BASIC DC MICRO GRID SYSTEM

(Closed Loop PI and PID controlled)

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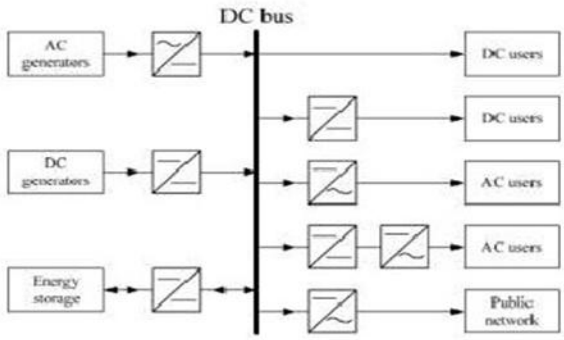
Abstract – *Throughout the world, conventional power system is facing the problems of gradual reduction of fossil fuel resources, poor energy efficiency and environmental pollution. Which is led to a new trend of generation power locally at distribution voltage level by using non-conventional or renewable energy sources like natural gas ,biogas, wind power, solar photovoltaic cells, fuels cells, combined heat and power systems, micro turbines, and sterling engines and their integration into the utility distribution network. This type of power generation is termed as distributed generation and the energy sources are termed as distributed energy resources. The expansion of DG has the potential to significantly change the nature of the distribution system and the power quality issues. The study includes review of each nonconventional source and also models various power conversions by use of power electronic devices. The micro grid is observed with DC-DC converter, when the micro energy sources power the local dc load and the dc distribution grid power change. This paper review explains the basic concepts of Micro grid and A simplified model of Micro grid is simulated with PI and PID controller and their response is studied.*

Key Words: Photovoltaic and wind modules, Energy storage system and wind power generation.

1. INTRODUCTION

The Micro grids are designed to generate the power at distribution voltage level along with utilization of waste heat; they have restricted energy handling capability. Hence the maximum capacity is normally restricted to approximately 10MVA as per IEEE recommendation. Hence, it is possible to supply a large load from several Micro grids throughout a common distribution network, by splitting the load pocket into several controllable load units with each unit being supplied by one Micro grid. By this way, micro girds can be interconnected to form much larger power pools for meeting bulk power demands. Most of the technologies require and inverter stage for gird connection. The inverter is used for fuel cells and for solar cells since the source is inherently DC and needs to convert to AC supply. Micro turbines operated at very high speeds produce AC voltage at high frequency requires inverters to covert to the supply frequency. The capacity of Micro grid being sufficiently small, the stability of main grid is not affected when it connected to the main grid. However, in future, when micro grids will become more commonplace with higher penetration of DERs, the stability and security of the main grid will be influenced significantly. Hence Microgrids need to be designed properly to take care of their dynamic impacts on main grid such that overall stability and reliability of the whole system is significantly improved.



Factors	AC microgrid system with centralized storage	DC microgrid system with distributed storage
Sizing Issues	Hard to incrementally resize. Inverter losses can dominate with mismatch to load	Lack of inverter/central-storage makes it easy to incrementally add more generation
DC-AC/DC-DC conversion losses	30% due to central battery bank + inverter	10% daytime, 23% nighttime: due to 3 DC-DC conversion steps
Losses due to internal rectification and conversion in loads	> 25%	0% for DC and >25% for AC loads
End-to-end Efficiency	< 60%	85-77% for DC loads, < 63% for AC loads

1.1 Microgrid configuration

Generally it consists of electrical and heat loads and microsources connected through LV distribution network. The loads and the sources are placed close together to reduce the heat loss during heat transmission. The microsouces have plug and play features. They are provided with power electronics interfaces (PEIs) to implement the control, metering and protection functions during stand-alone and grid-connected modes of operation. The combination of wind and solar energy resources on a rooftop was investigated. The combination of diverse but complementary storage technologies in turn can form a multilevel energy storage, where a super capacitor or flywheel provides cache control to compensate for fast power fluctuations and to smoothen the transients encounter by a battery with higher energy capacity. Wind and solar energy resources lead to reduced local storage requirements. A schematic of the dc micro gird with the conversions employed for power is given in Fig.1. the dc bus connects wind energy conversion system (WECS), PV panel, multilevel energy storage comprising battery energy storage system(BESS) and super capacitor, EV smart charging points, EV fast charging station and grid interface. The WECS is connected to the dc bus via a dc-dc converter. The BESS can be realized through flow battery technology connected to the dc bus via dc-dc converter. The super capacitor has much less energy capacity than the BESS. It is aimed at compensating for fast fluctuations of power and so provides cache control.

2 WIND TURBINE SYSTEMS

Wind energy is one of the most available and exploitable forms of renewable energy. Winds blow from a region of high atmospheric pressure to one of the lower atmospheric pressure. The difference in the pressure is caused by (i) the fact that the earth's surface is not uniformly heated by the sun and (ii) the earth's roation. Wind energy is a by-product of solar energy, available in the form of the kinetic energy of air.

The power contained in wind is given by kinetic energy of the flowing air mass per unit time. That is ,

$P_0 = ½$(air mass per unit time) (wind velocity)^2

$= ½(\rho A V_\infty)(V_\infty)^2$

$= ½\rho A(V_\infty)^3$

Where P_0 is the power contained in the wind in watts, ρ is the air density (approx.1.225kg/m^3 at 15°C and normal pressure), A is the rotor area in (square meter), V_∞ is the wind velocity without rotor interference, i.e., ideally at infinite distance from the rotor (in meters per second).

Wind turbines work by turning the kinetic energy of the wind into torque (a force) that caused the wind turbine to turn and drives an electrical generator to produce electrical power.

3. SOLAR PHOTOVOLTATIC (PV) SYSTEMS

Solar PV generation involves the generation of electricity form free and inexhaustible solar energy. The major advantage of a PV system are (i) sustainable nature of solar energy as fuel,(ii) minimum environmental impact,(iii) drastic reduction in customers' electricity bills due to free availability of sunlight,(iv) long functional lifetime of over 30years with minimum maintenance and (v) silent operation. Through PV cells can be effectively used as a DER in a Microgrid, yet they suffer from the disadvantages of high installation cost and low energy efficiency. Solar energy reaches the PV cell in two components, direct and diffuse. The direct component is about 85% and comes through direct radiation. The diffuse component is about 15% and comes through scattered diffusion in the atmosphere. A PV cell behaves as a photodiode. Most PV modules are equipped with maximum power point tracking (MPPT) systems that maximize the power output from the modules by shifting the operating point depending on the solar irradiance.

There are mainly four different types of PV cells, which are as follows:

(1) Monocrystalline silicon

(2) Multicrystalline silicon

(3) Thin-film silicon

(4) Hybrid

4. MAIN CONSIDERATION FOR DC POWER INTERGATION IS GIVEN BELOW.

A. Aggregated modeling of wind and solar Power.
B. Wind and Solar power forecasting.
C. Energy reserve Assessment for operation of Microgrid.
D. Formulation of optimized scheduling for microgrid.
E. Adaptive droop control of BESS

5. BENEFITS OF MICRO GRID SYSTEM

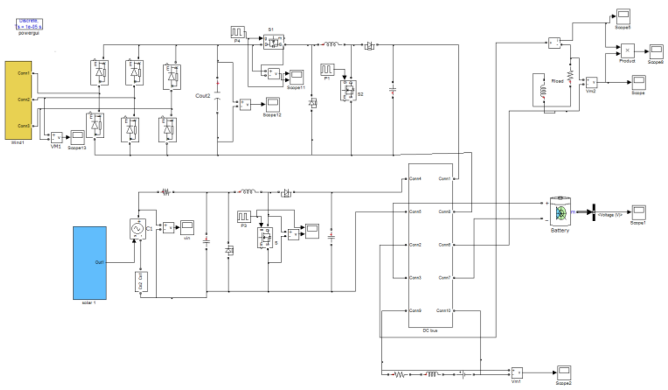
The flexibility of micro grids comprises important benefits, but their efficient implementation poses very challenging problems:

The benefits Micro-grids provide to power system Operation and planning need to be quantified and in- corporate into an appropriate commercial and regulatory framework, so that a level of playing field for all energy technologies can be established. In order to achieve the full benefits from the operation of Microgrids, it is important that the integration of the distributed resources into the LV grids, and their relation with the Medium Voltage (MV) network up- stream, will contribute to optimize the general operation of the system. The coordinated control of a large number of distributed sources with probably conflicting requirements and limited communication imposes the adoption of mostly distributed intelligence techniques.

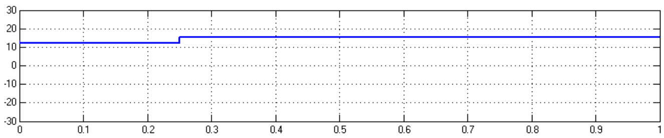
The design of Micro-source Controllers enhanced with advanced frequency and voltage control capabilities and possessing ride-through capabilities is essential for the stable operation of Micro-grids, especially in islanded mode of operation.

The design of smart Storage and Load Controllers able to face the stringent requirements posed by the islanded operation and especially during transition from inter-connected to islanded mode is also crucial.

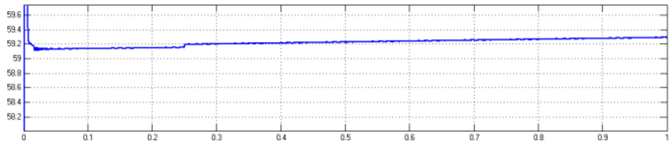
Open Loop Micro Grid System model



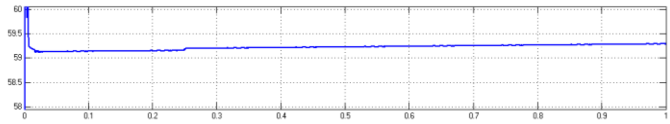
Disturbance circuit



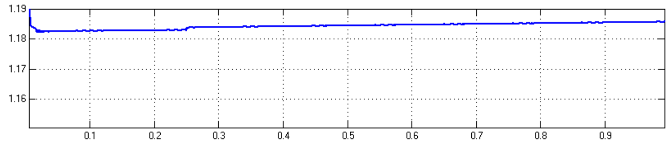
Output voltage of solar



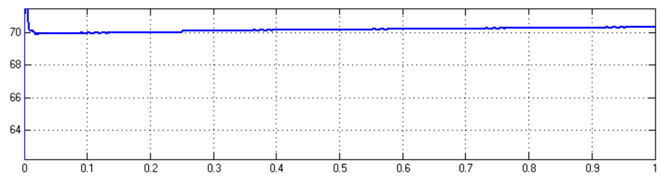
Output voltage of RLE load



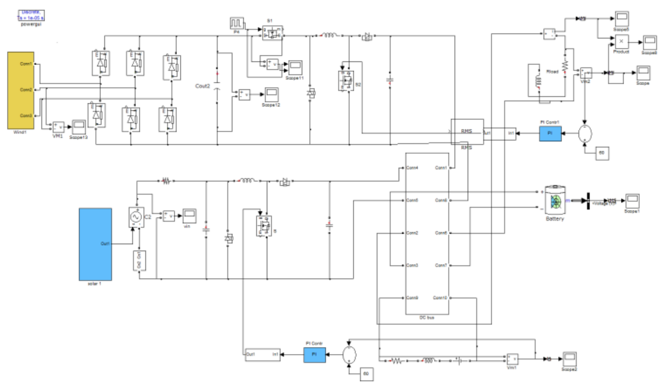
Output voltage of RL load



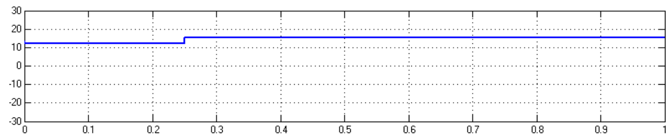
Output current



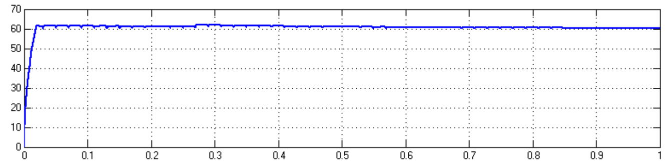
Output power



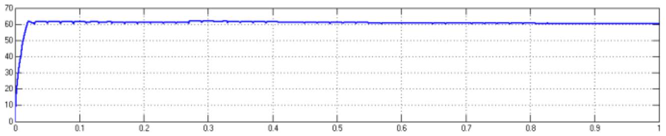
Closed loop with PI controller



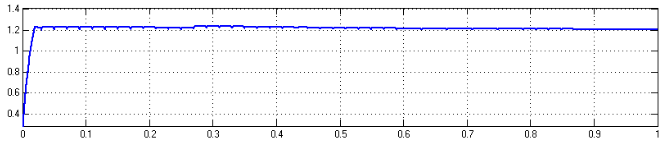
Output voltage of solar



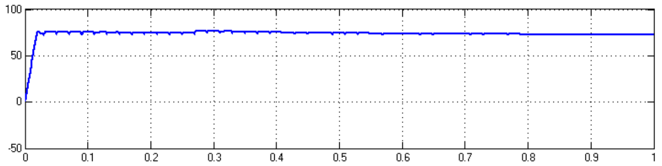
Output voltage of RLE load



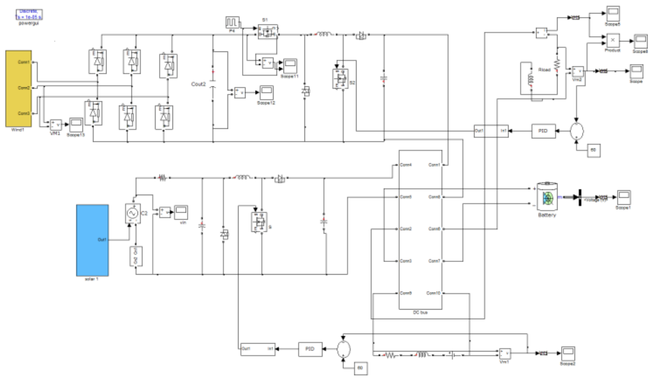
Output voltage of RL load



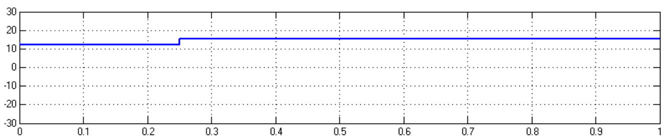
Output current



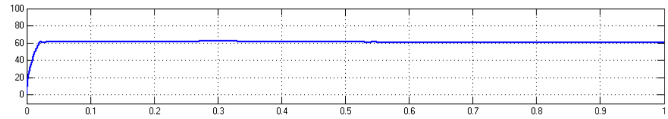
Output power



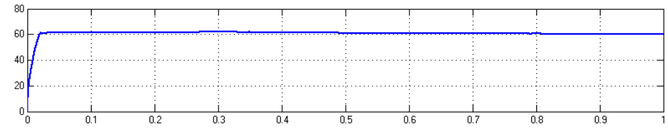
Closed loop with PID controller



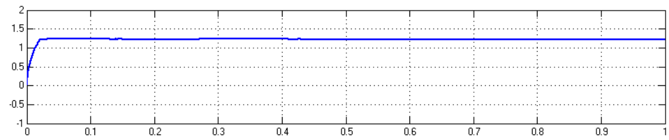
Output voltage of solar



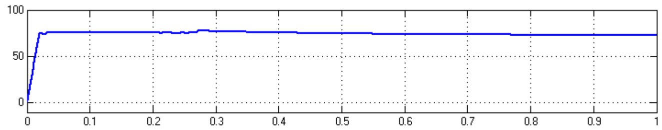
Output voltage of RLE load



Output voltage of RL load



Output current



Output power

Comparitive Table

converter	Tr	Ts	Tp	Ess
PI controller	0.35	0.6	0.39	3.3V
PID controller	0.28	0.43	0.32	1.8V

6. CONCLUSIONS

Modeling and operation of microgird with wind and solar energy is analyzed in this paper review. Frequent change in irradiance and wind energy variations are considered in this paper. This paper explored the wide performance of the microgrid when the local DC load and dispatch power to the load PV cell and Wind schemes. A circuit based PV system model with and incremental conductance method is used for the simulation.

Steady state error in Open Loop system is reduced to 1.8V in PID controlled system when comparing with PI system.

Settling time is reduced to 0.43sec using PID with comparing with PI.

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