Solar Generation and Battery Storage Modular System Feasibility Capstone

Graham Enns; Cole Leclair; Cole Sunderman; Alex Stanger-Seland;
Energy Engineering Students
Schulich School of Engineering, University of Calgary

ABSTRACT

•Feasibility study for a Solar Electric System
  •Sponsored by Seletech Electrical Enterprises Ltd.

•System designed for Seletech Warehouse

•5 Design Concepts Explored
  •0° Solar Panel Angle
  •10° Solar Panel Angle
  •47° Solar Panel Angle System (with 15kw Inverter)
  •47° Solar Panel Angle System (with 7.5kw Inverter)
  •70/25° Solar Panel Angle System(seasonal tilt)

•2 Design Layouts
  •1st does not include a battery storage
  •2nd includes battery storage

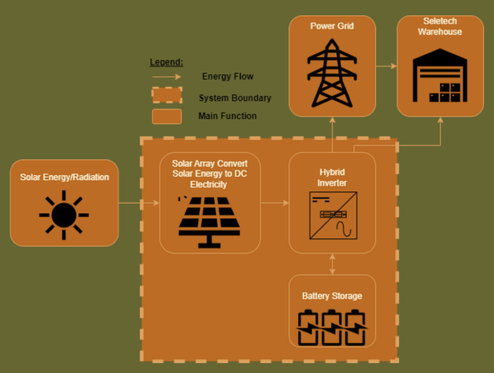

Figure 1. Block Flow System Design.

CONTACT

Thank you for reading the poster. For further question/clarification, please ask the team at the Design Fair or contact:

Graham Enns
Email: graham.enns@ucalgary.ca

INTRODUCTION

•Feasibility Study for a Commercial Solar Electric System
  • Designed for Seletech Warehouse
  • Desired to have the lowest payoff period
•Solar Simulations ran using SAM to find best solar panel, inverter and tilt option
  •5 Design Concepts Explored
    • 0° angle system
    • 10° angle system
    • 47° angle system (w/ 15kw Inverter)
    • 47° angle system (w/ 7.5kw Inverter)
    • 70/25° angle system (seasonal tilt)
  •Simulations Ran to find number of panels needed to reach yearly output for Seletech needs
  •Weather simulations ran to get most accurate results
    • Snow data
    • Shading Losses
•Battery Storage Explored
  • 60kW battery
  • Daily Simulations Ran
  • Saves on distribution and transmission charges from grid electricity
•Economics Ran on all system layouts
  •Sensitivities on distribution charge, energy price, transmission charge and energy production
•Goals
  •Obtain a low pay-off period (5-7years)
  •Like to have modular capabilities
  •Provide useful photovoltaic research for Seletech business decisions

METHODS AND MATERIALS

•Seletech Information
  •Vendor Pricing
  •Electricity Bills
•SAM (System Advisor Model)
  • Solar production simulation software from the US National Renewable Energy Laboratory
  •Simulations take in account numerous variables to give accurate electricity production data including type of panel, inverter, solar iridescence, cloud cover, sun angle, and temperature.
  •From this data we are able to calculate the yearly output and system size need to reach Seletechs needs
• Excel Economic Model
  • Sensitivities run a variety of variables
  • System most vulnerable to energy charge
• Excel Snow Data Model
  • Based off real world studies by NAIT and University of Calgary

RESULTS

•60kW Solar Electric System
  • Designed to reach Seletech electricity needs of ~90000kWh per year
  • 10° System with 15kW inverter
    • Solar Panel: LONGi Green Energy Technology Co. Ltd. LR5-72HBD-545M
    • Inverter: Fronius Primo 15.0-1208-240 [240V].
•Economics
  •Undiscounted Payoff Period
    • W/ no battery, ~10.3 years (~8.2 with tax credit)
    • W/ Battery, ~13.9 (~11.1 years with tax credit)
  •Sensitivities ran on
    • Energy charge, Variable Distribution Charge, Transmission charge, Energy Produced, Solar Panel Degradation, Cost of System, Local Access Fee, Carbon Credit Price, Battery Cost, Battery Size

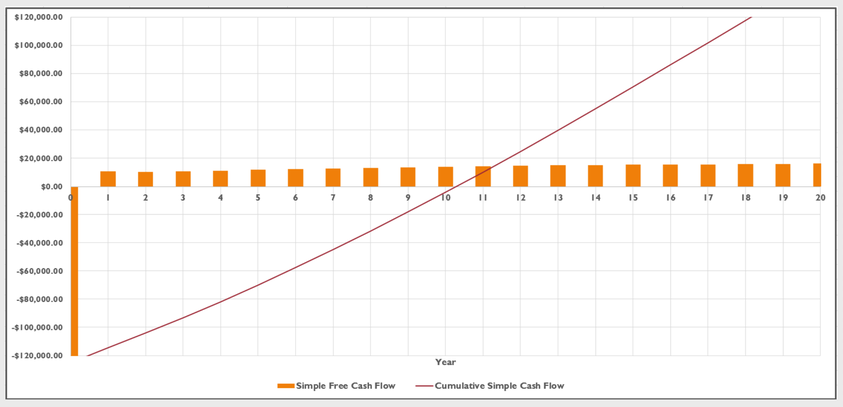

Figure 2. Simple Pay Back Period.

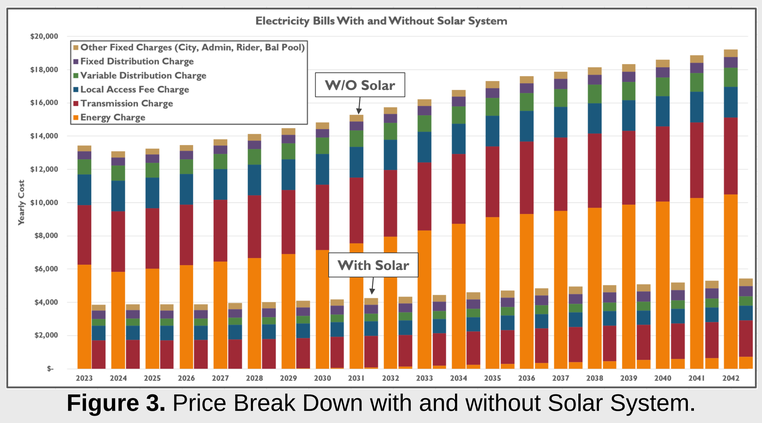

Figure 3. Price Break Down with and without Solar System.

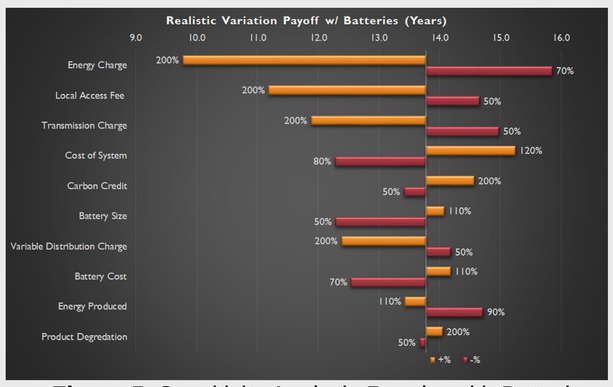

Figure 5. Sensitivity Analysis Results with Batteries.

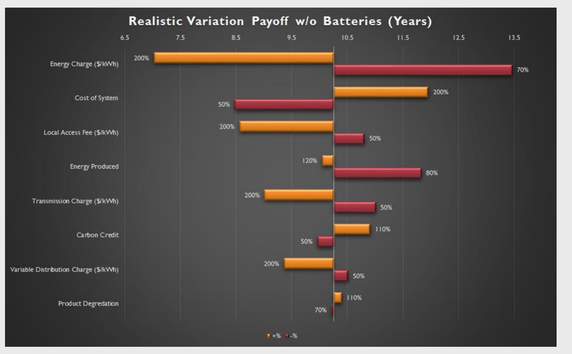

Figure 5. Sensitivity Analysis Results without Batteries.

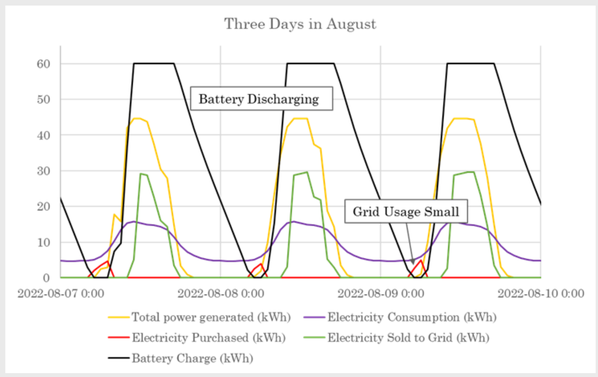

Figure 6. Battery Usage Example.

DISCUSSION

•Equipment Selection
  •Selected based on the size of system that was being recommended and cost.
  •Equipment specs deferred based on the system that was being tested
  •Equipment costs changed depending on the system setup
  •Batteries are still very expensive making it hard to recommend in final solution unless they are required
  •For a reliable system, high warranty components were chosen
•Weather
  •The single most important factor in the analysis.
  •Weather is hard to predict so data was collected from the past to help with analysis
  •Snow data can shift production massively
  •Sensitivity is a must as future weather cannot be predicted
•Electricity
  • Biggest competitor for solar energy is Enmax
  • Is it better to switch to solar or stick with grid electricity?
  •Seletechs electricity bill utilized to help determine the proper system
•Incentives
  •Municipal, Provincial, and Federal incentives were researched
  •Only incentive applicable for a commercial setting are tax right offs

CONCLUSIONS

•Payoff Period
  • W/ no battery, ~10.3 years (~8.2 with tax credit)
  •W/ Battery, ~13.9 (~11.1 years with tax credit)
•Recommendation
  •For immediate action
    • 10° angle system with 15kW inverter
    • No battery storage unless absolutely needed (off-grid situation)
  •To implement in the future
    • Continue to wait for price decreases on solar equipment
    • Wait for better incentives for commercial aspect

REFERENCES

1. T. Matthews, "Solar Photovoltaic Reference Array Report," NAIT, 2015
2. D. W. Oksana Treacy, "Performance monitoring of a 60 kWphotovoltaic array in Alberta," University of Calgary, Calgary, 2019.
3. National Renewable Energy Laboratory, "System Advisor Model (SAM)," National Renewable Energy Laborator, [Online]. Available: https://sam.nrel.gov/. [Accessed 6 December 2022].