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Optimization of Sustainable Solar-Diesel Hybrid System for Domestic Electrification in Urban Area

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ABSTRACT

Solar energy systems are freely available, environmental friendly, and they are considered as positive power generating sources due to their availability and topological advantages. Solar-diesel hybrid systems use renewable energy sources. Solar diesel hybrid system or stand alone plants are pollution free silent running and long life system for power generation and due to this improving the system efficiency and reliability and reduce the consumption of fossil fuels. The hybrid solar-diesel systems are becoming popular in remote area for power generation due to unavailability of grid supply and substantial rise in prices of petroleum products. This paper is to review the current state of the simulation, optimization for the stand-alone solar-diesel hybrid systems with battery storage. It is found that hybrid system apply in urban areas to reduce the consumption of grid supply or permanently disconnect it and totally depend on hybrid system. The main variables in this analysis are A.C. Primary Load Calculation, Global Solar Resources, Output of solar energy, Excess Electricity and State of battery charge. . The study presented is to promote the domestic use of Solar-diesel engine with battery bank in this region of Bhopal, India (Longitude 77o.42'and Latitude 23o.25').The research and development effort in this area is still needed for improving the systems' performance, establishing techniques for accurately predicting their output and reliability

KEYWORDS: Solar-diesel hybrid system, Optimization, Homer, Solar-PV

INTRODUCTION

Many efforts have been made in recent years to address issues surrounding the use of fossil fuels for energy Rapid depletion of fossil fuel resources has necessitated an alternative energy sources to fulfill the present demand. Another reason to reduce our dependency on fossil fuels is the global warming phenomena. Therefore, it is necessary to find alternative source of energy to met the demand of energy and minimize the negative environmental impacts. Utilization of solar energy has become increasingly significant, attractive and cost-effective, since the oil crises of early 1970s. However, a drawback, common to solar is their dependence on weather and climatic changes, and the variations of solar energy may not match with the time distribution of load demand. This shortcoming not only affects the system's energy performance, but also results in batteries being discarded too early. It is prudent that neither a stand-alone solar energy system can provide a continuous power supply due to seasonal and periodical variations [1] stand-alone systems having the problems by the variable nature of these resources can be partially or wholly dependent on the solar radiation. The use of different energy sources allows improving the system efficiency and reliability of the energy supply and reduces the energy storage requirements but initial cost of the system increased and area of installation is also increased With the complementary characteristics between solar energy and wind energy for certain locations, the hybrid solar power generation systems with storage banks offer a highly reliable source of power [2], (1 Vesta WECS, 600kW diesel generator, 400kW converter and 500 batteries) would have in comparison to a diesel generator-only system

(1000kWdiesel generator) over a 20-yr project span. Payback time requires the collection of annualized costs for both diesel generator-only and hybrid RES systems, which are calculated summing the fuel, O/M and replacement costs for each year. Annualized costs are then subtracted from each other for each consecutive year, giving the savings or loss for each year [3].

In the previous, the hybrid systems have been considered as preferred for remote systems like radio telecommunication, satellite earth stations, or far away from a conventional power system [4] The concept of PV is well understood and thousands of PV-based power systems are being working on different locations, for providing power. [5] The objective is to produce innovative, clean and efficient energy technologies and systems to develop a concept of "Zero Energy Buildings". This system consists renewable energy photovoltaic system. An existing building will be simulated by considering and they will be compared with the modified building and to show that such a hybrid system carried a load is carried out by Homer software. Based on simulation results [6] compares & concludes that HOMER is very user friendly, flexible, easy to model, analyze & optimize the micro power systems. Of course, with increased dependency on conventional source of energy creates awareness of the renewable energy. [7] Hybrid systems were designed by HOMER tool prove that it is feasible and sustainable power supply for hilly areas for standalone applications. The optimum design of a hybrid system becomes complicated through uncertain renewable energy supplies and load demand, non-linear characteristics of the components, high number of variables and parameters that have to be considered for the optimum design, and the fact that the optimum configuration and optimum control strategy of the system are interdependent.

PROBLEM FORMULATION

Electricity consumptions in urban area are totally dependent on the non conventional source of energy. Today people aware about the depletion of fossil fuel due to this move on renewable source of energy and realized the importance of conservation of energy. Our unit of electricity production is small and easily fitted in domestic application less space is require for installation. Although it has observed that generally component failure and less efficient occurs because of improper optimization of the system. The NREL (www.nrel.gov/homer/) provided Homer tool for optimizing of hybrid system. These paper present proper optimization techniques by selecting a compatible design modal for application by simulation.

POWER REQUIREMENT

HOMER software considered as a simulation tool ant the variables are: Day-to-day variable and time-step-to-time-step variable. Finally, we conclude that the scaled annual average and average load are 10.5 kWh/d and 0.436kW respectively, with the peak load of 1.7kW. Where both variables are 15% and 20% respectively. Thus we should design a Solar-diesel hybrid system which can hold the 10.5 kWh/d daily with the 0.436kW average load and the peak load of 1.7Kw

SYSTEM SELECTION

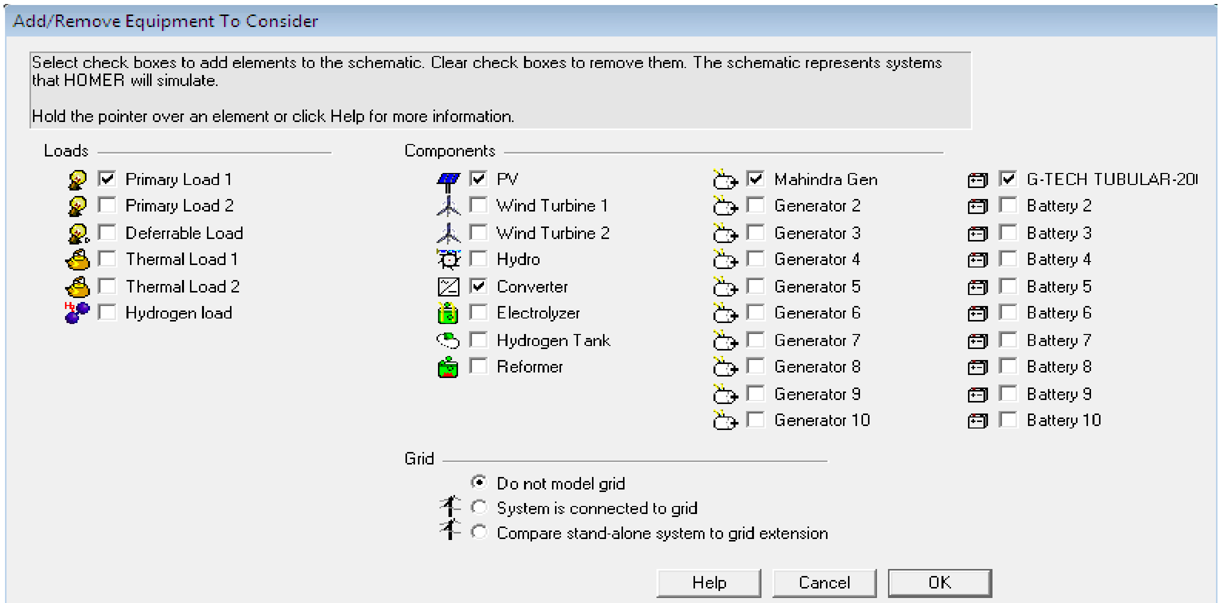

Figure 1:System selection

The first step is to select the component in the HOMER there is a number of option in the selection criteria simply add component as per your configuration. The selection of system is to be considered as hybrid system now calculate the daily load profile and enter in primary load. Solar radiation data as per your location automatically taken by HOMER by the site of NREL and cost of fuel we know is 1$. The photovoltaic selection as per the load condition and no of batteries and type of battery enter in the HOMER for optimization and simulation. The results outcome in the form of simulation and sensitivity. In this paper presents the sensitivity results

SOLAR RESOURCES

The time zone for India is GMT +05:30 and latitude and longitude for the proposed site in Bhopal is $23^{o}28$' and $77^{o}35$' respectively. Hourly solar radiation with clearness index data for the year 2014 collected from official website of NREL [www.nrel.gov/homer/]. The proposed site for installation of domestic hybrid system is Nehru Nagar, Bhopal Madhya Pradesh. The solar radiation intensity is maximum during the summer season instead of winter and rainy season. Scaled annual average of solar radiation is 5.18kWh/m^2/d.

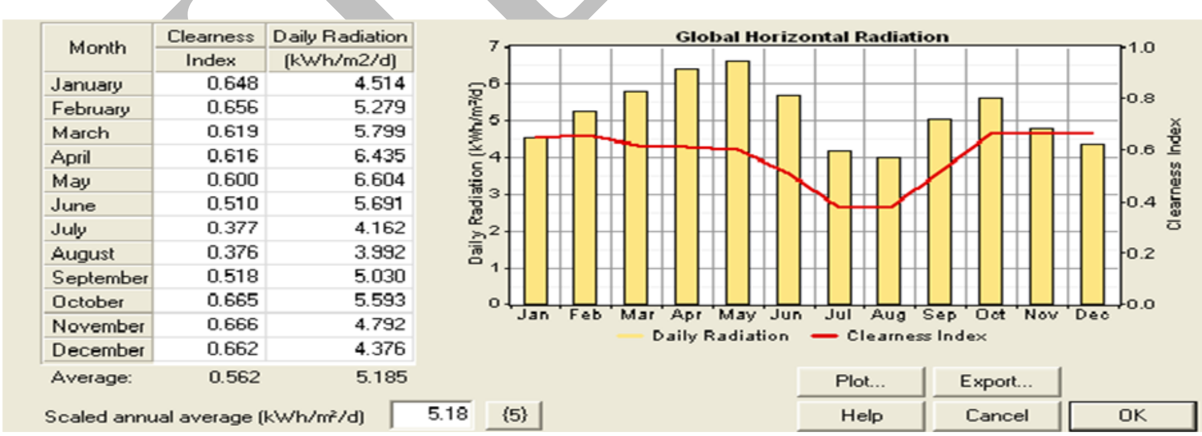

Figure 2: Average Daily Solar Radiation and Clearness Index

CONFIGURE THE INPUTS FOR GENERATING SUSTAINABLE CONDITIONS

PV inputs

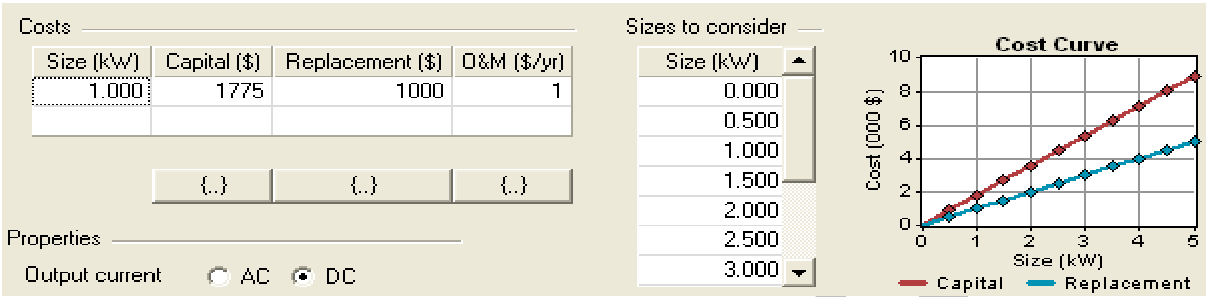

Figure 3: PV Inputs

Battery Inputs

There is a cost curve which represents the cost PV. The cost of 1kw of PV input is 1775$ and replacement cost is 1000$ .We are using two axis tracking system and the system having the angle of slope is 23 degree and the system receiving 20% of ground reflectance. The solar cell having nominal operating temperature is 47 degree. The PV system life is about 20 years and their efficiency at standard test condition is 13% .The Derating factor for the system is 80%. Today in India the research is focused on solar because it is available source of energy and its availability hours is 8 to 10 hours every day. These hybrid system reduce the load on grid supply

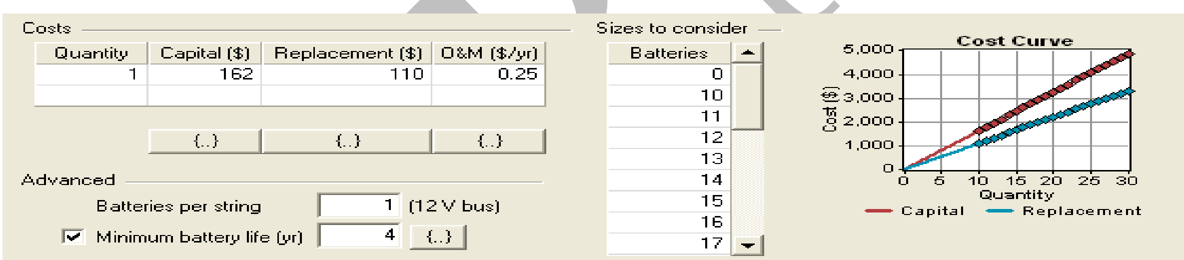

Figure 4: Battery Inputs

Converter Inputs

The converter is an electronic device which converts the DC electricity that comes from PV and it converted into AC current and also stop the flow of current from battery bank to solar cell, which matches the AC frequency of the power lines. The Cost analysis for the inverter is shown in Figure 8, where lifetime of a unit is 15 years with an efficiency of 90%. The capital cost of converter is 140$ with replacement cost of 75$ and O&M of 1$/yr.

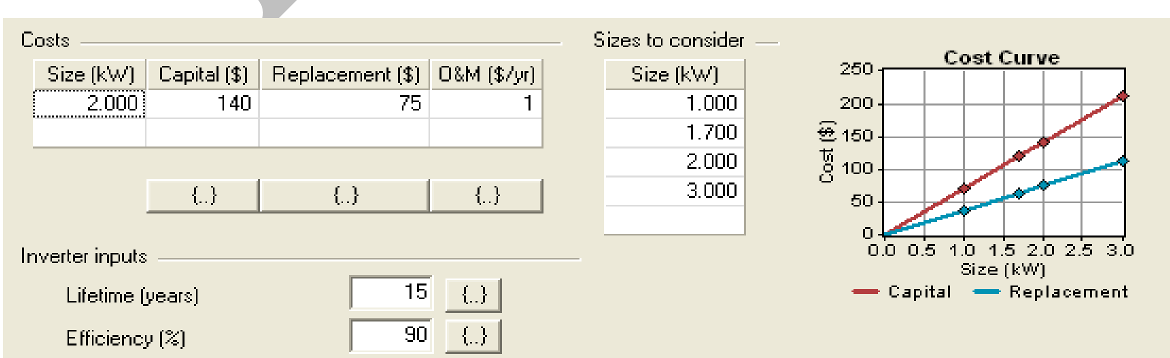

Figure 5: Convertor Inputs

RESULTS & DISCUSSIONS

Sensitivity results of the Sustainable Hybrid Systems

SYSTEM CAPACITY

1. **PV array capacity**

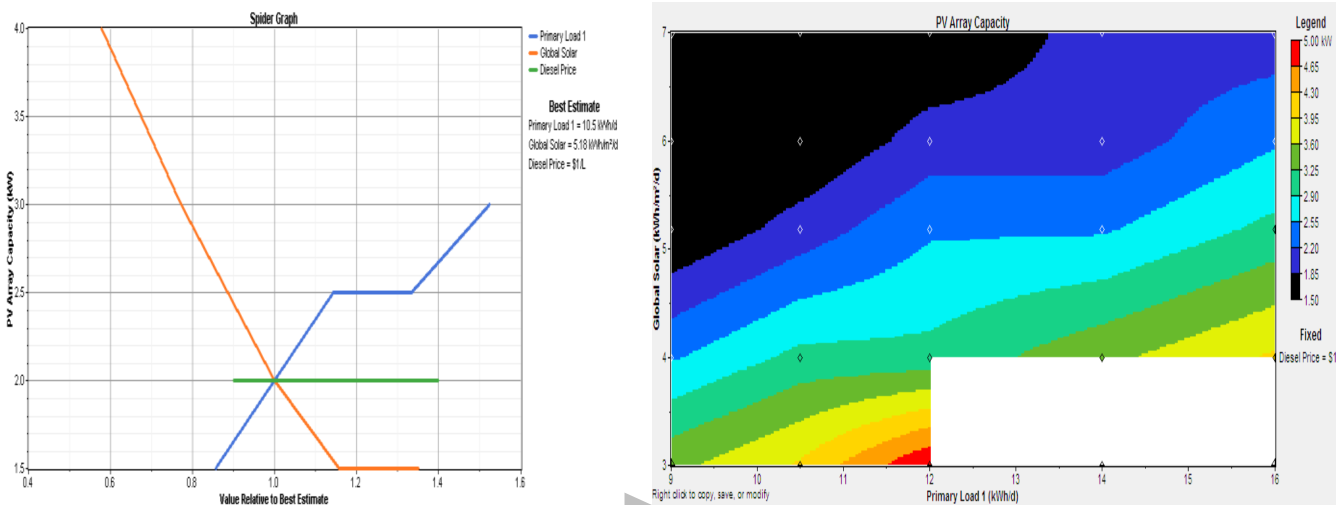

Figure 6: pv array capacity

In this figure the PV array capacity upto 4kW present in a spider graph which shows at 2kW is the best value in which all PV/primary load /diesel match at a point. that means best output comes at that point

2. Mahindra gen set capacity

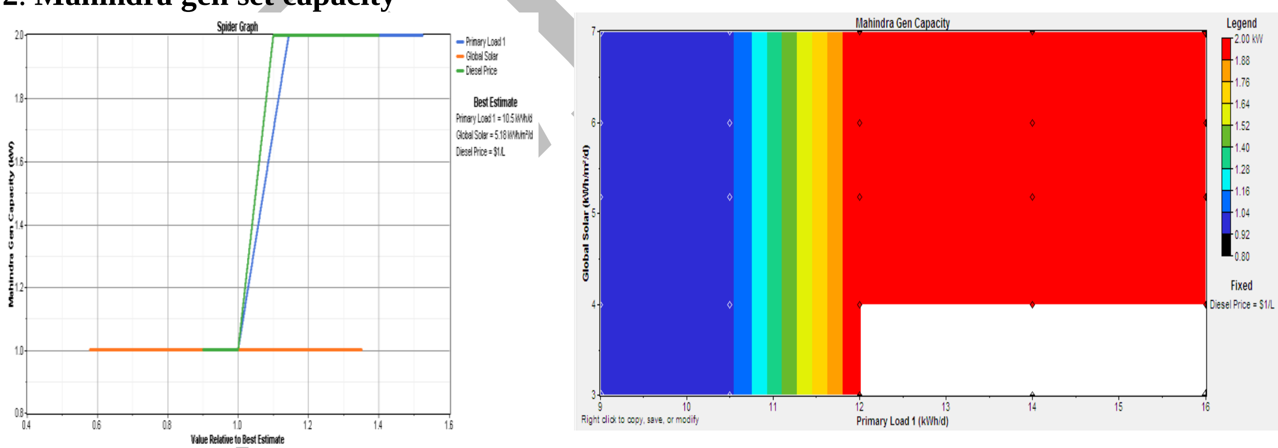

Figure 7: Mahindra gen set capacity

System runs on PV at 1kW but when load increases from 1kw diesel genset starts and similarly diesel consumption increases so diesel price is also increases due to diesel consumption

3. No of batteries

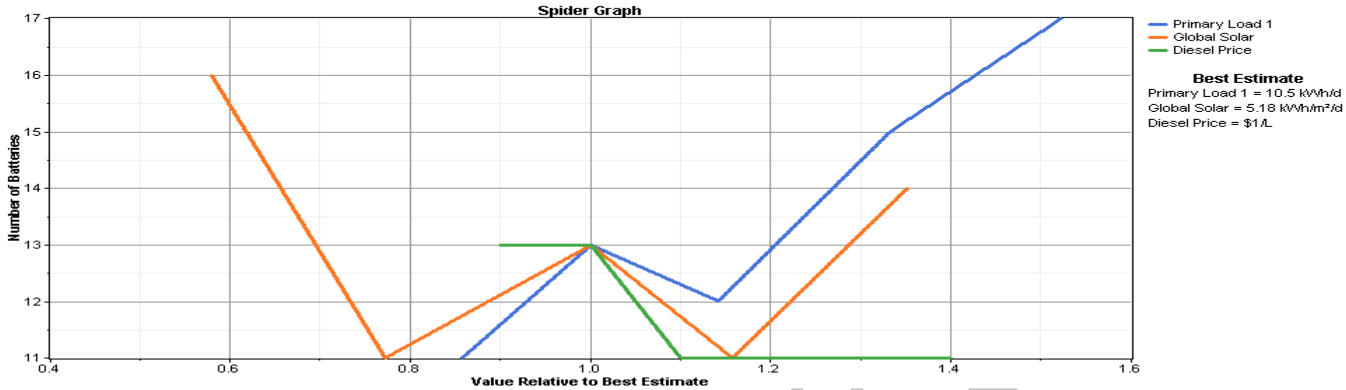

Figure 8: No of batteries

4. Converter capacity

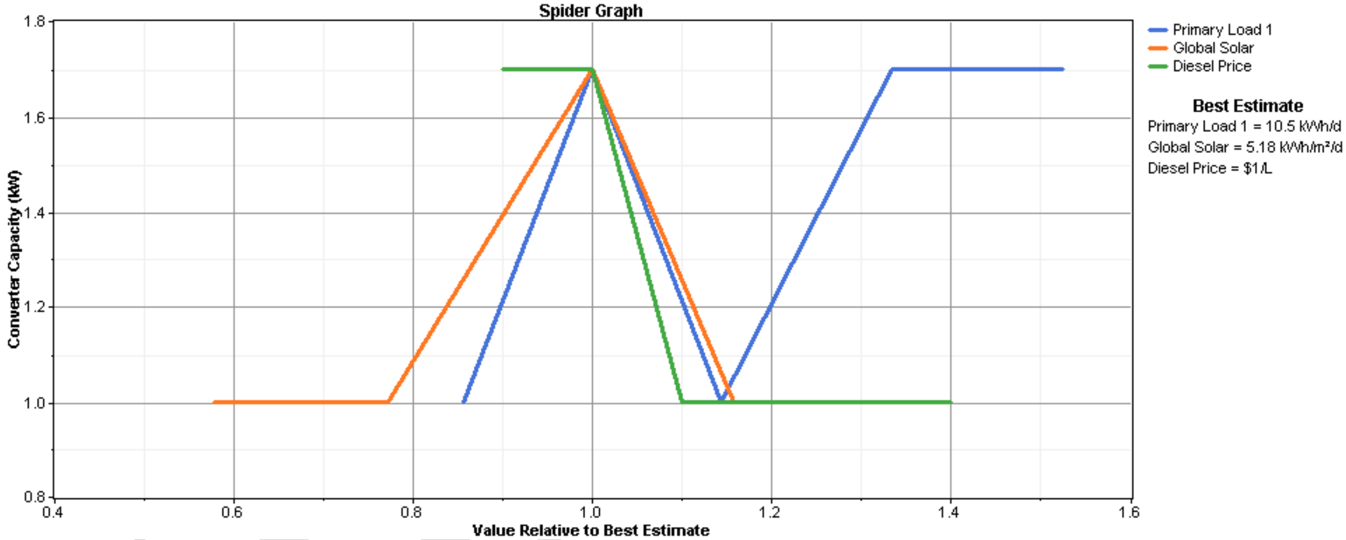

Figure 9: Convertor capacity

COST OF ENERGY

1. Levelized cost of energy

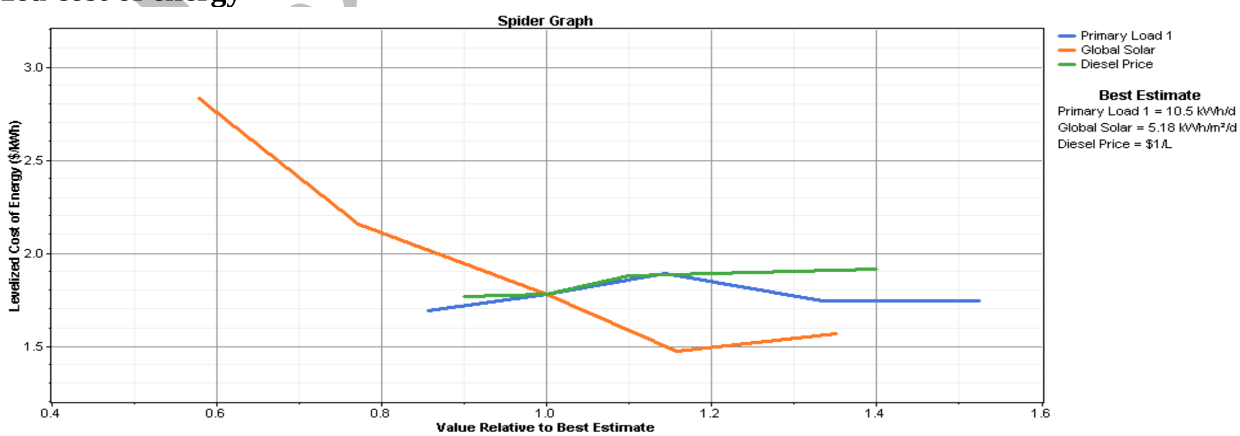

Figure 10: Levelized cost of energy

2. Total net present cost

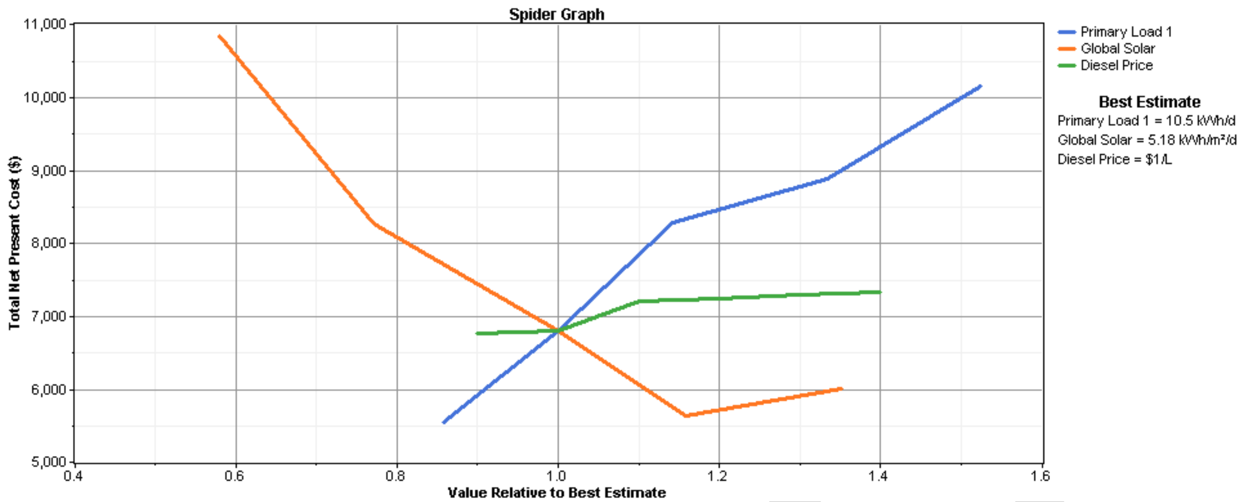

Figure 11: Total net present cost

3. Total capital cost

Figure 12: Total capital cost

4. Total annualized cost

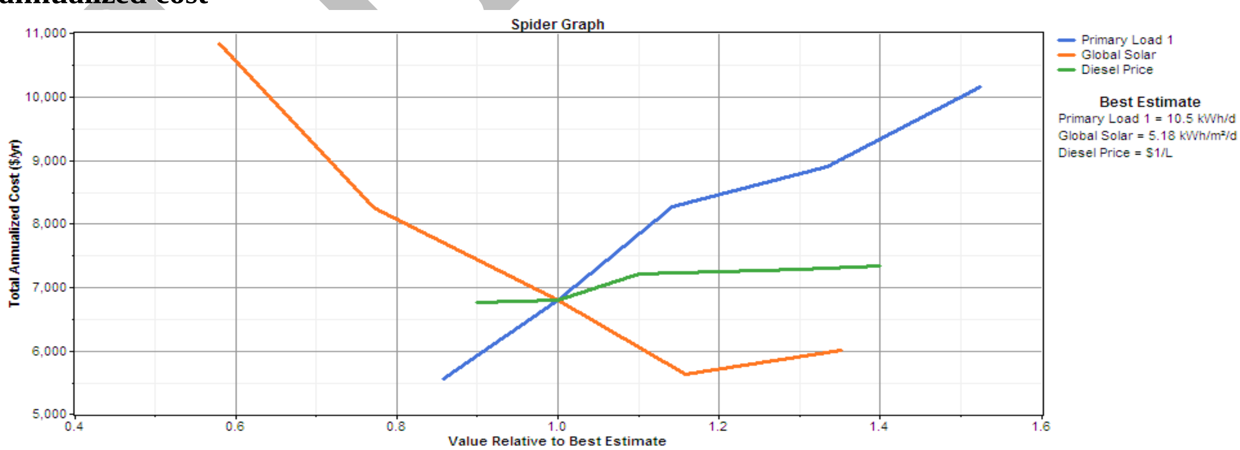

Figure 13: Total annualized cost

5. Total operating cost

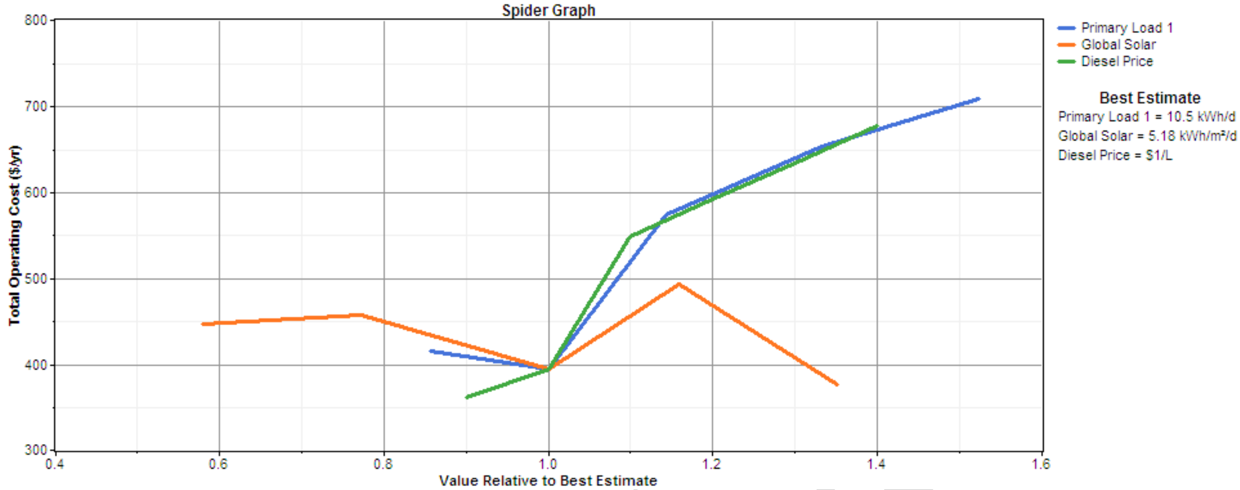

Figure 14: Total operating cost

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