Critical Load Serving Capability by Optimizing Microgrid Operation

Pavan Penkey
Student Member, IEEE
penk1970@vandals.uidaho.edu
University of Idaho
ECE Department
Moscow, ID, 83844, USA

In order to improve reliability of power supply, utilities are interested in forming microgrids in abnormal situations. In some cases the microgrid is used to minimize the adverse impacts on the most critical loads, such as hospitals, government offices, and police stations. The costs associated with failure to supply critical loads are significant. The ability to create a microgrid largely using existing generation assets with only the addition of control devices can result in significant savings during major events. Apart from these there are many other advantages of forming a microgrid like reduction in power losses, reliability, and enabling the development of sustainable and green electricity.

A significant portion of the power supply to the City of Spokane comes from Montana through a single 500kV line. If the line goes down under some circumstances, city grid could go down. The main objective of this project is to perform a study of establishing a microgrid to supply high priority loads in downtown Spokane area using hydroelectric facilities on the Spokane River. Implementation of the microgrid will require disconnection from the main grid and reconfiguration to pick up critical loads.
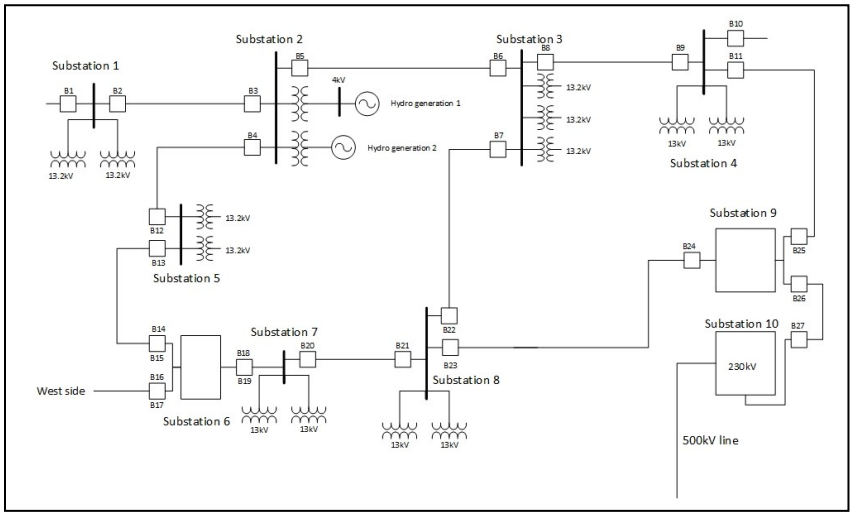

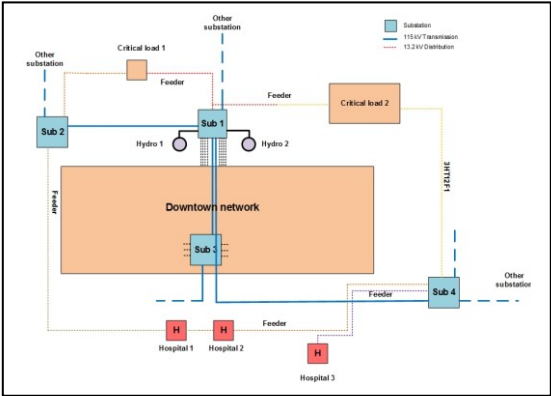Fig.1.Transmission line model within the scope of microgrid

Fig.2.Microgrid overview with critical loads and hydro generation

The information for modeling the microgrid is taken from different simulation packages (i.e.) the generators and transmission lines which are modeled in Powerworld as part of the larger WECC transmission model. Spokane downtown distribution network is implemented in a separate, disconnected Powerworld model with different MVA bases. The remainder of the distribution network that supplies few critical loads are modeled in SynerGEE. The modeling and simulation of microgrid is done in Powerworld simulation software as a single system by importing the distribution data from the different models. There are two hydro facilities available in downtown Spokane with a few small solar installations available. The idea here is to make use of these hydro facilities and more solar installations to form a microgrid to supply critical loads. Different scenarios are considered like seasonal variation of load and seasonal variation of hydro generation with water supply and in available PV output to determine various ways of supplying the critical loads, by identifying different feeder configurations.
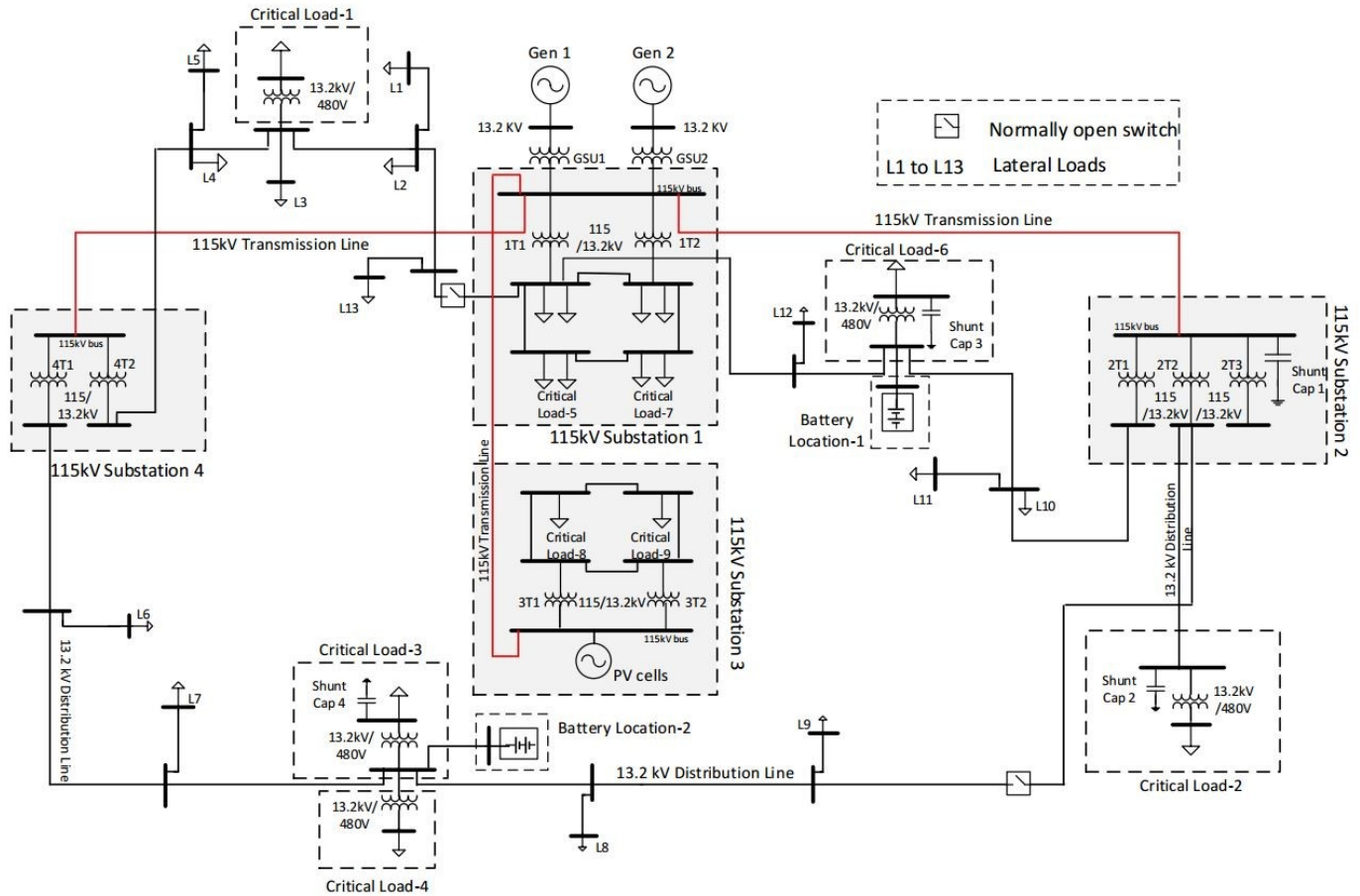

Fig.3.Final Powerworld model of the microgrid

In this case the microgrid is brought on line by first disconnecting from the grid, and then energizing transmission lines in the microgrid with hydro generation under no load conditions and then adding the critical loads in a sequence by maintaining the stability and almost constant frequency. A microgrid master controller will be developed to take care of load shedding or generation shedding in case of imbalance in this system. An automatic generation control system will manage the (upgraded) governors to bring frequency to nominal value. Additional analysis studied the impact additional renewable energy sources along with a battery. Stability analysis of the entire system put together by imposing few constraints. The results of the study demonstrate that microgrid development for downtown Spokane can potentially be applied in other areas of the Avista system or for other utilities.

The fig-1 shows us the Avista's transmission model in our area of interest. Fig-2 shows the block diagram showing the hydro generation and existing distribution network within microgrid. Fig-3 shows the complete model of microgrid in Powerworld.