EE5200: - Journal Paper Analysis

Modeling and Control Analysis of Grid Networks with Distributed Resources

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BASE PAPER: - Modeling and Analysis of Grid Networks with Distributed Resources using MATLAB/SIMULINK
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LINK : - https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6484415

BACKGROUND

In recent years, there is a tremendous growth in the utilization of renewable energy generation systems (Distributed Resources). However, the Interconnection of Distributed Resources (Wind, Solar, Synchronous Generator) with existing power grids may have various effects on the operation, safety and reliability of the electric power system. Hence there is an inevitability of a system impact study that must be carried out before interconnecting distributed energy resources with the existing electric power systems. Because of this system study requirement, the authors have presented this paper, this paper focuses on modeling of distributed generation networks using MATLAB/SIMULINK. In this paper analysis of system responses for various cases are carried out and suitable control strategies to maintain proper coordination between the power grid and distributed generation are proposed.

SIMULINK MODELS AND ANALYSIS

Authors have considered Wind Turbines(WT) and Synchronous Generator(SG) in the presented simulation model since these types of distributed generation are the most popular and frequently used. In this paper, three different grid networks with distributed generation have been modeled for analysis. The three types of model are as follows:

1) Model 1: - Wind Turbine(WT) with Grid Network
2) Model 2: - Wind Turbine(WT) and Synchronous Generator(SG) in Islanded mode
3) Model 3: - Wind Turbine(WT), Synchronous Generator(SG) and Secondary Load Bank in Islanded mode operation

Wind turbine with Induction generator is considered in all simulation models and 2-D Lookup Table is used to compute the turbine output torque.

In model-1, turbine output responses are analyzed by changing the input wind speed. Additionally, the protection system is modeled to monitor system parameter and to trip wind generator in case of any fault occurrence.

Model-2 helps in analyzing power-sharing phenomena between Wind turbine and Synchronous Generator. Requirement and selection of Static capacitor for power compensation is also explained in this simulation study.

Model-3 is developed to study operation of SG (Synchronous Generator) as SC (Synchronous Condenser) when load demand is maintained by the Wind Turbine. In addition, Active power Imbalance study is also carried out in this model by introducing secondary load (Three phase resistor with GTO). The concept of Ferro resonance is analyzed for two different values of compensating capacitor.

This paper covers impact studies on various grid systems. System impact studies focus on

1) Protection and coordination
2) Voltage Regulation
3) Unintentional islands
4) Power Quality
5) System Stability

The authors have provided simulation results/ system responses for various model and cases mentioned above.

CRITICAL ANALYSIS

1) Protection scheme employed in grid-connected operation is not clearly explained in the paper.
2) Facts devices required to maintain stable bus voltage within the specified range are not shown in the Simulink models.
3) Parameter required for modeling of Wind Turbine Induction generator are not specified in the paper.

CONCLUSION

Authors have presented an analysis on Interconnection of distributed generators with existing power grid for grid-connected and Islanded mode of operation using various MATLAB/Simulink models. Summary of modeling, analysis and employed control scheme is provided in tabular form.

PROPOSED CONCEPT

Simulink models provided in this paper can be remodeled by incorporating FACTS devices (STATCOM or SVC) at an appropriate location so that voltage imbalance causing due to the interconnection of DGs with Power grid can be managed/control.

Nowadays, the use of Solar (Photovoltaic cells) as a distributed generator is increased significantly, hence responses of PV system should also be analyzed when connected with the power grid. Most of the paper did not provide sufficient information of grid modelling of PV System Hence, we intend to develop a Simulink model which will also include PV system and we will also propose control strategies for PV system interconnection with grid.