Recent Research Progress and Control Strategy on Stand-alone DC Micro-grid with Multiple-sources and Variable-loads: A Review

[1]Vaibhav patel,[2]Deepa Karvat

[1]M Tech student,[2]Associated Professor

[1]Department of Electrical Engineering

[2]Department of Electrical Engineering

[1]*Parul Institute of Engineering and Technology*, Vadodara,India

[2]*Parul Institute of Engineering*, Vadodara, India

Abstract: For stable voltage on DC bus in DC network systems micro grid battery storage units and super capacitor unit are used to assist the main sources of renewable energy (PV array and wind). To provide good service on demand the micro grid storage system plays an important role. In this paper, there are five sources PV, wind, Battery, super capacitor and AC grid are operating in both condition grid connected or islanding condition. Boost converter are used for increase the voltage of PV, wind, super capacitor and battery units. The advantage of AC grid connection is that if hybrid storage units is not sufficient to provide voltage to a DC bus, then the AC grid will also provide a voltage to the DC bus. Firstly, DC micro grid with grid connection and variable loads are put forward. Secondly, study about its energy management and integration control system. Lastly, we focus on hybrid energy storage system (HESS). specially the HESS topology.

***Keywords*— DC micro-grid, hybrid energy storage system (HESS), PV, wind.**

I. INTRODUCTION

Nowadays, micro-grid is important part of intelligent power distribution system. At present scenario, the micro-grid classify in AC micro-grid, DC micro-grid, AC and DC mixed micro-grid [1-3]. Compared with AC micro-grid, DC micro-grid are more attractive because of their excellence in control complexity, reliability, efficiency and cost [4-5]. In DC micro-grid also reduce the numbers of converter.The advantage of use DC micro-grid is no need to control the frequency and reactive power. The most important task in DC micro-grid is the DC bus voltage control to maintain the power balance between power generation and power consuming [6]. However, the randomness of distribution energy sources (RESs) and instability of the loads create large range fluctuation in DC bus voltage [7]. Therefore, the hybrid energy storage system (HESS) is necessity for DC micro-grid to overcome DC bus voltage fluctuations and stable operation of the system. However, DC micro-grid structure, energy management integrated control technology and hybrid energy storage system need to be further studied to realize it's industry application. In this paper, DC micro-grid with grid connection and variable loads put forward. Then secondly, energy management and coordinated control technology are studied. Lastly, we focus on energy storage system, especially the HESS technology.

II. STRUCTURE OF DC MICRO-GRID

Asea brown boveri (ABB) company first proposed DC micro-grid structure in 2008. The micro-grid includes PV, energy storage, AC grid, a variety of converters and DC, AC loads.

Micro-grid run at two different mode one is island mode and another is grid-connected mode. In the island mode, there is no guarantee of continued power supply of important loads when hybrid energy storage runs out in the rainy and windless weather. Therefore, this types of micro-grid without controllable micro-source is not suitable to operate in long-term island operation of DC micro-grid. The structure of DC micro-grid are as show in fig 1

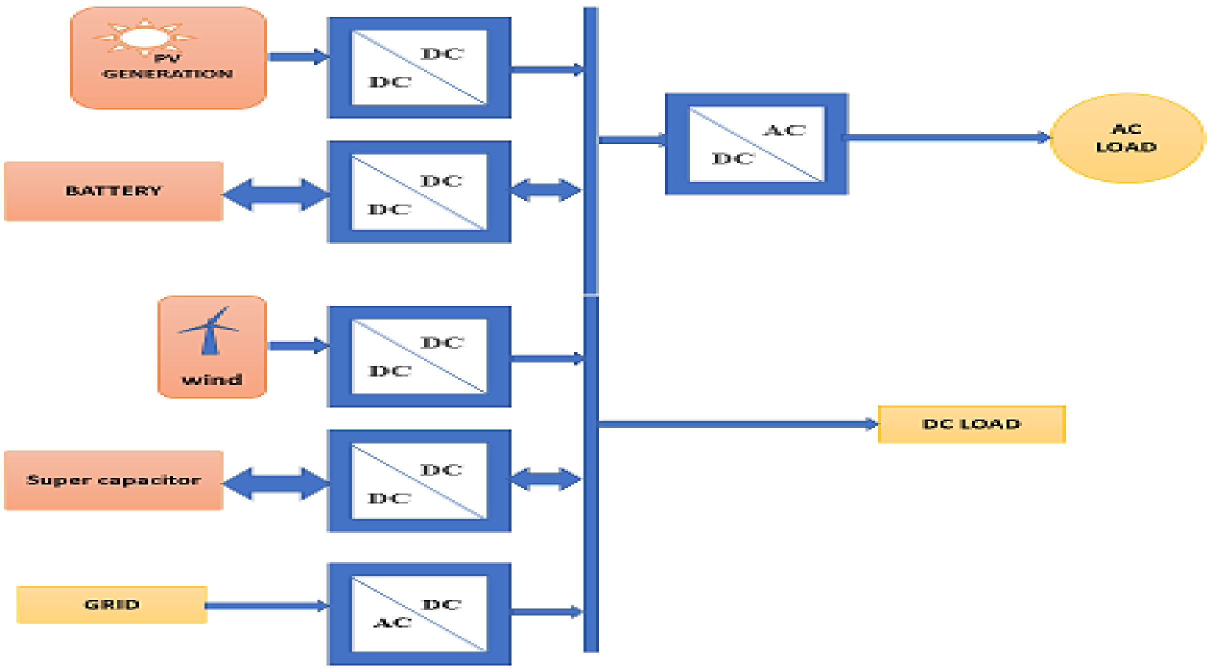

Fig 1. DC micro grid structure

We see that 24V generated PV and wind generated 24V and (20% to 30% of PV and wind) battery are connected with 600V DC bus connected with main grid through the bidirectional AC/DC inverter. The PV increase it's voltage by connecting boost converter. Battery and super-capacitor has bi-directional boost converter are use.

A. Structure of Stand-alone DC micro-grid with multiple-source and variable loads.

In this paper, we give a configuration diagram of DC micro-grid with multiple-source and variable load as shown in fig 2. Hybrid energy storage system (HESS) and variable load (important load, translational load and other all load). The networking with completely controllable battery and super capacitor can full use of PV and wind generation. Store excess energy and stabilize power fluctuation. It is use to improve the stability of micro-grid operation and reliability of power supply. Grid connected system composed of battery and super-capacitor can be connected to common DC bus via useful DC/DC converter. The DC bus can directly supply power the DC load and indirectly supply power to the AC load through the DC/AC converter. Compared to AC micro-grid, DC micro-grid is cheap. Based on this basic framework, we will simulate and optimize DC micro-grid system, also study various micro source, load collocation change, control strategy adjustment.

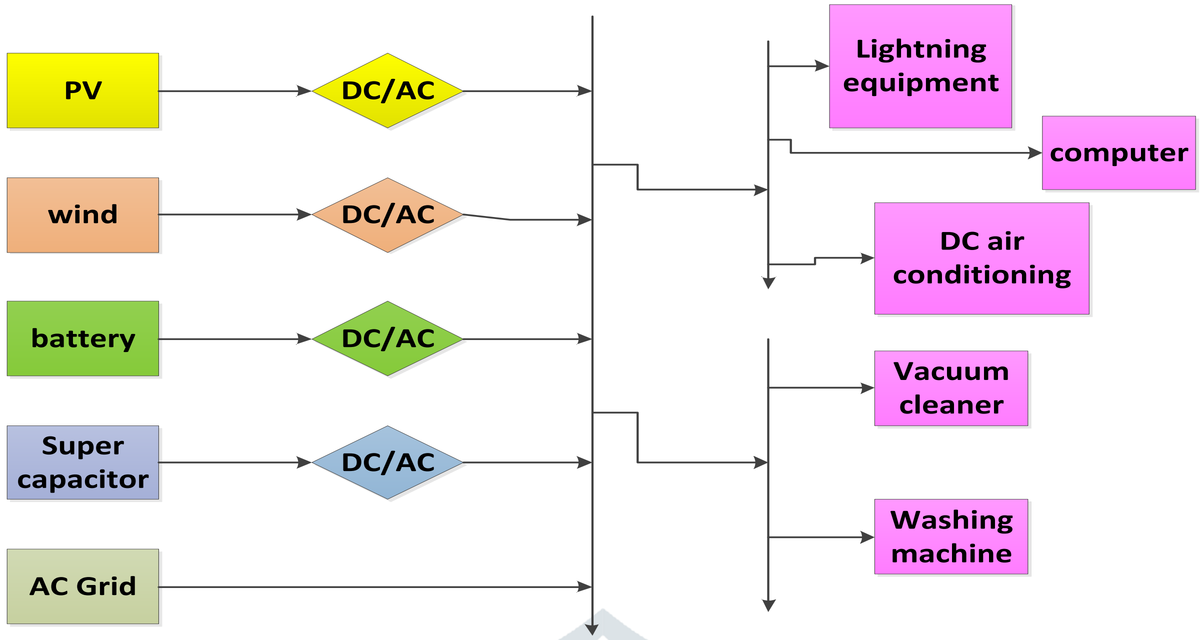

Fig 2. Structure of stand-alone DC micro-grid with multiple source and variable load

2 ENERGY MANAGEMENT AND INTEGRATED CONTROL TECHNOLOGY.

A DC micro-grid system can operate both in grid connected mode and islanding mode. The system can take power from AC grid when the DGs' energy is surplus in addition to meeting the requirements of loads. If AC grid breaks down, the system can disconnect it. DGs and BSs can provide energy to loads at the same time. If the BSs' energy is insufficient while DGs' is sufficient. DGs can translate power to BSs.

In liuguihua and li ming, 2013, is describe both modes grid connected mode and island mode management method [8]. In our micro-grid which have PV and wind generation, battery and super-capacitor as a hybrid energy storage system (HESS) and AC grid as a source.

In grid connected mode, the DC bus voltage is controlled by the grid connected inverter/rectifier in CVC mode. DGs are always running in MPPT mode. When the battery and super-capacitor are not sufficient to supply the load at time the rest power is charge the battery and super-capacitor. When the battery and super-capacitor is able to supply to load and the not fully charged BSs and SCSs (As shown in fig 3(a)), the rest energy sent to AC grid by grid connected inverter and BSs unit and SCSs are controlled at discharging mode. If DGs' energy is insufficient to supply to load and the BSs and SCSs is not fully charged (as show in fig 3(b)), the needed power is supplied by the rectifier from AC grid. If BSs' and SCSs' charging is completed, they should disconnect from the DC bus as standbys for discharging when the DC micro-grid is working at is In islanding mode, the DC bus voltage is controlled by the DGs or BSs or SCSs. The grid connected inverter/rectifier is always offline.

When the DG generating units operate at CVC mode and BSs need charging, the power balance among DGs. BSs and load should be considered. The charging current can be set to maximum when the DGs' energy is sufficient. On the contrary, if the DC bus voltage falls, the DGs' energy must be insufficient and the system should calculate the rest energy that can offer to BSs and reduce the BSs' charging current by the current limiter to ensure the stability of DC micro-grid system.

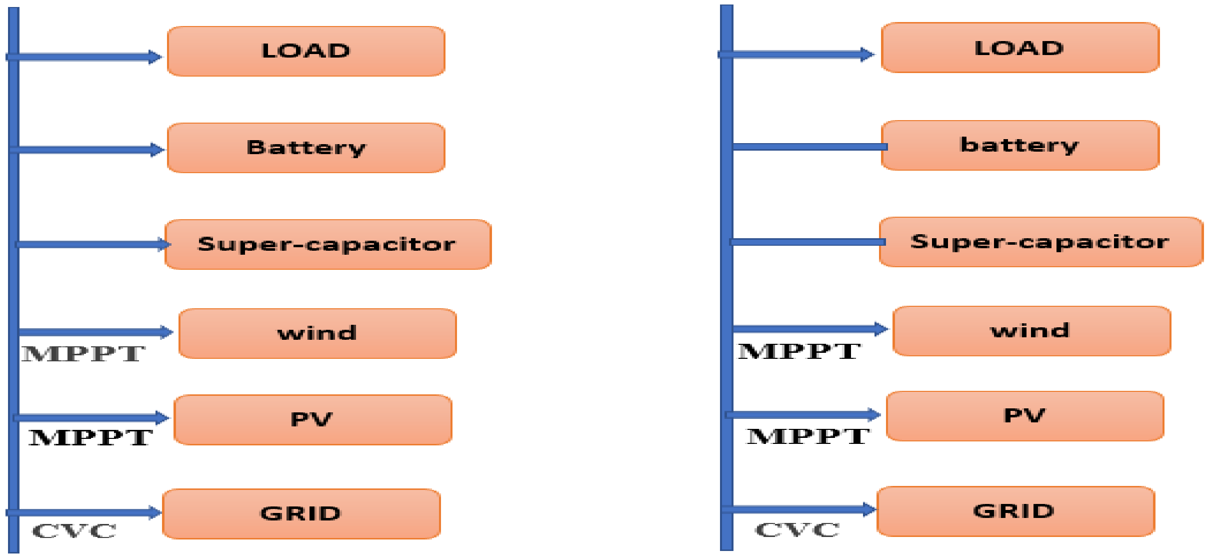

Fig 3. Energy management in grid connection

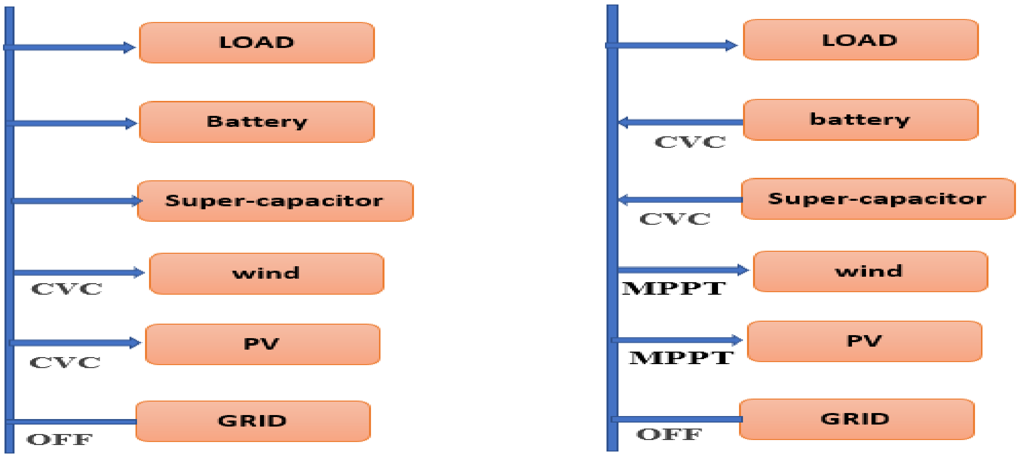

Fig 4. Energy management in islanding mode

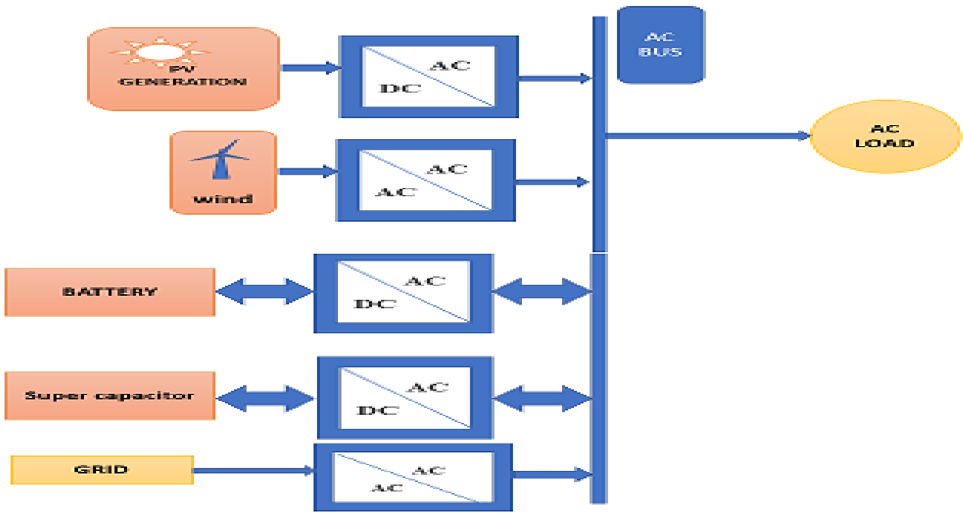

Fig 5. AC bus side parallel mode

B. DC Bus Side Parallel Mode

Whether battery and super-capacitor are directly connected to DC bus or not, two topology structure are shown in fig 6 and fig 7, the battery, super-capacitor directly connected to the DC bus (without converter) and DC bus connected with AC bus side though DC/AC converter in fig 6. In fig 7, battery and super-capacitor is connected with DC bus through bidirectional converter and also DC bus connected with AC bus through DC/AC converter.

As a common topology structure in fig 7, battery and super-capacitor are connected to DC bus through DC/DC bidirectional converter. It is convenient to stabilize the bus voltage and extend the service life.

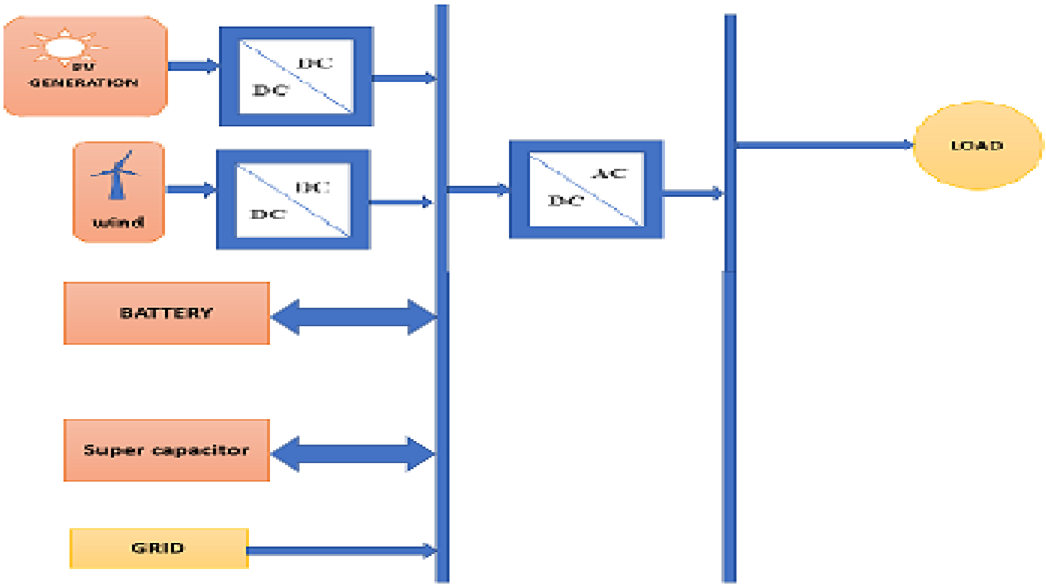

Fig 6. The HESS topology structure without converter

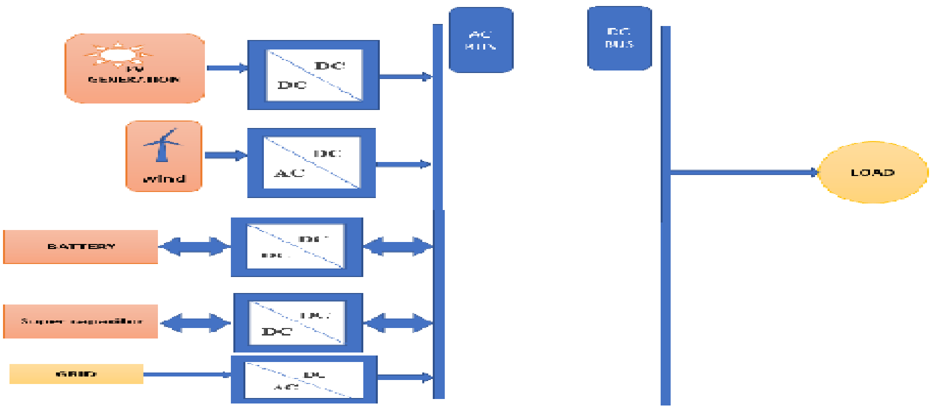

Fig 7. The HESS topology structure with converter

III. CONCLUSION:

DC Micro-grid structure, energy management, integrated control technology and hybrid energy storage system (HESS) are studied and summarized in detail. in multiple source and variable load as well as its energy management and integrated control technology. Lastly, we focus on hybrid energy storage system (HESS), specially, the HESS topology

REFERENCES

1. M. Singh,V.Khadkikar, A. Chandra,R. K. Varma, "Grid Interconnection of Renewable Energy Sources at the Distribution Level With PowerQuality Improvement Features," IEEE Trans.Pow.Delive, vol. 26, no. 1, pp. 307-315,Jan. 2011.

2. K.D. Young, V.I. Utkin and U. Ozguner, “A control engineer's guide to sliding mode control”, IEEE transactions on control systems technology, vol.7, no.3, pp.328-342, 199
3. M. A. Mahmud, H. R. Pota and M. J. Hossain, "Dynamic stability of three-phase grid-connected photovoltaic system using zero dynamic design approach, "IEEE Journal of Photovoltaics, vol.2, no.4, pp. 564571, 2012.
4. X.H.Wu,S.K.Panda,andJ.X.Xu,“Analysis of the instantaneous power flow for three-phase PWM boost rectifier under unbalanced supply voltage conditions”, IEEE Trans. Power Electron, vol. 23, no. 4, pp. 1679-1791, Jul. 2008.
5. Jie Zhang, “Simplified Variable band Hysteresis Current Control for Grid connected Inverter", IEEE Transactions on power Delivery, Vol. 14,No. 3, July 2003.
6. Jos Rodriguez, Jorge Pontt, Csar A. Silva, Pablo Correa, Pablo Lezana, Patricio Cortes, and Ulrich Ammann. Predictive current control of a voltage source inverter. Industrial Electronics, IEEE Transactions on, 54(1):495 –503, 2007.
7. H. Akagi, E. Watanabe, and M. Aredes. Instantaneous power theory and Applications to power conditioning. Wiley, 2007.
8. Swati sucharitapradhan, Member, IEEE, Raseswari Pradhan, Member, IEEE, “ Design of Sliding Mode Controller for three phase Grid connected Photovoltaic System” In International Conference on Signal Processing Communication, Power and Embedded System, IEEE, 2016.
9. Rutuja R. Patil, Member, IEEE and Prof. Suyog S. Hirve, Member, IEEE, “Space Vector Pulse Width Modulated Inverter for Grid Coupled Photovoltaic System at Distribution Level”, In IEEE 2016.
10. M. A. Mahmud, Student Member, IEEE, H. R. Pota And M. J. Hussain, Member, IEEE, “Dynamic Stability of Three-Phase Grid Connected Photovoltaic System Using Zero Dynamic Design Approach”, In IEEE journal of Photovoltaic, October 2012.