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Self Learning II

Battery Analysis

Solar energy generation is generally at peak production while energy consumption is at its lowest, this problem can be fixed using battery storage. Storing energy produced in batteries allows for a reduction of energy waste and an overall efficiency increase for the system. The two main types of batteries used are lead acid and lithium batteries. There are several variations of each type of battery and determining the most cost effective battery for our system will be beneficial. System Advisory Model (SAM) has been an extremely helpful tool for production and financial analysis. SAM has its own sections for batteries that goes into high detail and the team plans to fully optimize the battery storage using SAM and RE-OPT Light.

The first step to optimizing battery storage was to determine the most cost effective type of battery for a 20 year PPA. This was done by researching the different types of batteries and their advantages and disadvantages. For the Solar District Cup the batteries must be cost effective, store a large amount and doesn't need to store energy for long. Based on our three most important criteria Lithium Ion are the optimal choice. Solar storage batteries have a useful lifespan of 5 to 15 years [1], this is perfect for changing the batteries after 10 years. The batteries will only have to be replaced one time during the 20 year period which is perfect for the PPA. Lithium Ion are expensive but have great efficiency and a long lifespan, which is important when charging and uncharging them daily.

After determining the Ideal battery I calculated the optimal amount of storage for the size of our system. The dirt lot has an average monthly generation of roughly 720,000 kWh, The optimal storage size was calculated to be 57,600 kWh [2]. Once the battery sizing is determined I found the average cost for lithium ion batteries in 2018 and prediction in 2025. The average capital cost in 2018 was 271 $/kWh and the power conversion systems cost was 288 $/kW [3]. The average capital cost in 20125 was 189 $/kWh and the power conversion system cost was 211 $/kW. The images below are the two financial analysis done on battery storage for the dirt lot in 2018 and with the rates of 2025.

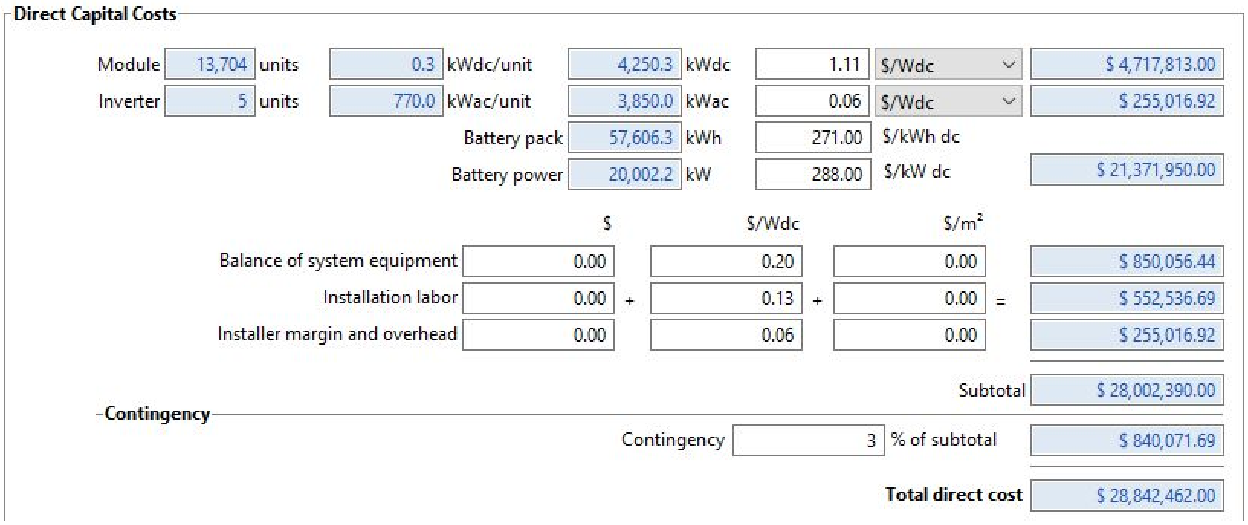

Figure 1. Direct Capital Cost 2018

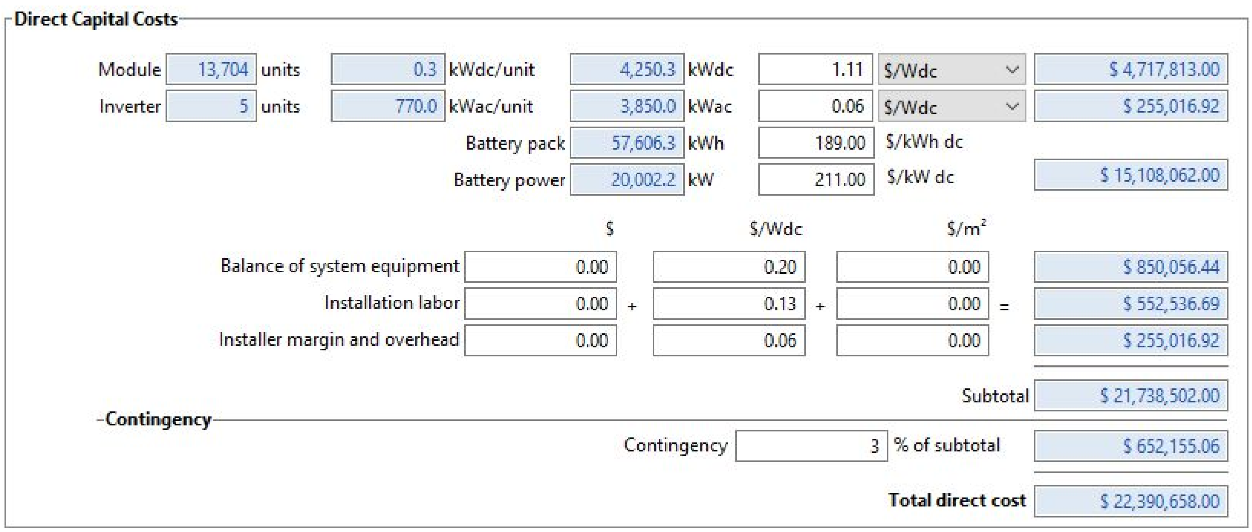

Figure 2. Direct Capital Cost 2025

The battery storage system is extremely expensive totalling 21 million dollars and the system without batteries was around 11 million. Even in 2025 the battery system isn't cost effective at least at this quantity. What could be done is an analysis on how much battery storage our system would actually need. In the Solar District Cup we are only given the usage data for 10 buildings. We can safely assume that our excess energy generation can be used for other buildings on campus. This would make batteries in our case almost completely unnecessary.

[1] "How to choose the best battery for a solar energy system," EnergySage, 16-Jan-2020. [Online]. Available:

https://www.energysage.com/solar/solar-energy-storage/what-are-the-best-batteries-for-solar-panels/. [Accessed: 24-Jan-2020].

[2] "Off-Grid Battery Bank Sizing," Solar Battery Bank Sizing Calculator | Size Off-Grid Batteries. [Online]. Available: https://www.wholesalesolar.com/solar-information/battery-bank-sizing. [Accessed: 24-Jan-2020].

[3] "Energy Storage Technology and Cost Characterization Report" U.S Department of Energy, July-2019, [Online PDF]. Available: https://www.energy.gov/sites/prod/files/2019/07/f65/Storage%20Cost%20and%20Performance%20Characterization%20Report_Final.pdf