of Microgrid[1,2] .The Microgrid concept involves a small transmission and distribution network that effectively make use of location specific Distributed Generation(DG) and Distributed Energy Resource(DER)[3] .The concept of Microgrid is driven by two fundamental principle:

(a).In order to have maximum benefits from integrating distributed energy resource, the customer, utility and society should employ a "System Perspective"

(b). A business model should be prepared with the objective of achieving the reduction in the initial investment cost involved in these technologies [4].

Microgrid provides many benefits both to the user as well as to electricity supplying utility. From the user end, since it is connected to the grid it can improve the network quality, reduce emissions and reduced the cost to be paid by the consumer. On the utility end implementation of Microgrid with Distributed Generation (DG) reduces power flow on transmission and distribution lines which in turn reduces the losses in the lines and cost for the additional power [5].
The general organization of the paper is as follows; Section II deals with the Architecture of microgrid. Section III deals with various technologies used in the microgrid system. Section IV deals with Comparison of Microgrid with Conventional grid. Status of microgrid is presented in section V and Section VI concludes the paper.

II. ARCHITECTURE OF MICROGRID

The microgrid defined by CERTS [6] (Consortium for Electric Reliability Technology Solution of the USA) is a micro power system including a cluster of loads, storage and multiple DGs. It could meet the requirement of power quality and reliability of power supply. It provides both heat and power to the local area. Fig. 1 shows the basic microgrid architecture. In this example, the microgrid is assumed to be radial with three feeders and some loads. Power electronics devices such as inverters are in charge of the DGs to provide power flexibility.

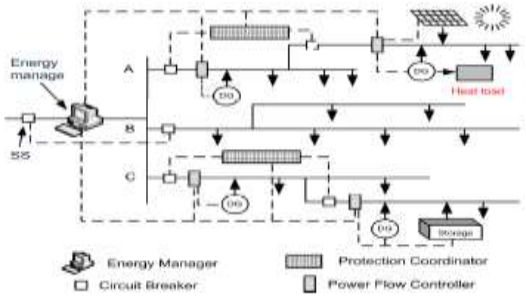

Fig.1.Shows Architecture of Microgrid [7].

Microgrid system operate at a low voltage and it consists of several distributed energy resources such as solar panel, wind turbine , micro turbine and various energy storage devices

such as flywheel, battery, super capacitors etc. Microgrid can operate in two modes:

1. Grid Connected Mode
2. Islanded Mode

The Architecture of AC and DC Microgrid is presented in Fig.2 (a) and Fig. 2(b) respectively

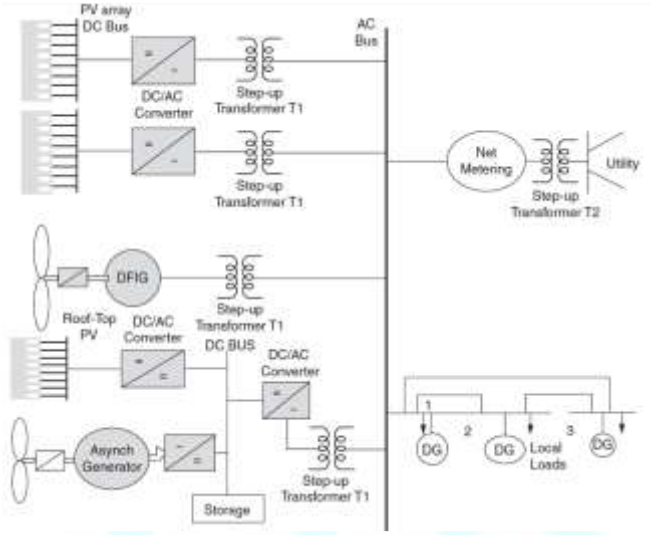

Fig.2 (a) shows AC Microgrid

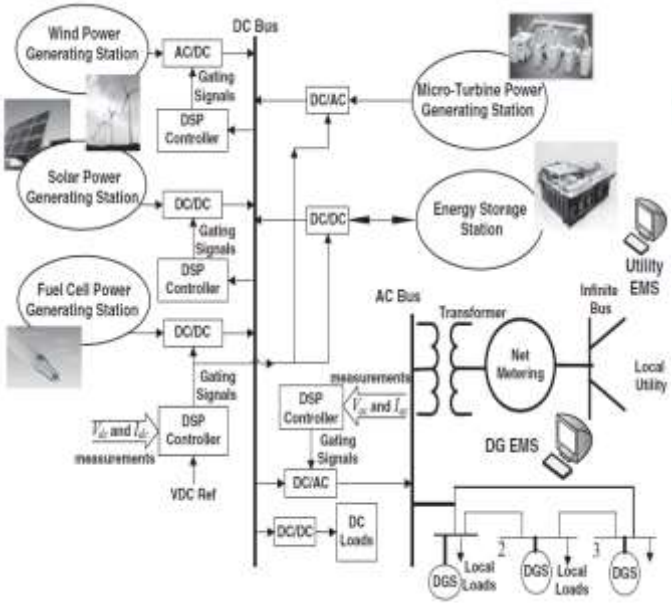

Fig.2 (b) shows DC Microgrid

Microgrid electrical connections points that connected to low voltage network through point of common coupling (PCC) consists of several distributed energy resources and various types of loads such as Residential loads, Commercial buildings loads, campuses and industrial load[8].

III. TECHNOLOGY USED IN MICROGRID

Operation of microgrid system cannot be isolated from technologies that support each part of the microgrid system, as the source of energy (distributed generation), energy storage, interconnect switches and control system involved in microgrid system. Technologies in energy sources include the ample utilization of renewable energy sources such as photovoltaic, wind turbines, and fuel cells etc. Technologies in energy storage include battery, super capacitor and flywheels. Energy storage in microgrid is used:

- To Provide Stabilization of the microgrid system in the face of fluctuating energy sources and load changes.
- Enables load sharing operation in microgrid system.
- Reduce the loads spikes and electrical interference
- Backup energy source [9].

Switch Interconnection technology in Microgrid system according to IEEE 1574 network interconnection standard employing Digital signal processor is shown in the Fig.3

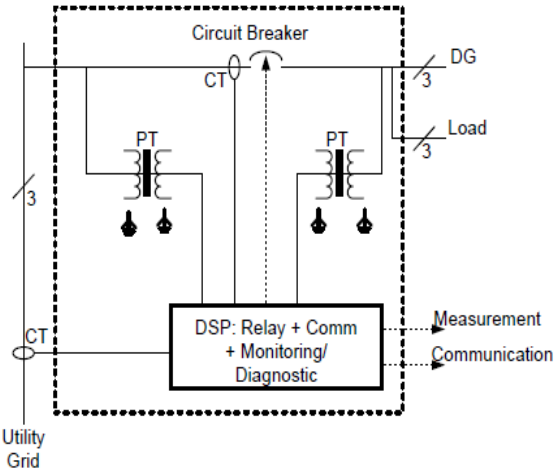

Fig.3 shows schematic diagram of circuit breaker on connection to the grid

Control system technologies used in the microgrid system can be grouped in two modes of operation are connected to the network mode and isolated mode (islanding). The control system is required to keep the stability of microgrid operation particularly in frequency and voltage variations so as to maintain stability in case of change in load in a system and during interconnection with other networks.[10].

IV. COMPARISON OF MICROGRID WITH CONVENTIONAL GRID

Traditional grid consists of centralized structure and this type of structure does not have any intelligence ability to store and process the data, whereas the microgrid follow the decentralized approach employing intelligent techniques and processes to store and process the data. Fig.4 shows the Block diagram of (a).Conventional grid (b).Microgrid [11].

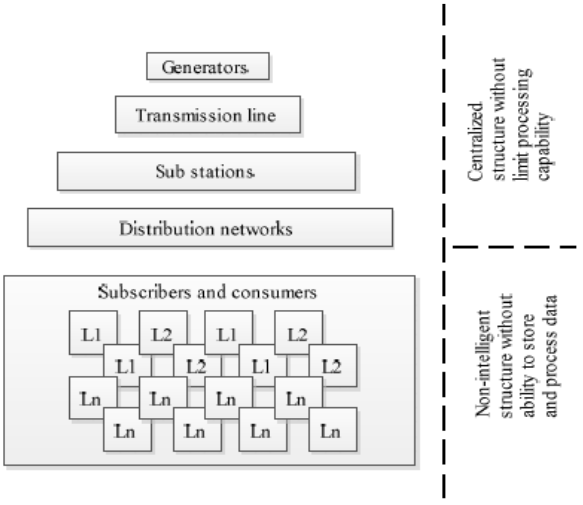

Fig 4(a).Shows Block Diagram of Conventional Grid

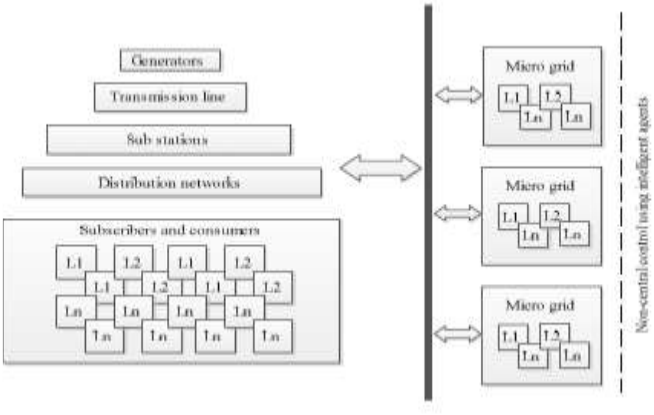

Fig 4(b).Shows Block Diagram of Future Grid

Table 1.Shows Comparison between conventional power systems and future ICT enabled smart grid/Microgrid system [12].

Conventional Grid	**Microgrid**
Electromechanical	Digital
One Way Communication	Two way Communication
Centralized generation	Decentralized Generation
Restricted measurement of sensor and elements	Comprehensive measurement of Sensors
Wide interruption at time of outage	Filtering and islanding disconnection
Limited service to customers	Various services to customers

V. STATUS OF MICROGRID

Status of Microgrid across the different parts of the world is presented below:

1. North America: - The Consortium for Electric Reliability Technology Solutions (CERTS) is the most renowned of U.S. microgrid. The main objective of this project was to make it easier to operate the micro-generators together to supply the utility grid [13]. North America is not mainly focused on renewable energy generation but also focused on having the reliability of power sources by integrating microgrid technology. Furthermore, it is more concerned with the use of decentralized control for regulating the distribution level voltage and frequency. Table 2 shows some of Microgrid testbeds operating in North America region [14].

Project Name	Detail [Structure/Power Nature/Type]	DGs Renewable	Load	Storage
CERTS Testbed Ohio	Mesh/AC/Testbed	No	Residential	Battery
University of Miami Testbed, Florida	Radial/DC/Testbed	PV, Fuel Cell	Residential	Battery
FIU Testbed, Florida	Radial/DC/Testbed	PV, Wind, Fuel	Residential Motor	Flywheel
Mad River Park Microgrid	Mesh/AC/Testbed	PV	Residential, Commercial	Battery
Ramea wind-diesel Microgrid	Mesh/AC/Real	Wind	Residential	Battery

2. Japan: - The most commonly used renewable energy resources in Japan are wind and photovoltaic. The majority of projects in Japan are sponsored by new energy industrial technology development organization (NEPO) [13]. Table 3. shows some of Microgrid testbeds operating in Japan region [14].

Technology used Installed	**Capacity**	**Remarks**
Solar Power plant	300 kW	Serving more than 1500 Customers
Solar home Lightning	3200 KW	Serving about 30,000 people
Bio-mass Gasifier	1000 kW	Serving around 1000consumers
Wind farm	1000 kW	Grid connected

Project Name	Detail [Structure/ Power Nature/Type]	DGs Renewable	Load	Storage
Bronsbergen Park Microgrid	Mesh/AC/Real	PV	Residential	Battery
Am Steinweg Microgrid	Mesh/AC/Real	PV, CHP	Residential	Battery
CESI RICERCA DER Testbed,	Radial/DC/Testbed	Solar Thermal, PV	Residential	Battery Flywheel
NTUA Microgrid Athens	Radial/AC/Testbed	Wind, PV	Static	Battery
University of Seville Spain Testbed, Seville	Mesh/DC/Testbed	PV, Fuel Cell	Residential Commercial	Battery
FEUP Microgrid Testbed, Porto District	Radial/AC/Testbed	PV, Wind, Fuel Cell	Static	Battery

3. European Union: - The European Union has one of the highest levels awareness of global warming and climate change at present. There are various laws defined by the European Parliament, for example, 2001/77/EC, 2003/30/EC and 2006/32/EC. These laws focus on decreasing the amount of carbon footprint by stated amounts for every state, while increasing the amount of renewable energy generation [15]. Table 4. shows some of Microgrid testbeds operating in EU region [14].

4. India: - A total of 33 grid interactive solar PV plants in coordination with small amount of biopower have been installed in country and these projects are getting assistantship from Ministry of New and Renewable Energy(MNRE) [16].Some of the Microgrid projects in India are given below:

(a). Sagar Island Microgrid: This project covers Sunderban Region. These project is being funded by MNRE, Govt. of India,Indo Candian Enviorment Faculty(INEF) and West Bengal Renewable Energy Development Agency (WBREDA). Table 5. [17]. shows Sunderban region microgrid details:

Project Name	Detail [Structure/Power Nature/Type]	DGs Renewable	Load	Storage
Aichi Microgrid, Tokoname	Radial/AC/Real	No	Commercial/ Industrial	No storage used
Kyoto eco-energy Microgrid	Mesh/AC/Real	Gas	Residential	Battery
Hachinohe Microgrid, Hachinohe	Radial/AC/Real	Gas	Commercial/ Industrial	Battery
CRIEPI Microgrid, Akagi	Mesh/AC/Real	No	Static	No storage used
Sendai Microgrid, Sendai	Radial/AC/Real	Gas	Residential Commercial	No storage used

(b). Asia Pacific Partnership: - In Asia Pacific Partnership there are total 7 countries are participating (Japan, US, Australia, Korea ,China, India, and Canada) with US leading them. They formed a force known as renewable energy and distributed generation task force. The main objective of this task force is to identify feasible location of microgrid across these countries in world .In Maharashtra study is being done by this force to identify the areas where benefits from renewable generation is maximum[18].

5. Rest of World: - Asian microgrids are mainly located at remote application and their main focus on generating whatever amount of renewable energy is available for a reliable power system and to have the stability of the system's nonrenewable DG or storage systems if it has used. It is common practice to have centrally controlled microgrids or agent-based microgrids [19].The unique project of Korea has been installed by the Korean Energy Research Institute (KERI). The microgrid test facility is equipped with a photovoltaic simulator, fuel cells, diesel generators, and a wind turbine simulator along with various type of loads, storage [20]. Table 6. shows some of Microgrid testbeds operating in Rest of World [13].

V. CONCLUSION

In this paper review on Microgrid system has been summarized. Microgrid system is an alternative electricity network that can be used to meet the electricity needs of the future. Microgrid system works autonomously so it requires a complex control system to regulate the operation of microgrid So it is good alternative to our conventional grid, But its technology needs some advancement in terms of technology so that ample benefits can be obtained from this in future.

Project Name	Detail [Structure/Power Nature/Type]	DGs Renewable	Load	Storage
HFUT Microgrid, China	Mesh/AC/Testbed	PV, Wind, Fuel Cell,Hydro	Static, Motor	Battery
Tianjin University Testbed China	Radial/AC/Testbed	PV	Static	Battery
INER Microgrid Testbed, Taiwan	Mesh/AC/Testbed /Real	Wind, PV	Static	Battery
NUAA Testbed China	Radial/AC/Testbed	Wind , PV	Static, Motor	Battery
QUT Microgrid Testbed Australia	Australia Radial/DC/Testbed	Wind,PV	Residential Motor	Battery

VI. REFERENCES

[1] M., Kezunovic; J. D., McCalley ; T. J., Overbye; , "Smart Grids and Beyond: Achieving the Full Potential of Electricity Systems," *Proceedings of the IEEE*,2010

[2] Zhou Xue-song; Cui Li-qiang; Ma You-jie; "Research on Control of Micro Grid," *Third International Conference on Measuring Technology and Mechatronics Automation (ICMTMA)*, 2011, pp. 1129-1132.

[3] M., Dicorato; G., Forte; and M., Trovato; "A procedure for evaluating microgrids technical and economic feasibility issues," in Proc. *IEEE Bucharest Power Tech Conference*, Romania, Jun. 2009.

[4] G., Diaz; C. G., Moran; J. G., Aleixandre and A., Diez; "Complex-Valued State Matrices for Simple Representation of Large Autonomous Microgrids Supplied by *PQ* and *V f* Generation," *IEEE Trans. Power Syst.*, vol. 24, no. 04, pp. 1720-1730, Nov. 2009.

[5] A. L., Dimeas; and N. D., Hatziargyriou; "Operation of a Multiagent System for Microgrid Control," *IEEE Trans. Power Syst.*, vol. 20, no. 03, pp. 1447-1455, Aug. 2005

[6] R. H., Lasseter; "CERTS Microgrid", *IEEE International Conference on System of Systems Engineering*, April 16-18, 2007

[7] Ming Sun; Juan Y; DENG B; "Analysis of Impact of DGs on Line Protection of Distribution Networks", *Power System Technology*, vol.33(8), pp,104-107,2009

[8] Ali, Keyhani; Mohammad N., Marwali; and Min, Dai; "Integration Of Green And Renewable Energy In Electric Power Systems", John Wiley & Sons, 2010

[9] B.S., Hartono; Budiyanto; Rudy Setiabudy; "Review of Microgrid Technology" ,*IEEE Transaction on Quality in Research*, 2003

[10] Benjamin, Kroposki; Ro-bert, Lasseter; Toshifumi, Ise and Nikos Hatziargyriou, "*Making microgrids work*", *IEEE power & energy magazine*, IEEE 2008

[11] Meysam, Shamshiri; and Chee, Wei Tan; " A Review of Recent Development in Smart Grid andMicro-Grid Laboratories" *PEOCO*,IEEE,2012

[12] Syed, Afsar; Govardhan, Nadendl; Dr.Rama, Sudha; "A Review of Recent Development in Smart Grid Systems, *IJAREE&IE*, Vol. 4, Issue 1, January 2015

[13] Ustun Taha, Selim; Ozansoy, Cagil; Zayegh ,Aladin; " Recent developments inmicrogrids and example cases around the world—a review",*Renew Sustain Energy Rev*, 2011

[14] Eklas, Hossain; Ersan, Kabalci; Ramazan, Bayindir ; Ronald, Perez "Microgrid testbeds around the world: State of art*", Energy Conversion and Management 86* , pp. no.132–153,2014

[15] Ramazan, Bayindir; Eklas ,Hossain and Erdal , Bekiroglu; "Microgrid Facility at European Union" *3rd International Conference on Renewable Energy Research and Applications*,2014

[16] S. A. Khaparde, "Infrastructure for Sustainable Development using RenewableEnergy Technologies in India" in *Proc. IEEE Power Engineering Society General Meeting.*, pp. 16, Jun. 2007.

[17] V. S. K., Murthy ; S. A., Khaparde and C. V.; Dobariya; "Deployment of MicroGrids in India" *IEEE Transcation,*2010

[18] [Online]. Available: http://unfccc.int/kyoto protocol/items/2830.php Nov., 2009.

[19] SN, Bhaskara; BH,. Chowdhury; "Microgrids — a review of modeling, control ,protection, simulation and future potential" , *IEEE power and energy society general meeting;* 2012

[20] Kremers Enrique, de Durana Jose Gonzalez, Barambones Oscar. "Multi-agent modeling for the simulation of a simple smart microgrid", *Energy Convers Manage* ,2013

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