Performance Analysis of Centralized Control in Micro-Grid

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Abstract— Power electronics provide the control and flexibility required by the MG concept. A properly designed power electronics and controllers insure that the MG can meet the needs of its customers as well as the utilities. Implementing an MG can be as simple as installing a small electricity generator to provide backup power at an electricity consumer's site, or it can be a more complex system that is highly integrated with the electricity grid that consists of electricity generation, energy storage, and power management systems. They comprise a portfolio of technologies, both on supply side and demand-side that can be located at or near the location where the energy is used. MG devices provide opportunities for greater local control of electricity delivery and consumption. They also enable a more efficient use of waste heat in combined heat and power (CHP) applications, which boosts efficiency and lowers emissions. The CHP systems provide electricity, hot water, heat for industrial processes, space heating and cooling, refrigeration, and humidity control to improve indoor air quality and comfort.

Keywords: CHP, MATLAB, Micro-Grid, MPPT algorithm

I. Introduction

Recent developments in the electric utility industry are encouraging the entry of power generation and energy storage at the distribution level. Together, they are identified as distributed generation (DG) units. Several new technologies are being developed and marketed for distributed generation, with capacity ranges from a few kW to 100 MW. The DG includes micro turbines, fuel cells, photovoltaic systems, wind energy systems, diesel engines, and gas turbines [1]. Power electronics provide the control and flexibility required by the MG concept. A properly designed power electronics and controllers insure that the MG can meet the needs of its customers as well as the utilities. Implementing an MG can be as simple as installing a small electricity generator to provide backup power at an electricity consumer's site, or it can be a more complex system that is highly integrated with the electricity grid that consists of electricity generation, energy storage, and power management systems.

Power balance can be achieved either directly by local controllers which use local measurements or by a central controller that sends appropriate set point signals to the local controllers of different DG units and controllable loads. The main objective of this mechanism is to ensure that all units are involved in supplying load in a pre-determined manner.

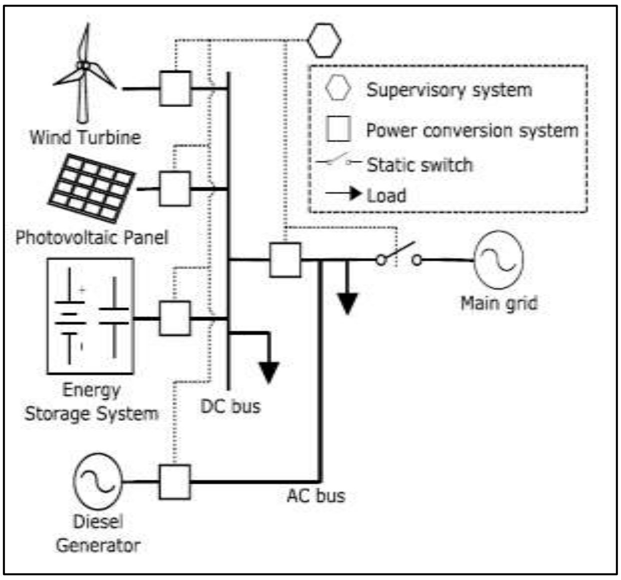
1) The main functions carried out at this level are:
- Optimal operation in both operating modes.
- Power flow control mostly in grid connected mode
2) A MGCC will address the following tasks:
- Secondary control whose task is to restore the micro grid voltage and frequency.
- Synchronization between the micro grid and the main network.
- Power quality tasks
3) Local controllers (LCs) carry out the following functions:
- Voltage stability provision
- Frequency stability provision
- Plug and Play capability of DERs

II. Problem Formulation

Although a great deal of research exists on the development of microgrid control strategies, none fully address the following requirements: robustness to topological and parametric uncertainties, satisfactory transient response of the controllers, obviating the need for a complex communication infrastructure, improving fault ride-through capabilities, and developing smooth control transition schemes.
- lack of adequate robustness and inability to accommodate microgrid uncertainties
- poor transient performance,
- inability to initiate a black start after system collapse
- dependency on specific microgrid configurations,
- coupled real/reactive output power components of DER units,
- relying on a dominant DER unit to regulate microgrid voltage/frequency,
- the need for a high-bandwidth and uneconomical communication link,
- lack of a back-up control scheme in case of communication failure, and
- the need to modify a central controller after each DER unit switching.

III. Methodology

In this dissertation, the control scheme is devised based on a linear state-space model of a microgrid. The equations describing the microgrid are first derived in natural (abc) reference frame and then transformed to a synchronous (dq) reference frame based on which the robust decentralized controllers are designed. MATLAB/Simulink environment is used to verify the derived linear model, design and analyse the proposed control strategy, and evaluate its robustness.



A. Architecture of a Microgrid

The frequency stability is no longer ensured by the robustness of the main grid. The islanded MG must then control the grid frequency by itself. The frequency of the power sources dictates the power unbalance between generation and demand. Eq. (1) represents the conventional frequency vs. power droop control.

$$f_0 - f = K_p \Delta P \quad [1]$$

Where f is the measured MG frequency and f0 is the reference frequency. The slope Kp depicted in Eq. (2) is chosen in order to obtain slight frequency variation when the power varies between zero and its maximum value Pmax.

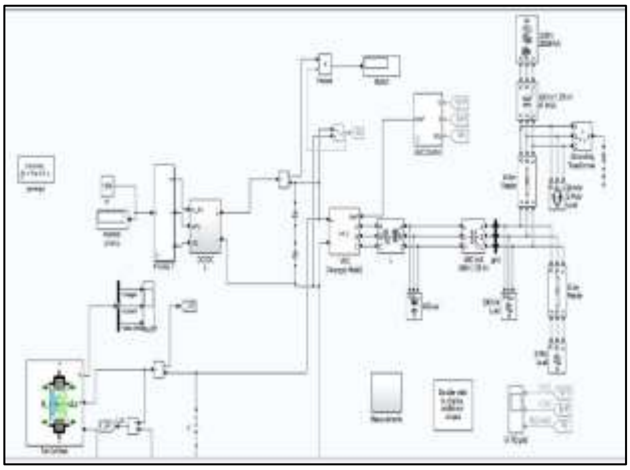
$$K_p = \frac{f_{max} - f_{min}}{P_{max}} \quad [2]$$

IV. SOFTWARE /TOOLS

The design philosophy for such sections is coherence with limit state principles. This approach sets acceptable levels of safety against the occurrence of both serviceability limit states (excessive deflections, cracking) and ultimate-limit states (failure, stress rupture, fatigue). While calculating the flexural resistance of a section strengthened with an externally applied FRP system.

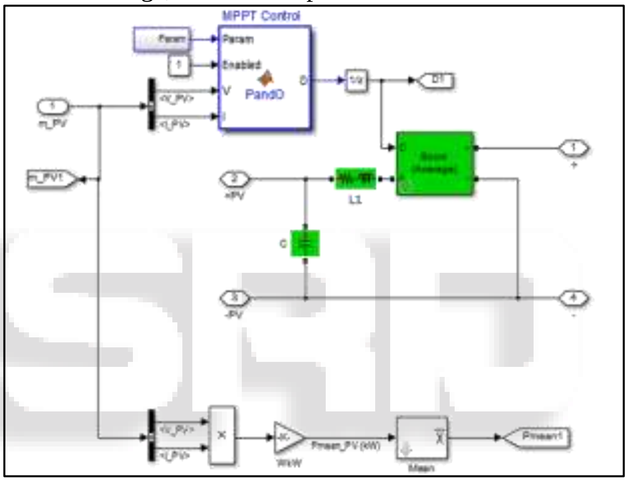
In order to evaluate the performance of the secondary controller and the control approach for improving the transient behaviour of the system, a model has been implemented in MATLAB for time-domain simulation. Figure shows a system consists of two DGs with mentioned hierarchal control approach. This system is adapted from IEEE 399 standard for low-voltage applications.

Mat lab Simulink software was used to design grid connected 400KW micro grid which consist of 4 PV array. Each array has 100KW generating capacity of power.



Simulink Model of 400KW grid connected micro grid:

These algorithm produce pulse for boost converter to boost PV array voltage from 263.5 to500 V. again these voltage of each PV array feed to a common DC bus where We find Voltage, current and power.

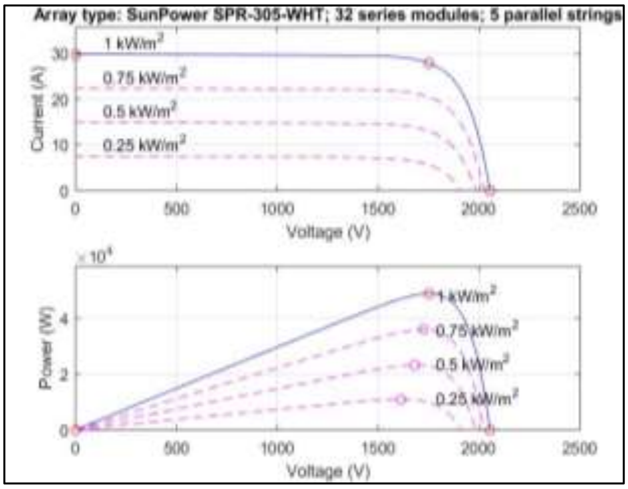


Simulink model of MPPT and Boost converter

V. EXPERIMENTAL RESULTS

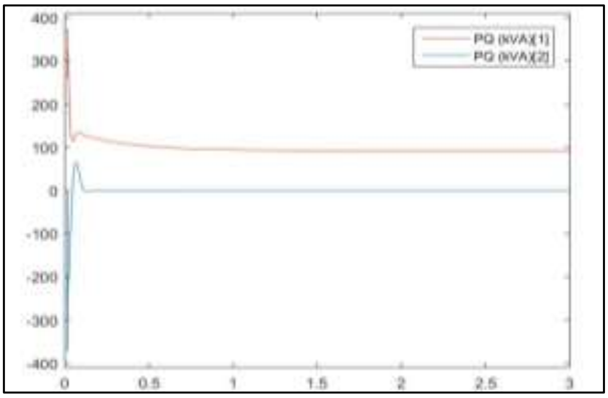
PV array I-V and P-V characteristics are shown in below figure from the model which is used in Simulink model respectively

A. I-V and P-V characteristic of PV array



I-V and P-V characteristic of PV array

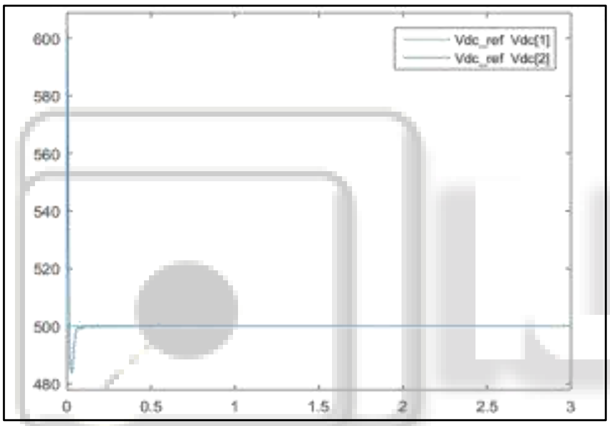
B. DC BUS Voltage



DC BUS Voltage

Above figure show Boost dc output voltage with ref dc voltage.it is almost constant but some fluctuation occurs due to variation in irradiance. We take reference value of output dc voltage 500V constant for converter distributed control.

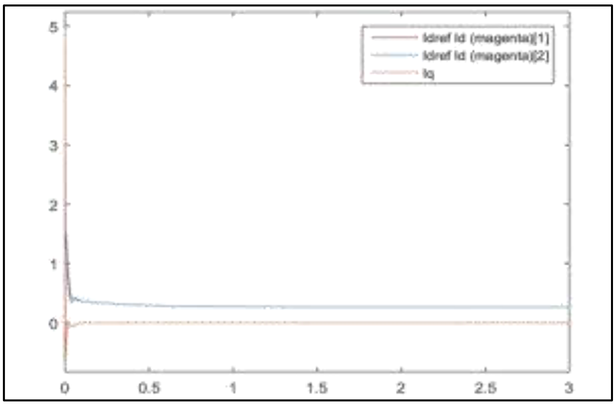
C. Reference DC Current



Reference DC Current

The models are developed for all the converters to maintain stable system under various loads and resource conditions and also the control mechanism are studied. MPPT algorithm is used to harness maximum power from DC sources and to coordinate the power exchange between DC and AC grid.

D. Reference DC Current



Reference DC Current

A transformer 230/25KV connected in line which convert voltage from 230Volt to 25KV at connect line from a grid .At grid level we measure voltage and power and we find fallowing results.

VI. CONCLUSIONS

The modeling of hybrid microgrid for power system configuration is done in MATLAB/SIMULINK environment. The present work mainly includes the grid tied mode of operation of hybrid grid. The models are developed for all the converters to maintain stable system under various loads and resource conditions and also the control mechanism are studied. MPPT algorithm is used to harness maximum power from DC sources and to coordinate the power exchange between DC and AC grid. Although the hybrid grid can diminish the processes of DC/AC and AC/DC conversions in an individual AC or DC grid, there are many practical problems for the implementation of the hybrid grid based on the current AC dominated infrastructure. The scenario based simulation results show the validity of proposed approach using a typical microgrid derived from IEEE 399 Std. and simulated in MATLAB.

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