Literature Review :

Theortical Background

Due to the environmental and economical conditions and the need to provide a clean environment and decrease the carbon emissions in the atmosphere and due to decrement in the fossil fuels,recent technological developments in microgeneration is micro-grid is the future of efficient and fast restoration of power system .

**Micro-grid**

“A group of interconnected loads and distributed energy resources(DERs)with set electrical boundaries that act as single controllable entity with respect to grid that can connect and discoonect itself from the grid based on the mode required”

The term micro-grid dates back to 1882 when Edison installed 50 DC micro-grid before the operation of the utility grid .Withe the utilization of utility grid and benefiting from economic and increasing transmission process leading to fade away of micro-grids.Certainly in the past years with advancement in technologies of power electronics and DER and more engagement with the electricity consumer the micro-grid concept started seeing the light again.

There are three assorted features if we compromised the DER installations could be considered as a micro-grid :There must be a master controller to control the system componenets as a single controllable entity,and the installed generation capacity must exceed the peak critical load thus when we can disconnect from the grid and must importantly clearly defined electrical boundaries

The above mentioned characteristics thus present the micro-grid as a small-scale power supply network for small community ,it allow the penetration of distributed generation into system.One of its major advantage is that its ability to work alone during utility grid disturbance or outage;in means that micro-grid can operate in two modes

i)ON-grid ii)OFF-grid(Islanded)

ON-grid mode is when the micro-grid is connected to the main utility grid and work in synchronization with it, this mode enables bidirectional powerflow and if any disturbance happens to the main grid the micro-grid will switch to off-grid mode or whats known as standalone grid (islanded) it acts as main provider to the specified geographical area working autonomously with high quality service by acting as local voltage and frequency regulator [1](An overview on micro-grid control).Micro-grid aren’t backup generation;backup generation have been around for quite a while providing temporary supply to local loads when there is a disturbancein the main utility grid supply ,however,micro-grids has wide range of benefits and noticeably more flexible than backup generation.

The Micro-grid main components include Loads, DERs, master controller, smart switches, protective devices, as well as communication, control and automation system.

Micro-grid load are known to be of two categories critical and non-critical (fixed and flexible);critical load (Fixed )must be satisfied at all conditions and isn’t altered whilst the non-critical load (flexible) can differ and be adjusted based on the economic incentives or the status of the grid (islanded requirements).

DERs consist of distributed generation units(DG) and Energy Storage System (ESS) which can be installed on the utility or consumer premises. The distributed generation units are either dispatchable or nondispatchable ;dispatchable units can be controlled by main controller and are subjected to technical constraints depending on the unit type.Nondispatchable cannot be controlled by the micro-grid controller as its input is changeable and unrestrained such units are like Solar and wind mainly renewable sources .The intermittency shows that generation is not always available ,the unpredictability reveal that the generation tends to be unstable in different time scales .Those stated characteristic effect our nondispatchable units negatively and usually increase the forecast error a good solution is always to reinforce those units with energy storage system (ESS).

As we know the demand of electricity varies based on the time of day and time of year .while in traditional power system we aren’t capable of storing electricity and this lead to a gap between supply and demand. Micro-grid having a mixed power generation will allow as to fill in the mismatch as some generations have large response time and others have little flexibility and some generations can start real quickly to provide more or less depending on demand .Provided the late reasons the energy storage system is quite beneficial in managing such system .ESS synchronize with DGs as assurance to micro-grid generation capability. Its inclusion within the micro-grid system allows the excess energy generated to be stored or in the typical scenario could be put into the utility grid

The master controller in the micro-grid perform the scheduling in the dual-mode of the micro-grid based on economic and security considerations, usually the master controller is responsible for interaction with utility grid ,the decision to switch between on-grid and islanded.

With that been said micro-grids benefits are :improve reliability by introducing self-healing at local distribution network, managing local loads due to higher power quality ,carbon emission reduction due to diversification usage in renewable energy sources , economically reducing the Transmission and distribution (T&D) costs[](S. Parhizi et al.: State of the Art in Research on Microgrids: A Review)

**Technical challenges of Microgrid**

Integration of DERs units and microgrid introduce a number of technical challenges that require to be addressed in control design and protection system to ensure the level of reliability isn’t effected and the potential benefits of DG are fully harnessed.Some of this challenges are stability issues arising while at transmission level and other are assumptions applied to distribution sytems.

Most relevant challenges in protection and control are bidirectional power flow, stability issues , modeling, low inertia , uncertainty. [] OLIVARES et al.: TRENDS IN MICROGRID CONTROL .

Along with the above the microgrid must be able to guarantee reliable and economical operation of microgrid while overcoming the aforementioned challenges .Henceforth, this are some of the required features in control system :output control , power balance, DSM,economic dispatch ,transition between mode of operation [] OLIVARES et al.: TRENDS IN MICROGRID CONTROL .

**Control hierarchy in micro-grids**

To be able to understand how the micro-grid is controlled and how it can operate in the two modes on-grid and islanded with regards to what the power system control architecture might be there are two distinctive approaches to be clarified: centralized and decentralized.

A centralized control that is characterized by having one main central controller responsible for gathering all the required data for decision making from the various DERs by peforming the required calculations and conclude the control actions for each unit at this single point.

In another hand we have the decentralized control in which we have a local controller for each DERs unit that only receives local information and is neither fully aware of system variables or other controller action.

Implementing a centralized control system is merely infeasible due to the extensive and computation needs that are required due to the interconnected power sytems that cover bigger geographical areas ,furthermore using decentralized approach is also not possible due to the different units in the system that need coordination which is not fulfilled by the local variables so a comparise has to be found between the centralized and decentralized approach in means of hierarchy that consist of three levels :i) primary control ii) secondary control iii) tertiary control those levels vary in i) speed of reponse