NAME OF THE CANDIDATE: MUNISH MANAS

NAME OF THE SUPERVISOR: PROF. ZAHEERUDDIN

DEPARTMENT OF ELECTRICAL ENGINEERING

TITLE: DESIGNING AND OPTIMIZATION OF A SMART MICRO-GRID TOWARDS SUSTAINABILITY

ABSTRACT

An attempt has been made for designing and optimizing a grid connected microgrid consisting of controllable renewable sources like wind, solar, biomass and battery. For making this microgrid sustainable and more reliable, provision of utility grid insertion is given in case total microgrid sources falls short of supplying the total load. In order to implement an efficient energy management scheme, a microgrid central controller gives the control actions after obtaining the status of the active loads and power sources. In this study the status of loads and power sources is acquired with the support of multi-agent model (handling each source and load by way of an agent) and the data acquisition system of these renewable sources and loads consists of multiple sensors interconnected through Low Power Radio (LPR) and communicating to control centre as per IEC standard IEC 61400-25 over one of many GPRS communication. The Microgrid Central Controller (M.G.C.C.) designed using LabVIEW software of National Instruments would use an embedded Energy Management Algorithm to take decisions, which are then communicated to the controllable sources in order to manage the utilization of their power output as per the load - supply power balance.

The main purpose of the research is to enhance the multi-objective optimization and designing a photovoltaic, wind and biomass hybrid system for community smart DC Micro-grid using particle swarm optimization. The aim of the research is to maximize the availability of power as well as to reduce the cost which reduces the size of system with highest possible availability. It was stated that the output power of photovoltaic, wind and biomass generators would have the highest priority for feeding the direct current bus. It was found that proposed method especially particle swarm optimization had shown the effective cost and availability of photovoltaic, wind and biomass generators. When compared with other algorithms, particle swarm optimization performs well in reducing the cost of the photovoltaic, wind and biomass generators. In addition to that, it was noted that availability of photovoltaic, wind and biomass generators would be obtained within a commendable convergence rate of iterations with values closer to those in existing microgrid pilot set ups, using PSO algorithm.An overview of emerging self-sustainable technologies for smart grid in Indian power sector is also presented in this work. There are 14 major pilot projects of smart grid in India and in this part of our research work we analyzed the design of critical smart grid technologies such as Distributed Generation, Communication, Advanced Metering Infrastructure, Demand Response, Electric Energy Storage (EES), Home Area Network, Cyber Security, and Electric Vehicles.

Method:

As all the renewable sources are not active all the day at the same time thus as per the load demand during a particular period a combination of various power sources should be deployed to meet the load. The dynamic modeling of the NaS battery has been optimized to meet the load demand of the microgrid where typical modules may have 320 cells and a rated capacity of 200 kWh in total. The terminal voltage of these modules varies between 325V and 790V hanging on state and direction of charge but the nominal operating voltage of these modules are 700Vdc.

Further smart M.G.C.C. has be developed based on multi agent system (MAS) concept and the data acquisition system of these renewable sources and loads consists of multiple sensors that are interconnected through Low Power Radio (LPR) to communicate with the control center as per IEC standard IEC 61400-25(wind energy) and IEC 61850-7-420 (solar PV).

This research has also stipulated a novel mathematical design of the cost of microgrid components and energy availability from these sources in the form of an optimization problem. Inorder to solve this optimization problem a metaheuristic technique called Particle swarm Optimization (PSO) algorithm is used which is an extremely simple algorithm and is more effective and efficient to optimize a wide functions range. The main aim of this optimization is to increase the availability of power and reduce the cost which reduces the size of system with highest possible availability

Conclusion and Future Work:

The presented research work has successfully designed and implemented an energy management algorithm for sustainable operation of a microgrid empowered by intermittent renewable energy resources and a battery in a grid connected mode. This work establishes the necessity of considering the status of various renewable energy sources and other supportive power backups in a time synchronized manner in order to successfully formulate an energy management algorithm for a sustainable microgrid and then using it to design a microgrid central controller for real time operation and control. . In addition to that, it was noted that using PSO algorithm, the optimal values of Cost and Availability of photovoltaic, wind and biomass generators was obtainedwith values of 14 crore Cost for 80 kW Availability at second intersection of the two graphs is the optimum point of operation, which are the values closer to those in existing microgrid pilot set ups (e.g. Mysore Pilot Project). Thus, it can be concluded that when comparing with other metaheuristic algorithms, PSO algorithm is more effective in its convergence and accuracy.

Future work would pertain to the designing of a hybrid microgrid system with photovoltaic, wind and biomass generators considering the ramp up and ramp down constraints of biomass. Further it would be based on the energy efficiency of energy generators. It would aim at optimizing a renewable hybrid system for community smart direct current micro-grid using a hybrid Genetic Algorithm based PSO (GAPSO) technique. In addition to that, future work would also compare the effectiveness of proposed algorithm with earlier implemented PSO based technique.