Jamestown S'Klallam Tribe - Community Resiliency Center Microgrid Design

Students: Vanessa Affandy, Aimee Phung, Cody Young

Objective

- The Jamestown S'Klallam Tribe wants to implement a microgrid system on their social and community services building (SCS). The Tribe is currently being supplied by a local utility, with a backup diesel generator for outages.
- A microgrid system would increase the duration of backup power during a power outage, while reducing the tribe's carbon footprint and their overall dependency on non-tribal entities to promote tribal sovereignty.
- Our project is a feasibility study on the design and economics of the microgrid.

Requirements

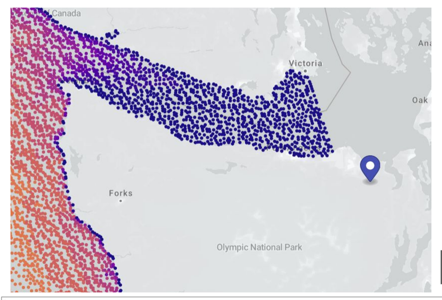
The requirements of the project include:

- Preserve the appearance of tribal architecture and artwork in the design process for solar panel and battery locations.
- Support critical loads for at least 7 days in the occurrence of an emergency or long-term power outage.
- Reduce the carbon footprint of the SCS building.

Renewable Energy Research

Hydro power

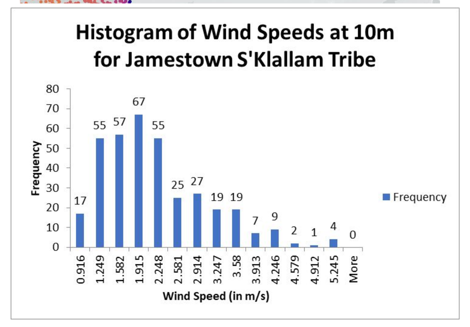
- Due to the tribes reliance on nearby streams and their advocating for ecological wellness, we have decided to not implement hydropower into our design as this could damage the nearby ecosystems they are reliant upon.
- Additionally, the marine energy map indicates a dearth of wave power within the designated area.



[1]

Wind Power

- Wind was not viable, as the wind speeds[7] in the area were very low.
- Using the Freedman-Diaconis rule on NASA's wind speed data for the area, we generate this histogram:



Solar Power

- As you can see based on the graphic from the global solar atlas, this location has a higher PV potential than nearby locations. Meaning out best choice out of the available choices is solar power.

[2]

Load Data Analysis

The depicted plot (Fig. 1) demonstrates a discernible surge in the building's load during the winter months, while the observed characteristics and numerical values remain relatively consistent across the years, undeterred by:

- Weekend vs. weekday operations
- The COVID-19 pandemic

It is inferred that the building's equipment operation has been consistent, meaning heating and cooling are the main variables in the load.

Load Data Analysis

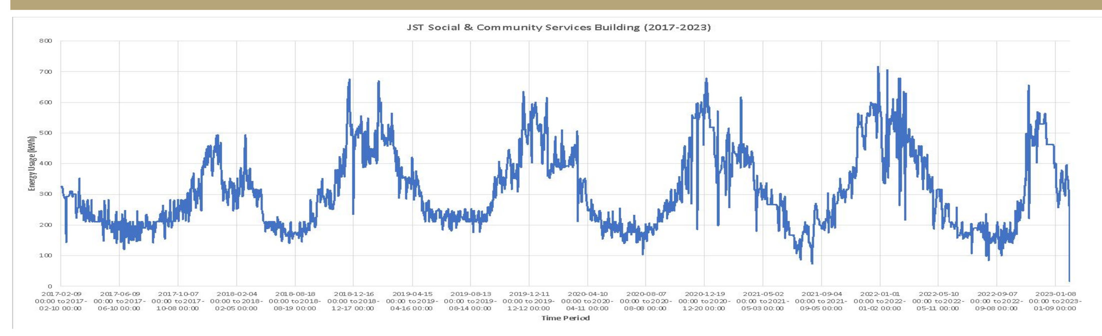


Fig. 1 - The graph presented above illustrates the daily load profile of the SCS building from 2018 to 2022.

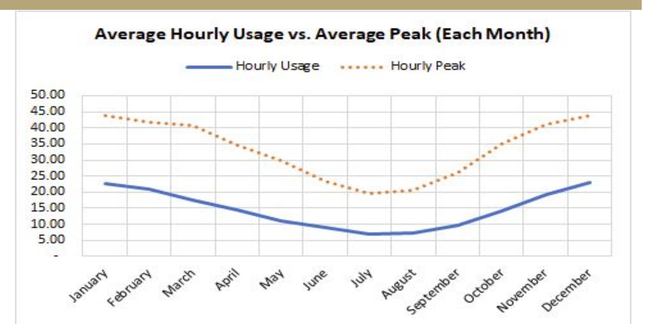


Fig. 2 - Ave. Hourly Usage vs. Ave. Peak each month

Hourly Load Profile Model

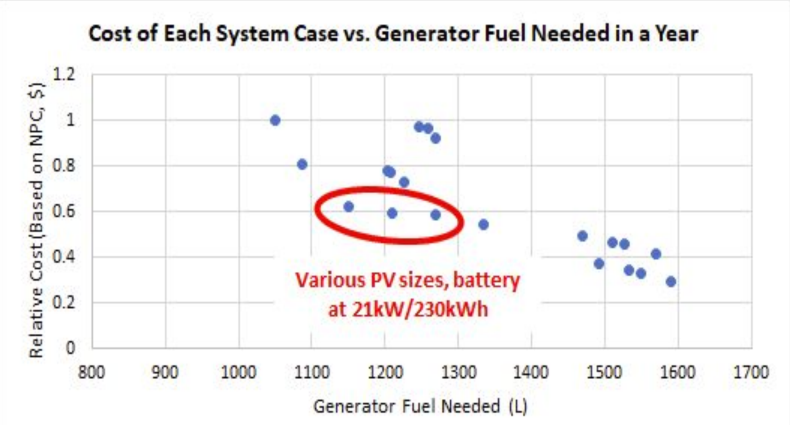
Shown in Figure 2, our findings reveal that the SCS building exhibits a distinct hourly energy consumption pattern:

- Winter months: ≈20 kW, peaks at ≈40 kW
- Summer months: ≈8 kW, peaks at ≈20 kW

Microgrid Sizing

Through the simulations of our system utilizing HOMER, with the potential PV sizes, employing a 21 kW/230 kWh battery:

- Accommodates typical load
- Reduces daily peak load
- Diesel generator only operates in the case of a one-week-long winter outage



Implementation; Site Selection and Generation

Location	System Size	Yearly Generation (% of Total Load)
Wing C - Southeast facing roof of the west SCS Building	13 kW	12.5%
Wing A - Southeast facing roof of the east SCS Building	7 kW	7%
Area south of the SCS Building, north of the Drain Field	28 kW	27.5%
Combined - Total PV System	48 kW	47%

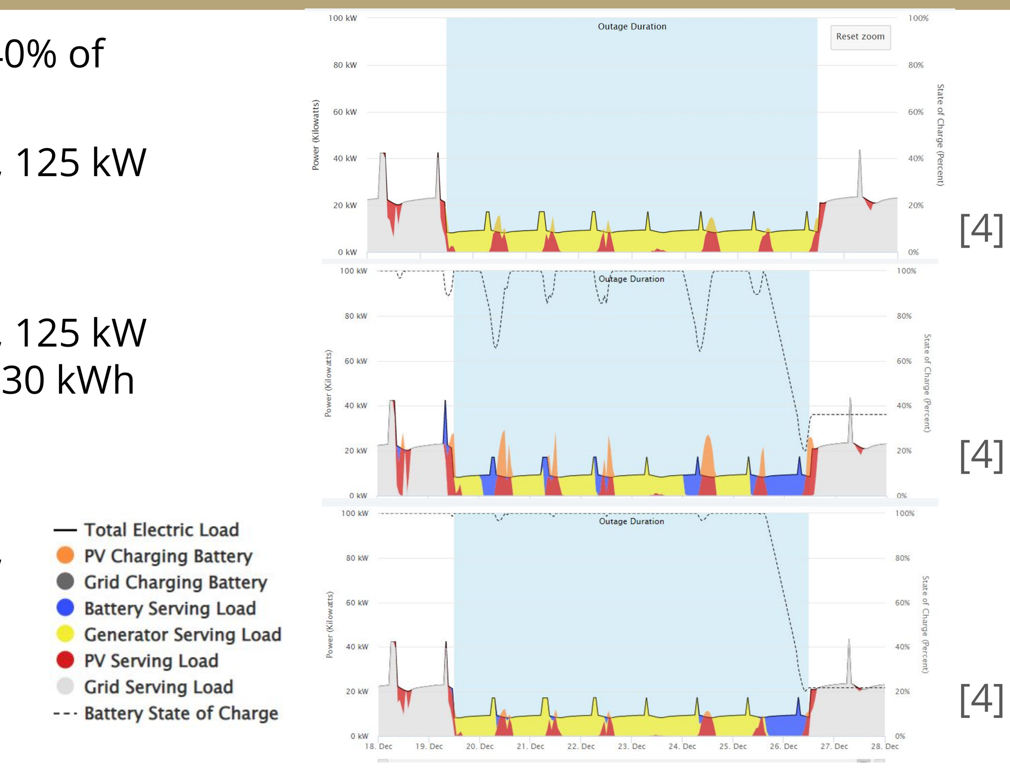
Wing C [3]

Wing A [3]

South Field [3]

Results - Design cases and System Scheduling

- Outages at critical load (40% of total load)
- Case 1: 48 kW PV System, 125 kW Generator, no Battery
- Case 2: 48 kW PV System, 125 kW Generator and a 21 kW/230 kWh battery system
- Case 3: 20 kW PV System, 125 kW Generator and a 21 kW/230 kWh battery system



Results - Economics

The table below compares the economics of two PV system sizes (at full load during a typical year) that will be considered for the tribe's microgrid:

	System Size					
	20 kW					
% Grant Funded	0%	50%	80%	90%	100%	
LCOE (real)	133.84	111.03	97.38	92.84	88.23	₵/kWh
NPV (25 yrs)	-746,934	-606,335	-522,171	-494,189	-465,755	$
Net Savings (yr 1)	2,178	2,178	2,178	2,178	2,178	$
	48 kW					
% Grant Funded	0%	50%	80%	90%	100%	
LCOE (real)	66.95	53.99	46.24	43.67	41.03	₵/kWh
NPV (25 yrs)	-768,102	-591,161	-485,454	-450,386	-414,265	$
Net Savings (yr 1)	4,293	4,293	4,293	4,293	4,293	$

Numbers used in calculations were derived from NREL 2021 and 2022 studies [5][6].

Conclusions, Future Work and References

Conclusions:

- We recommend that the Tribe selects Case 2: 48 kW PV System with a 21kW/230kWh battery system.
  - The system will provide the most resiliency for the cost but still falls under all requirements for the microgrid given by the Tribe's representative.
- Future work on this system will include a detailed work given high frequency data collected from the SCS building.
- Measurement of angle of roofs and land where PV panels will be installed for detailed solar report.
- Discussion with utilities to discuss system to grid connection.

References

[1] NREL. *Marine Energy Atlas.* [Online]. Available: https://maps.nrel.gov/marine-energy-atlas/
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[5] The National Renewable Energy Laboratory , "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021." U.S. Department of Energy, Denver, Nov. 2021
[6] The National Renewable Energy Laboratory, "2022 electricity ATB Technologies and Data Overview," ATB, https://atb.nrel.gov/electricity/2022/index (accessed May 22, 2023).
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ADVISER: Daniel T. Schwartz, Bosong Li
INDUSTRY SPONSOR: Jamestown S'Klallam Tribe, Robert Knapp (Representative)

A special thank you to our sponsor, advisers, and mentors!