# RESILIENT POWER FOR JEFFERSON COUNTY EMERGENCY MANAGEMENT, SHERIFF, AND 911 CENTER

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Jefferson County Washington

## Jefferson County's Resilience Problem

- Jefferson County is located on the Olympic Peninsula, making it vulnerable to natural disasters.
- In the event of a natural disaster, Jefferson County could be without power for up to a year according to FEMA.
- A Microgrid would allow the critical loads of the Emergency Management, Sheriff, and 911 Center to remain active in the case of total power outage.

Figure A: Map of Jefferson County Department of Emergency Management Offices. Boxed area is the microgrid location.

## Microgrid Requirements

- The Microgrid needs to be able to supply power to all of the critical loads in the event of a full blackout.
- In the case of these facilities, the critical loads account for a substantial amount of the load since almost all the centers are essential.
- To accomplish this the Microgrid must be fully operational off-grid, requiring batteries that can sustain the facilities under different solar availability circumstances.

## Load Profile Analysis

- Jefferson County provided us with their utility electric bill for analysis. Based on the site visit, we were able to record the types of equipment connected to the electrical system. The information helped us create a load profile of the site.
- We separated the load profile into ventilation systems, residential kitchens, water heating, commercial washer/dryers, commercial kitchen, heating, and lighting
- The number of people incarcerated influences the load profile because the ventilation and heating is changed depending on the number of people in the county jail.
- Winter months has a larger load profile than Summer months because of the heating load shown in Figure B.

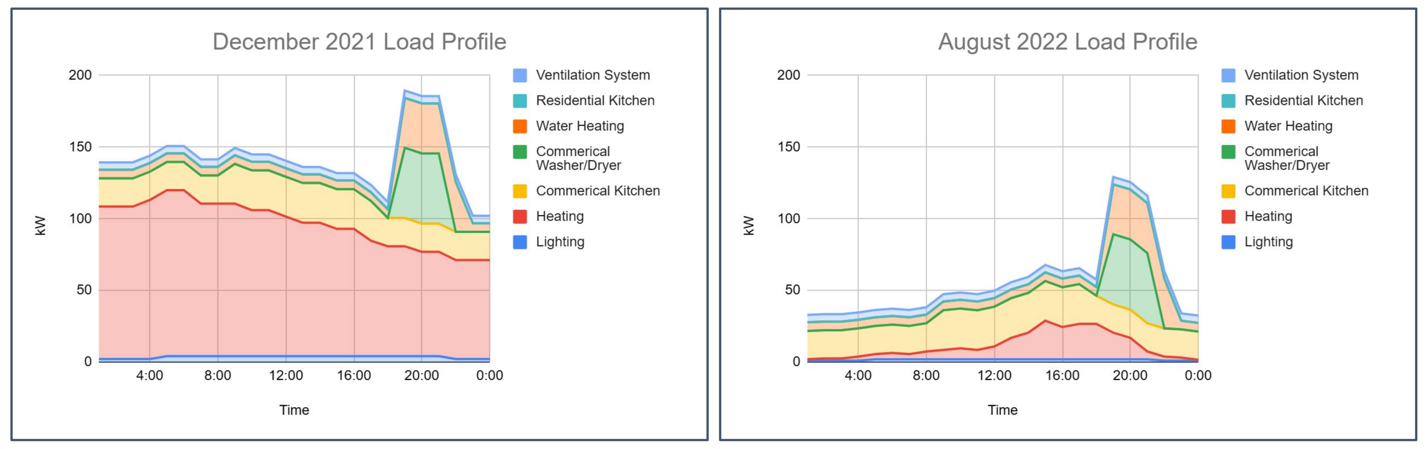


Figure B: Load Profiles for December 2021 and August 2022

## Simulation Analysis

- After inputting the load profiles to REopt and SAM, we were able to get the sizing of the microgrid from REopt. The simulations provides us with the sizing of the PV, battery's power, and the battery's capacity shown in Table 1. The site already has an operating diesel generator.
- REopt has the ability to schedule the system. The following figures C to F show the system being scheduled for a 1-week outage.
- The schedules show that during an outage, the system will recharge the batteries whenever the system produces more than the demand. Then, discharges during the time when the PV system cannot meet the demand. Also, the system predicts when there isn't enough sunlight shown in the second half of the outage. Therefore, the generator will turn on to cover the load.

| 1 Week Case Scenario | | | | |
|---|---|---|---|---|
| Critical Load | PV Size (kW) | Battery Power (kW) | Battery Capacity (kWh) | Project Cost |
| 100% | 560 | 290 | 4875 | $8,012,354 |
| 75% | 420 | 217 | 2572 | $5,089,310 |
| 50% | 245 | 121 | 828 | $2,449,534 |
| 25% | 29 | 27 | 100 | $309,064 |

Table 1: The system sizing of the 1-Week cases. The size of the critical load influences the size of the system itself.

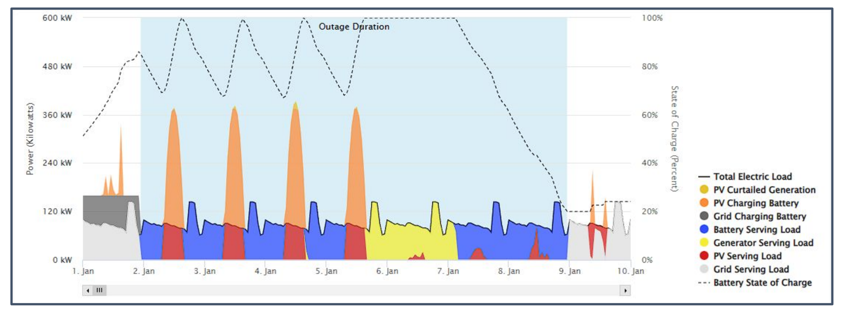

Figure C: 100% Critical Load

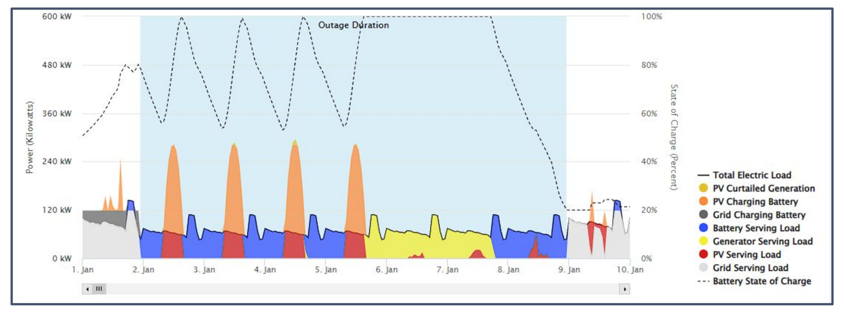

Figure D: 75% Critical Load

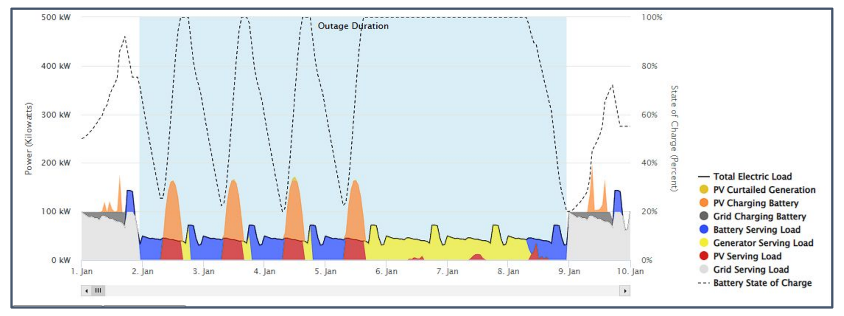

Figure E: 50% Critical Load

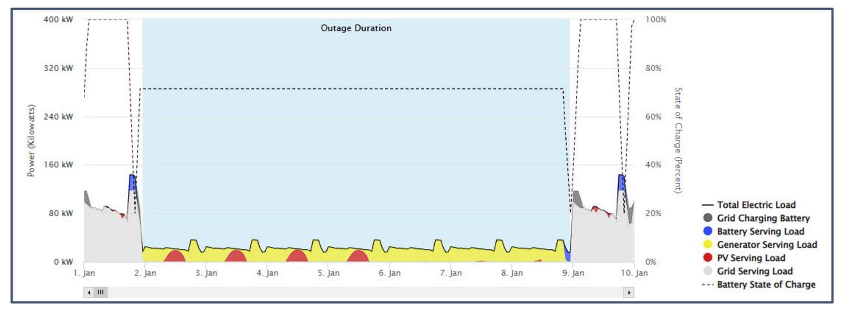

Figure F: 25% Critical Load

- For normal operations, Figure G shows the Summer operations and the Winter operations for a 100% critical load system.
- Because Washington State allows Net Metering for systems below 100 kW, the system will curtail some of the production during the Summer operations due to the system being larger than 100 kW. However, the system can act by itself without the need of the main grid.
- The Winter operations shows that the main grid is still serving the load but the battery and the PV system helps lower the amount the grid serves the load.

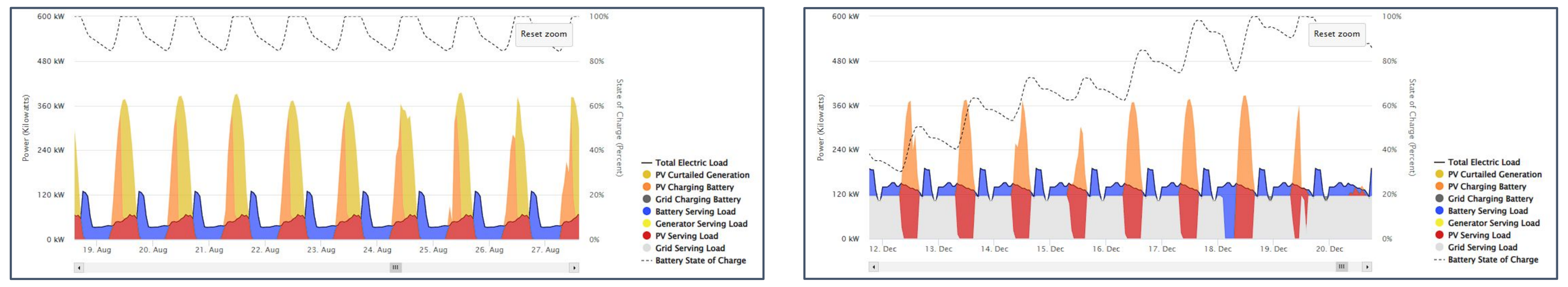

Figure G: Normal Summer Operations (Left) and Winter Operations (Right)

## Techno-Economic Analysis

- We were able to perform a techno-economic analysis of the system by combining the information from REopt, NREL's research, and SAM. The results contain information such as O&M of each system [1], project cost [2], labor/permitting cost, fuel cost, and sales tax.
- To perform a net present worth analysis, we took the US inflation rate which was 5%. The electrical escalation rate was 4% based on electricity cost in Jefferson County [3].
- The following analysis assumes a 25 year lifecycle.
- The project assumes that the county will be able to attain grant money that will cover majority of the project cost. Therefore, the graph analyzes the NPW based on 0%, 100%, 90%, and 80% cost funded shown in Figure H.
- The smaller project (25% Critical Load) does not provide a positive net present value due to the cost of the O&M and the savings earned from the power generated.
- Table 2 shows the NPW of the projects.

| SAM w/ Gen O&M | | | | | |
|---|---|---|---|---|---|
| Critical Load | 0% Grant | 100% Grant | 90% Grant | 80% Grant | Minimum % Grant |
| 100% | -$4,888,782 | $1,389,106 | $761,317 | $133,528 | 77.87% |
| 75% | -$2,772,378 | $1,215,229 | $816,468 | $417,707 | 69.52% |
| 50% | -$1,260,936 | $658,337 | $466,409 | $274,482 | 65.70% |
| 25% | -$257,363.00 | -$15,203 | -$39,419 | -$63,635 | N/A |

Table 2: NPW of the different designs

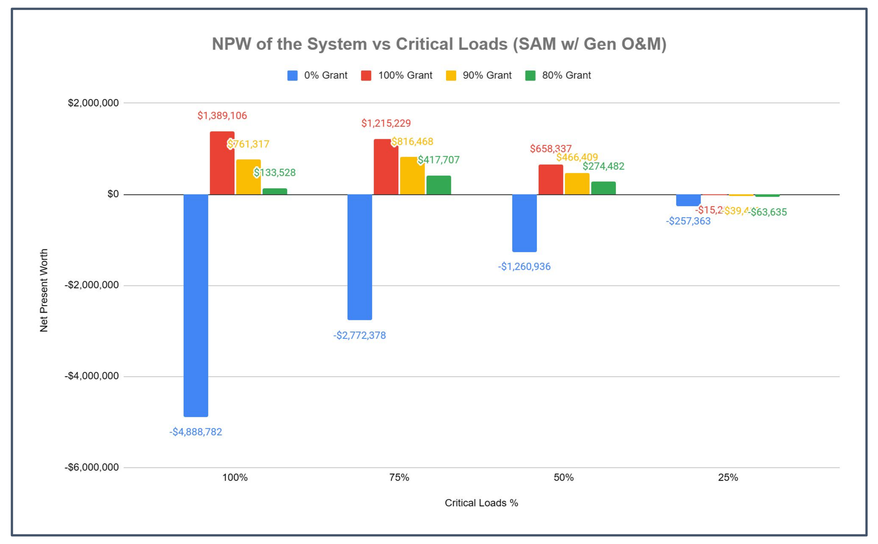


Figure H: Net Present Worth graph of the 4 different critical load levels.

## Conclusion and Future Work

- This project shows the benefits of building a microgrid based on the critical loads. The project would most likely be funded with grant money. The benefits of having these systems is that the site can last for at least one week of no power from the main grid.
- For future work, we would like to have in-depth analysis of the critical loads. We would like to find the percentage of loads that can be shed during an emergency.
- Additionally, we would like to research further into improving the energy efficiency of the offices and jail as this would decrease the demand for electricity. The result would be a smaller, cheaper system that can still be resilient to outages in Jefferson County.
- In the future, we hope that our work can be a starting point for Jefferson County to build a fully capable Microgrid on their facilities.

## References and Acknowledgments

**Faculty**: Bosong Li, Daniel Schwartz

**Students**: Vanessa Affandy, Evan Bowman, Wesley King, Aimee Phung, Sophia Votava, Cody Young

[1] "2022 Electricity ATB Technologies and Data Overview." *ATB*, atb.nrel.gov/electricity/2022/index. Accessed 22 May 2023.

[2] *The REOPT Web Tool User Manual - NREL*, reopt.nrel.gov/tool/reopt-user-manual.pdf. Accessed 22 May 2023.

[3] "Rates for Electricity." *JPUD*, 5 July 2022, www.jeffpud.org/rate-schedule/.

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