ECE 2795 Homework Assignment #6

Due date: 4/23/2010

For all questions elaborate some few conclusions or comments about the results. You are free to do as many assumptions you consider appropriate. This homework has one problem only but with multiple questions. Questions have been highlighted.

Consider that you are designing a 200 kW microgrid and you are planning to power it with a 200 kW microturbine running with natural gas. The microturbine has an expected life of 10 years, costs $200,000, and the installation adds $100,000. Assuming that the cost of money is zero and you run it continuously with an operation and maintenance cost of 1¢/kWh, **what is the COE?** You may need to search for some information on the Internet (e.g. natural gas cost in EIA) and do assumptions based on the information in the class notes (e.g. efficiency).

Now assume that you finance the microturbine with a loan with 5 % yearly interest. The microturbine has an availability of 0.993 (MUT = 8700 hours and MDT = 60 hours). To simplify the problem we can ignore the reliability effect of the natural gas supply and the operation and maintenance cost. When you operate the microturbine you save 2 cents for each kWh with respect to the cost of electricity. **What are the yearly savings?** Your load is an airline reservation call center, so your downtime cost is $100,000 per hour. **What are the net present value and your internal rate of return?**

Now, you also have the possibility of using the utility grid to power your load when the microturbine fails. Having the grid tie cost you an additional $350,000. The grid's availability is 0.9992 (MUT = 2440 hours, MDT = 2 hours). **What is the availability of the combined microturbine-grid power supply?** The expected down time is

$$MDT = \frac{1}{\upsilon_{\mu T} + \upsilon_{Grid}}$$

Why? What is the system's repair rate? If the failure rate for such arrangement is

$$\lambda = \frac{\left(\lambda_{\mu T}\lambda_{Grid}\right)\left(\upsilon_{\mu T} + \upsilon_{Grid}\right)}{\left(\lambda_{Grid} + \upsilon_{Grid}\right)\left(\lambda_{\mu T} + \upsilon_{\mu T}\right) - \lambda_{\mu T}\lambda_{Grid}}$$

what is your MUT? Does the additional investment of having the grid connection worth it (i.e. what are the NPV and the IRR)?

Since the grid connection interface costs $350,000 and an additional microturbine total cost including installation is $250,000, you want to calculate which option is best: the last option of a microturbine and the grid, two microturbines and no grid, or one microturbine only (the first case). **To determine this you need to calculate the NPV and IRR for the two-microturbine option.**