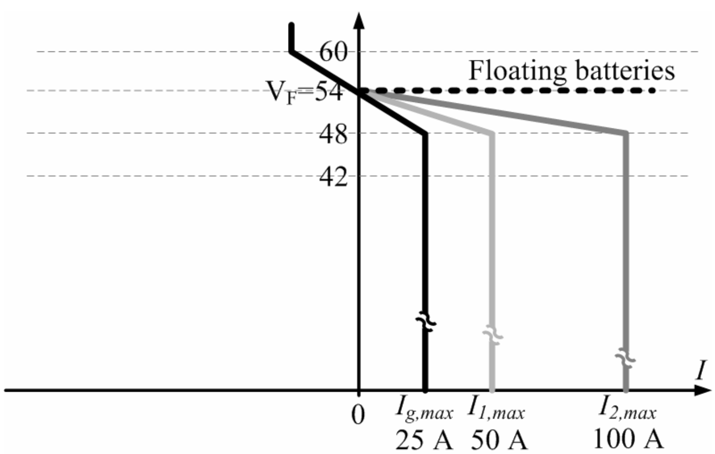
ECE2795 Homework Assignment #5

Due date: 04/09/2015

For all questions elaborate some few conclusions or comments about the results. For all questions with simulations include a graph with the used model. State all the assumptions considered in the simulations. Also for all simulations, the results should focus on the steady state, so the transient period may or may not be shown. You are free to do as many reasonable assumptions you consider appropriate. In graphs indicate all relevant values.

1) Consider the dc microgrid shown at the end with two microturbines, a current load and lead acid batteries directly connected to the microgrid main bus. The maximum output current of one of the microturbines is 100 A and the other is 50 A. The batteries float voltage is 54 V, their nominal voltage is 48 V and their lowest allowable voltage is 42 V. The maximum current that can be provided by the grid or injected into the grid is 25 A.

a) Consider that the microgrid is initially operating at no-load and with no power flowing to or from the grid. The batteries are fully charged so the microturbines local controllers operate with a droop control and a secondary controller regulating their output voltage at the batteries floating voltage of 54 V. That is, the droop lines are configured as shown in the droop graph below with all the no-load voltage references equal to the float voltage of 54 V. Remember that when drooping all sources share the load current in a proportional way with respect to their capacity (maximum currents). What are the droop resistances?



b) Now, the current increases to 120 A. What is the current output for each of the microturbines and for the grid interfacing converter (GIC)? What is the main bus voltage? What is the new no-load reference voltage for all droop lines? What is the batteries current? Draw the new droop graph.

c) Now, suddenly the grid experiences an outage and will remain in this condition for the rest of this problem. With the same load, what is the current output for each of the microturbines and for the grid interfacing converter (GIC)? What is the main bus voltage? What is the batteries current? What is the new no-load reference voltage for all droop lines? Draw the new droop graph.

d) After a while, the load current increases to 200 A. Obviously, the microturbines cannot power the load alone so they are unable to keep the batteries floating and they start to discharge keeping the microgrid bus voltage at about 48 V. In this condition, what is the current output for each of the microturbines? What is the batteries current? What is the new no-load reference voltage for all droop lines? Draw the new droop graph.

e) Eventually, the batteries fully discharge an the main bus voltage reaches 42 V (the load current stays at 200 A). In this condition, what is the current output for each of the microturbines? What is the batteries current? What is the new no-load reference voltage for all droop lines? Draw the new droop graph.

f) To prevent having to drop all the load and allow the batteries to be recharged, the load is partially shed, so the new load is back again 120A. The secondary loop is now able to regulate the main bus voltage at the batteries float voltage of 54 V. In this condition, what is the current output for each of the microturbines? What is the initial batteries current? What is the new no-load reference voltage for all droop lines? Draw the new droop graph. Note: the load could have been reduced to 150 A in case there was no interest in recharging the batteries.