EENG 577 Final Project Proposal

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***Abstract*—As renewable penetration increases, the power supply becomes more stochastic. Rural areas lacking reliable grid infrastructure often utilize microgrids as a backup to power critical loads. Here we propose a case study exploring the transient effects of changing solar irradiance in such a microgrid with solar PV, a generator, and a motor.**

I. Introduction

The key focus of this project is to analyze the time response of the system when the solar generation is dynamically disconnected leaving the generator to carry the full load. By employing state-space modeling, we plan to capture the transient behavior of the micro-grid and gain valuable insight into micro-grid stability with high solar penetration. This will be accomplished using state space models for the generation and load. To simulate industrial conditions, the generation will be modeled as a synchronous machine and the load will be an induction motor operating with a lagging power factor.

II. Schematic

The model will consist of four main components including a synchronous generator, solar photovoltaic (PV) generation, DC to AC inverter, and an induction motor as the load shown in Figure 1.

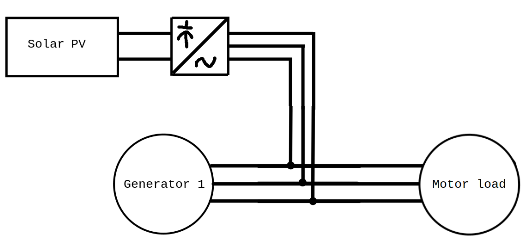

Fig. 1. Flowchart of the three devices in the proposed model

TABLE I
Preliminary Ratings of the components

Device	Rating
Motor Load	0.8pf lagging 100kW continuous, 200kW peak
Synchronous Generator	480V 60Hz 200kVA
Solar PV	80kW 240Vdc
Inverter	80kVA 60Hz 480Vac 240Vdc
3ph AC Lines	480V 525A

III. Simulation

Simulink offers model based simulation engineering (MBSE) where different components can be captured and decomposed into block bodies that accept inputs and provide outputs. The software allows users to integrate multiple interconnected and independent items such that models can be reduced to a minimum number of state variables. Simulink is integrated with Matlab such that sub components of the primary model can use the aid of built in Matlab functions and calculations.

To accomplish this, we need to further research how solar generation is modeled and how it responds to fault conditions such as voltage sag and overcurrent. This will allow us to better understand what scenarios result in the solar generation to disconnect from the grid. Also, we need to research parallel operation of two generators such that the total power supplied by the source is equivalent to the amount consumed by the load on the assumption that the sources have the same terminal voltage, phase sequence, and the phases are in sync. The basic constraint of connecting two generators in parallel with a load is that the total real and reactive power generated is equal to the total real and reactive power consumed shown in (1) and (2) [1].

$$P_{\text{tot}} = P_{\text{load}} + P_{\text{loss}} = P_{\text{G1}} + P_{\text{G2}} \tag{1}$$

$$Q_{\text{tot}} = Q_{\text{load}} + Q_{\text{loss}} = Q_{\text{G1}} + Q_{\text{G2}} \tag{2}$$

IV. Conclusion

Using state based modeling techniques in Simulink we hope to better understand how micro-grids with high levels of renewable energy penetration respond to fluctuations in power form renewable energy sources. Here, we are looking at the transients on the armature windings of the synchronous machine and the oscillations on the induced torque when one of the sources is varied to zero. We expect to see three distinct components including the subtransient period, transient period, steady-state period where each phase winding has a superimposed DC component on top of a symmetrical AC component [1].

References

[1] Stephen J. Chapman. (2005).*Electric Machinery Fundamentals.* McGraw-Hill.