MODELING UW CAMPUS AND BATTERY DESIGN AS FLEXIBLE LOAD

GE VERNOVA

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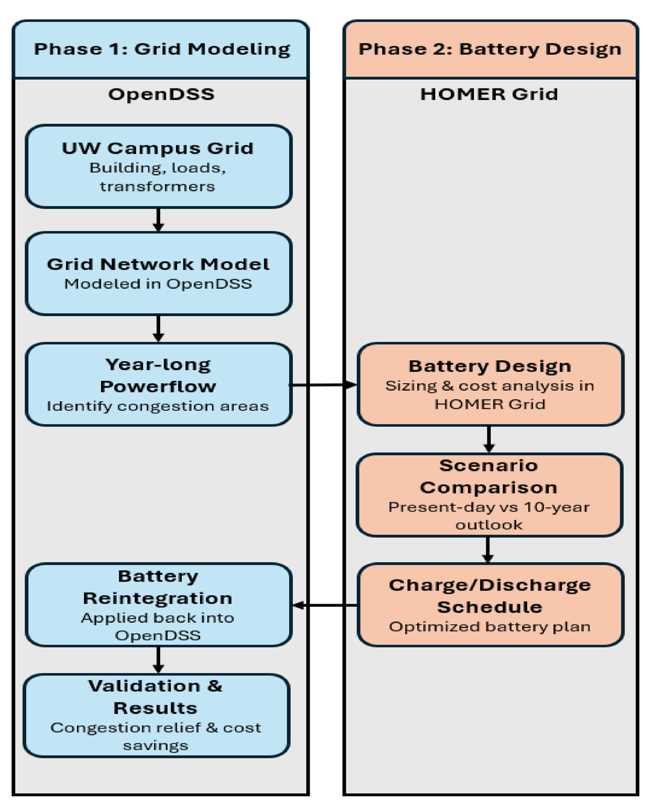
Introduction

- Electrical demand on the University of Washington Seattle campus varies throughout the day, creating changing load conditions across the distribution system.
- Peak demand periods can lead to congestion on campus feeders and higher loading on equipment.
- Peak demand also drives higher electricity costs, creating an opportunity for cost savings through better load management.
- Climate-driven reductions in mountain snowpack are expected to decrease regional hydropower output, increasing electricity costs and the value of on-campus battery storage.

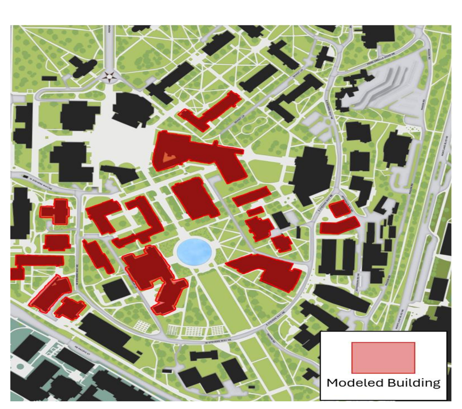
Project Overview

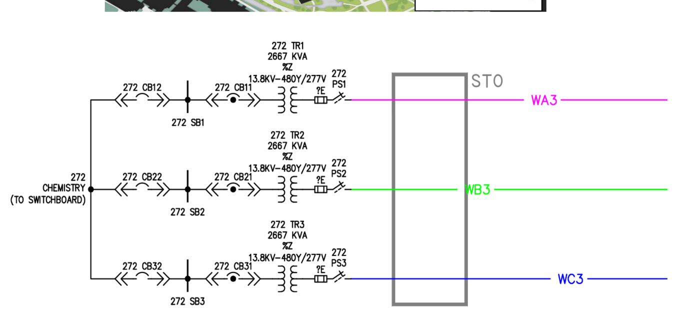
- Model the UW campus distribution system in OpenDSS, including feeders, transformers, and building loads.
- Perform a yearly time-series power flow analysis to identify peak demand periods and potential congestion.
- Design a Battery Energy Storage System (BESS) using HOMER Grid for optimal sizing and cost analysis.
- Compare battery economics under present-day and projected 10-year tariff scenarios.
- Apply the optimized charge/discharge schedule back into OpenDSS and evaluate peak shaving and cost savings.



Modeling Assumptions & Parameters

- Network modeled in OpenDSS as a 13.8 kV distribution system, including feeders, transformers, and building loads, based on the UW campus one-line diagram.
- Underground feeder parameters taken from the Southwire SPEC 464 datasheet, matching the actual cables installed on campus.
- 18 loads modeled across 19 campus buildings.
- Load sizes estimated as (# of transformers) x (rating) x (de-rating factor 0.3-0.7) x (pf 0.9), adjusted for redundant configurations.

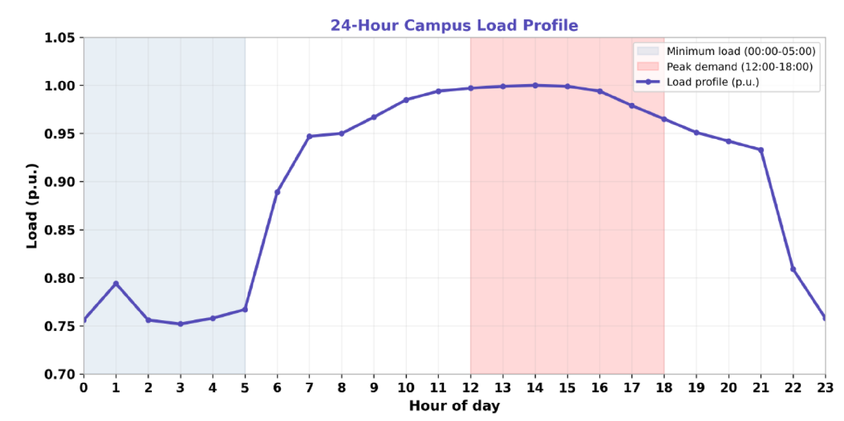




CHEMISTRY BUILDING

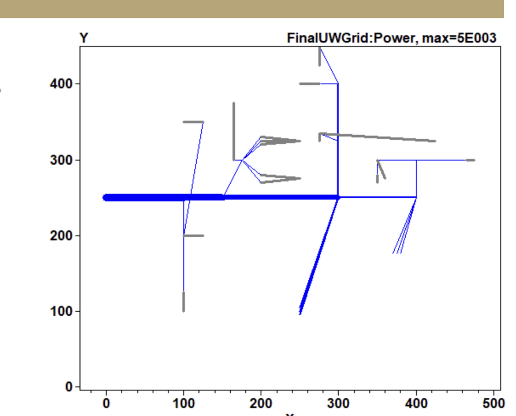
Load Shape Modeling

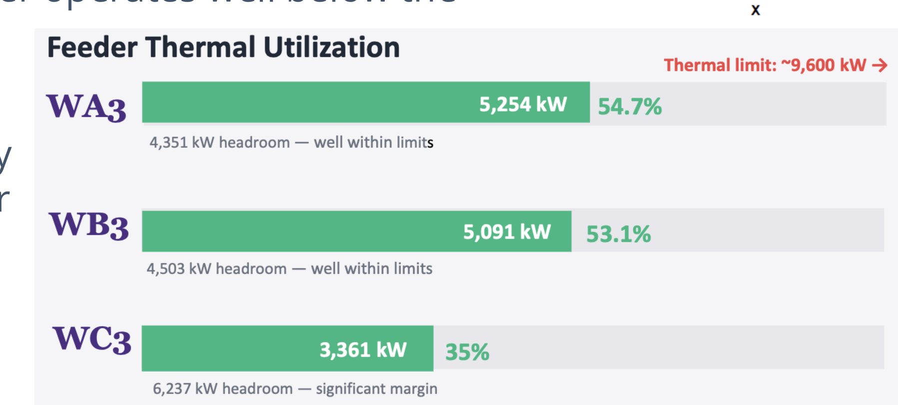
- Load shape based on annual CSE building consumption data and applied to all 18 modeled loads using a 24-hour normalized profile with 1-hour resolution (8,760 data points).
- Peak demand occurs from 12:00–18:00, with minimum load from 00:00–05:00.



Power Flow & Peak Demand Analysis

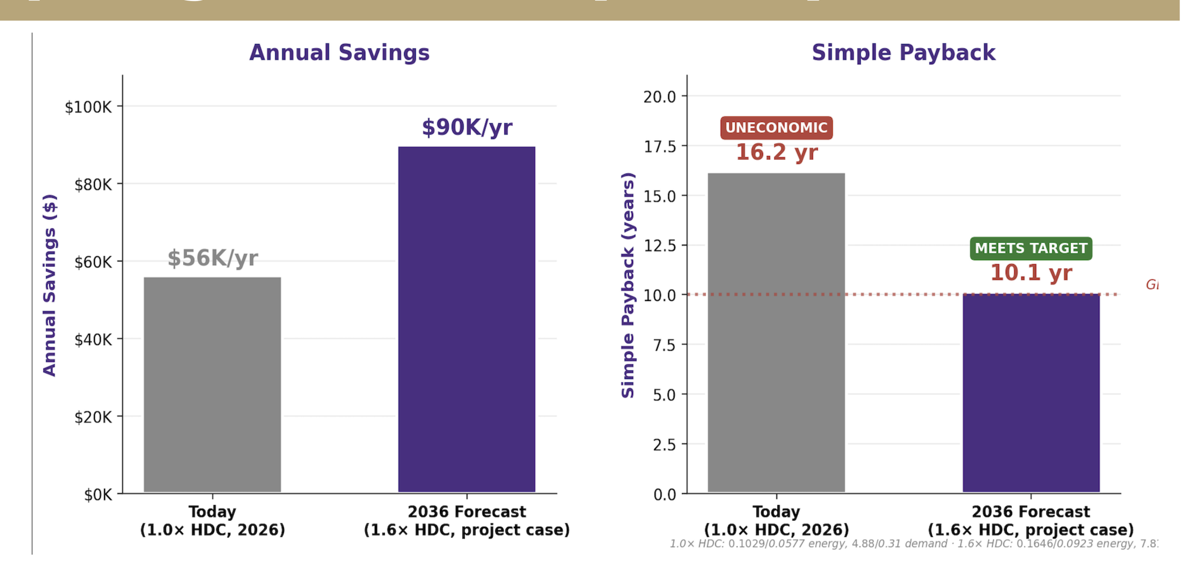
- Ran an 8,760-hour time-series power-flow simulation in OpenDSS to capture campus load behavior across the full year.
- Annual load varied from 0.75 to 1.00 p.u. — strong weekday-daytime peaks against a flat overnight valley, typical of a research university.
- WA3 is the largest feeder (5,254 kW peak), followed by WB3 (5,091 kW) and WC3 (3,361 kW), but every feeder operates well below the ~9,600 kW cable thermal limit.
- No congestion exists today — so the BESS is for peak shaving against monthly demand charges, not for relieving feeder stress.





Battery Design & Scenarios (HOMER)

- HOMER Grid sized the optimal BESS for the WT4 substation under both today's and 2036's high-demand-charge (HDC) tariffs.
- Optimum design: **5 MWh lithium-ion** (5 × 1 MWh modules) at **525 kW symmetric** charge/discharge.



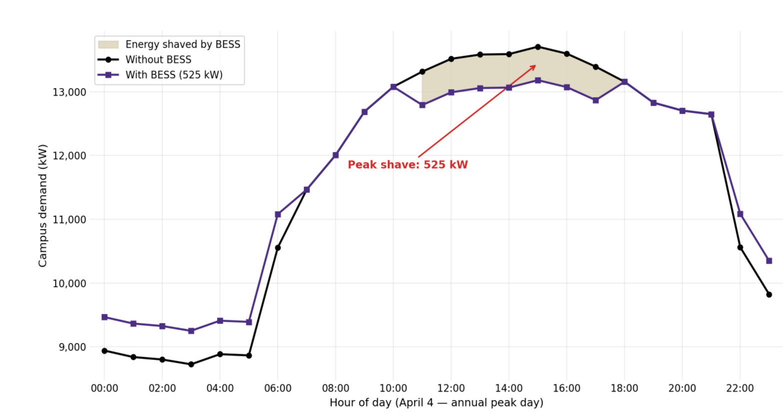
Component	Price	Install Size	Total Installed Cost	Annual Expenses
Generic 1 MWh Li-Ion	$182,000 / ea	5 ea	$910,000	$5,000 / yr

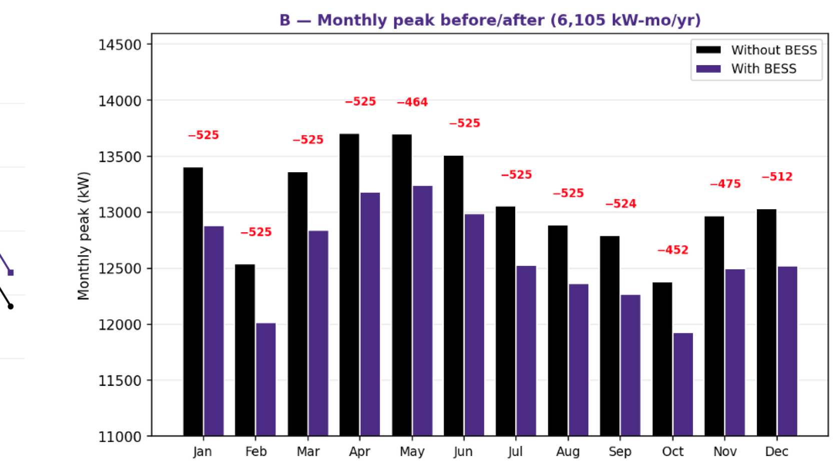
- Two tariff scenarios evaluated: **today** (1.0× HDC) and **2036** (1.6× HDC, with 2 % annual inflation per the SCL Strategic Plan).
- At today's rates: **~$56 K/yr** savings → **16.2-year payback** — uneconomic.
- At the 2036 forecast tariff: **~$90 K/yr** savings → **10.1-year payback** — meets GE Vernova's target.

Battery Operation & Results

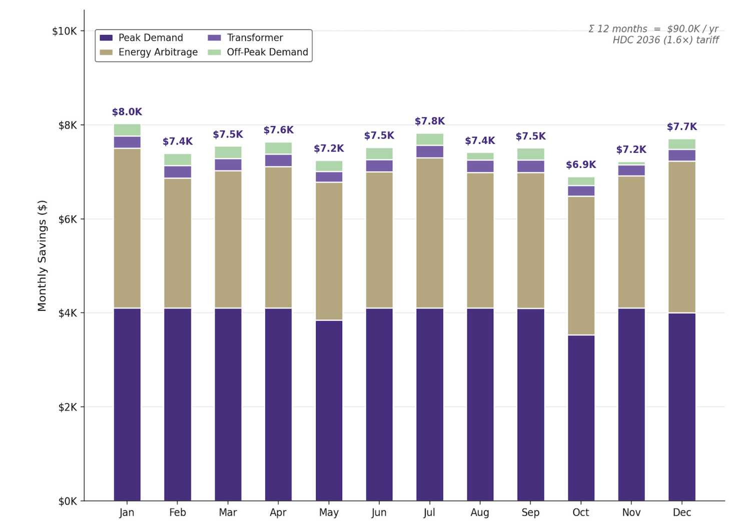
Results shown for the projected 2036 tariff scenario

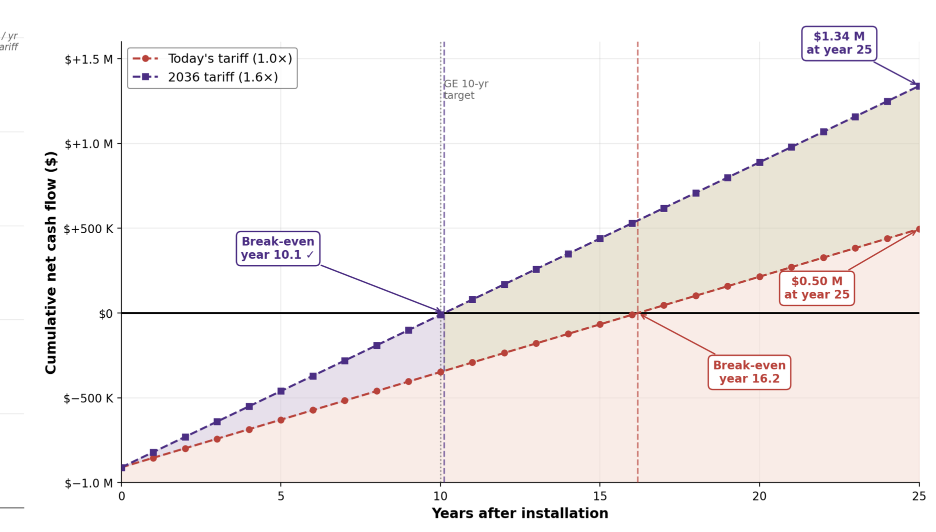
- The battery operates as a peak-shaving system, dispatched on a daily 7-hour discharge / 10-hour charge cycle.
- During low-demand hours the battery charges; during high-demand hours it discharges.
- Consistent monthly peak reductions achieved across all 12 months, totaling 6,105 kW-mo/yr.





- By year 25, the battery is projected to generate $1.34 million in savings under 2036 electricity tariff rates.
- At today's rates the battery is not yet economic, but rising Seattle City Light electricity rates over the next decade are what make the investment worthwhile.





Conclusion & Future Work

Our work has shown that:

- At today's electricity rates, the battery does not offer strong financial returns.
- Rising electricity costs make the 10-year scenario significantly more attractive in payback and cost savings.
- Savings come from lower peak-hour energy costs and reduced monthly demand charges.

The next steps for this project are:

- Expand the model to include more campus buildings and incorporate real building load data.
- Add campus solar generation and evaluate additional long-term operating scenarios.

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