Summary of End of year report 2009

Project P1: Control methodologies of distributed generation for enhanced network stability and control

The first part of the project investigates the modelling and stability aspects of power distribution system with distributed generation (DGs). The voltage stability and oscillatory stability of the system in presence of DGs are investigated. Both static and dynamic models of DGs are discussed. The DGs are modelled as power factor controlled source and voltage controlled source depending on the nature of available energy resources.

In this report, voltage and small signal stability have been analysed with different DG's located in a selected 16 bus distribution system. It is a 23 kV, 100MVA balanced system with 3 feeders and 13 sectionalizing branches. The principle reason behind choosing this modified 16 bus system for starting the static voltage stability analysis is its simplicity and easy to visualise the impact of distributed generation sources. While locating the DGs in this system, we have considered four different kinds of DGs namely: variable speed wind turbine, fixed speed wind turbine, solar panel in aggregated form and bagasse based cogeneration plants which targets all the possible generation technologies (i.e. synchronous, asynchronous and static generation). A number of simulations were carried out to understand the impact of static voltage stability and small signal stability on the locations of different DG units in a selected distribution system. The MATLAB and PowerFactory software have been used for simulation.

The scenario analysis was performed with no penetration, 10% penetration and 20% penetration of DGs. The significant penetration of distributed generation reverses the power flow and the network is no longer a passive circuit supplying loads. The static voltage stability study with PV and QV analysis clearly shows that the penetration of DG's in the existing power system has an influence on voltage profile, loading limit and reactive power margin of the system. The voltage magnitude of the buses increases with the increase in DG penetration, which is more significant in a stressed system. The loading limit reaches to 3.15 than the base case 2.98 with DG penetration of 20%. As most of the DGs are consuming reactive power, locating the placement of reactive power sources will be vital to maintain the system voltage stability. Future work will include design of control methodologies with these issues to improve the voltage stability of the network.
The oscillatory stability is important for safe dynamic operation of the system. Oscillatory stability is studied by linearizing the nonlinear dynamic equation and evaluating the eigenvalues. The location of eigenvalues on complex plane gives the information about the stability of the system. In a system, if the distributed generators are added, they contribute the damping and reduce the magnitude of low frequency oscillation. It will improve the small signal performance of the power system. These results are obtained with fixed value of load and generation. When the power system is subjected to intermittent generation, the scenario might be different. These will be studied in the next part of this study.

This study highlights the significance of DG's with respect to their behaviours in power system stability studies. Moreover, the complexities of these issues with respect to QV curve and PV curve has been outlined with future direction of work. Preliminary study with small signal stability shows some remarkable advantage in respect of small signal stability study with DG's connected in the low voltage network. However, it is premature to put any conclusive statement and further studies with more complicated issues are planned for the future work.

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