HW 1: Energy Transport and Storage

By: Yash Shailendra Gokhale (ysg)

Data Tabulated:

Area under Focus	Nassau, Bahamas
High Diesel price	1.79 $/L
Low Diesel price	0.895 $/L[1]
High grid power price	0.748 $/kWh
Low grid power price	0.374 $/kWh[2]
Project lifetime	20 years
Discount rate	10%
Inflation rate	2%
Sellback to grid	0
Outages	2/yr for 6 hours each

Q1. Sensitivity Analysis of the diesel price and grid power price

4 cases were considered as follows:

1. High diesel price and high grid power price
2. Low diesel price and high grid power price
3. High diesel price and low grid power price
4. Low diesel price and low grid power price

HomerPro Simulations were carried out for all these four cases and the following results were reported:

Power Price ($/kWh)	Diesel Fuel Price ($/L)	NPC ($)	Renewables Frac. (%)	LCOE ($)	Operation Hours of Microturbine
0.374	0.895	41.8 M	2.16	0.314	8706
0.748	0.895	62.8 M	2.16	0.472	8759
0.374	1.79	49.5 M	2.16	0.372	16
0.748	1.79	81.7 M	2.16	0.615	8734

From the above table, it can be observed that the LCOE is lowest for low power price and low diesel fuel price. The percentage of renewables in all cases is 2.16%.

[1] http://www.globalpetrolprices.com/Bahamas/diesel_prices/
[2] https://www.nrel.gov/docs/fy15osti/62691.pdf

Q2. Sensitivity Analysis of Microturbine size

In this case, standard fuel price (0.895 $/L) and standard grid power price (0.374 $/kWh) was used for all the calculations.

Microturbine size was varied as follows: 200 kW, 600 kW, 800 kW, 1000 kW and 1500 kW. The aim of this sensitivity analysis was to check if an alternate size result in a lower LCOE.

Running the simulations, the optimized result is as follows:

The 1500 kW generator results in a lower LCOE as compared to the 1000 kW. The new LCOE is 0.304 $, which is around 0.1$ reduction from the case wherein microturbine was 1000 kW.

Jin 350 (kW)	Gen100 (kW)	NPC ($)	COE ($)	Ren Frac (%)	Hours of Gen100
200	1500	40.4 M	0.304	2.16	8304

Q3. Adding a Natural Gas Powered Gen-set

The aim of this is to analyze which would be a better option: The diesel-powered gen-set vs natural gas powered gen-set.

The analysis for standard prices of fuel and grid power price yield the following results:

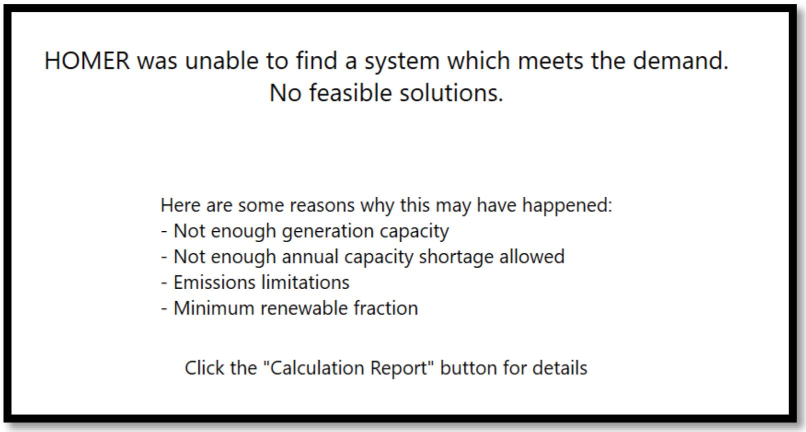
Jin350	Gen100	J320	NPC	COE	Ren Frac (%)
200	1000	1067	24.9 M $	0.187 $	2.16
200	0	1067	28.0 M $	0.211 $	2.16
200	1000	0	41.8 M $	0.314 $	2.16
200	0	0	48.8 M $	0.367 $	2.16

From the above table, it can be seen that: Using only the Natural Gas fired Gen-set has an LCOE of 0.211$ as compared to 0.314$ by using only the Coal fired Gen-set. It is thus a better option to use J320 instead of Gen100 to obtain a lower LCOE.

Comparing the hours of generation, the Natural Gas Fired Gen-set needs to run for 8759 hours, whereas the Diesel fired Gen-set needs to run for 8706 hours. The Production of Natural gas Gen-set is 7.8*10^6 kWh, whereas the production of diesel Gen-set is 7.4*10^6 kWh. From this, it can be observed that, although the natural gas Gen-set runs for a lower amount of time as compared to the diesel fired Gen-set, it has a higher production output. Thus, the Natural Gas Gen-set has a higher production/hour than the Diesel fired Gen-set.

Q4. Minimum requirement of Renewables: 10%

Running the Homer simulation, with a minimum constraint of 10% renewables does not lead to any optimum result. The output of the simulation is as follows:



This implies that the solution cannot be obtained if the system requires a minimum 10% share of renewables. This can be attributed to the fact that 10% of the energy demand cannot be catered using renewable energy as the total contribution from the renewable energy sources does not add up to 10% of the energy requirement.

Conducting sensitivity analysis on the minimum renewable energy requirement yields that the maximum share of renewable energy can be 2.16%, which is that in the earlier solutions. Thus, no solution is obtained as the total demand cannot be met.