



MODELING UW CAMPUS AND BATTERY DESIGN AS FLEXIBLE LOAD

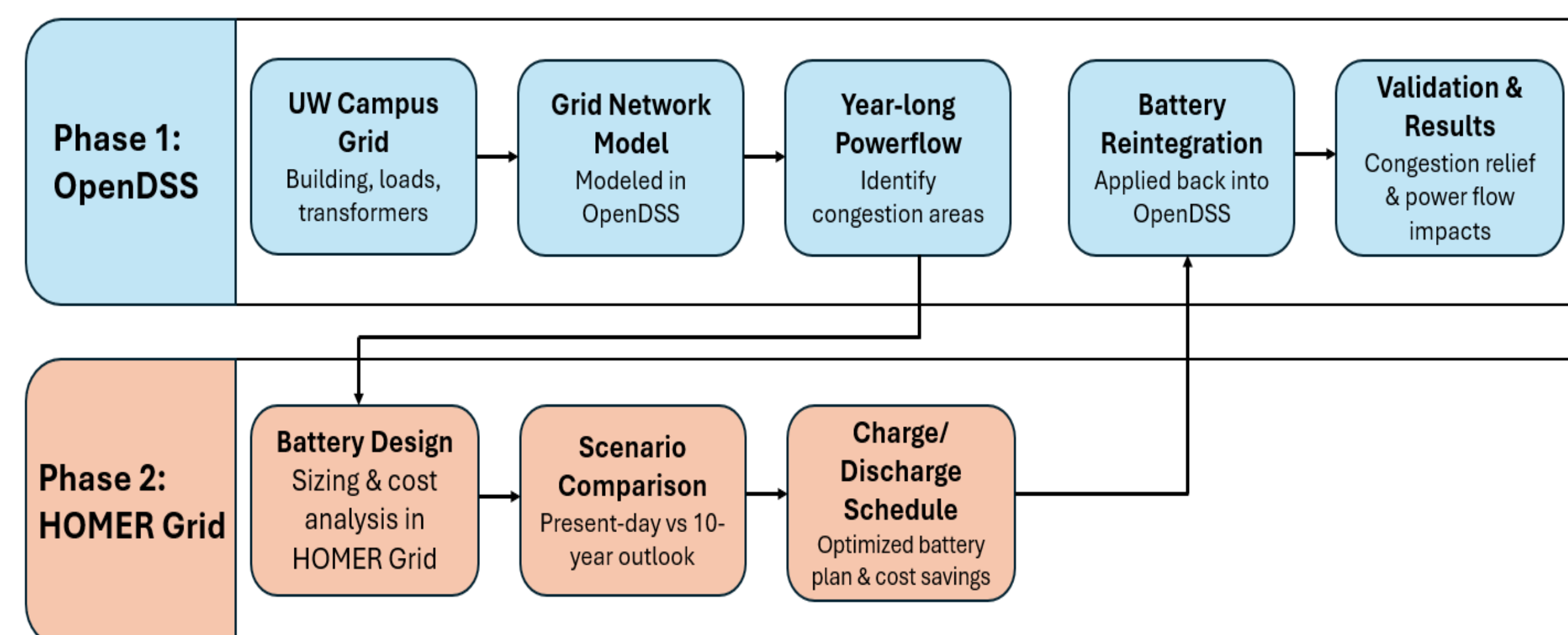


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Introduction

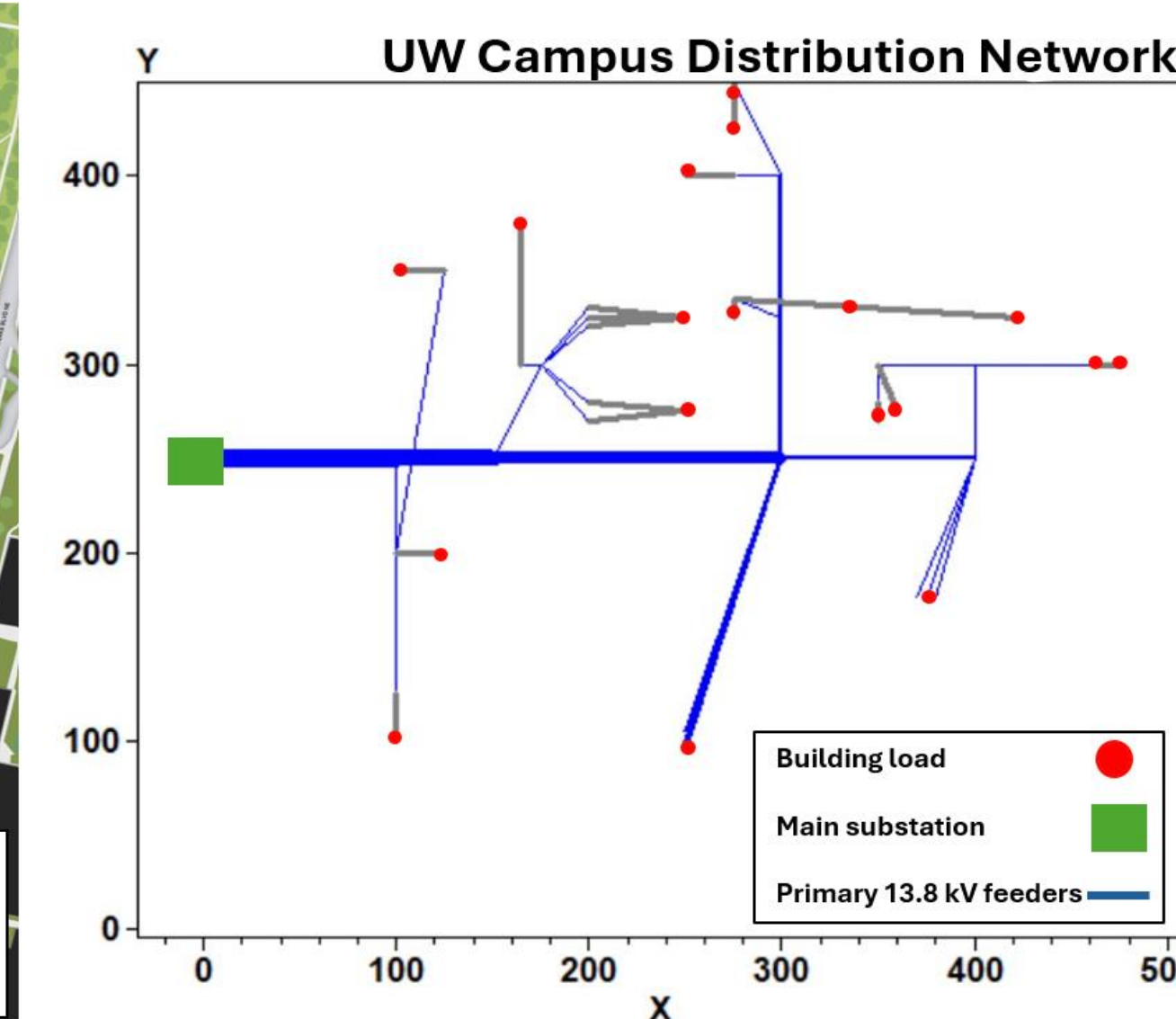
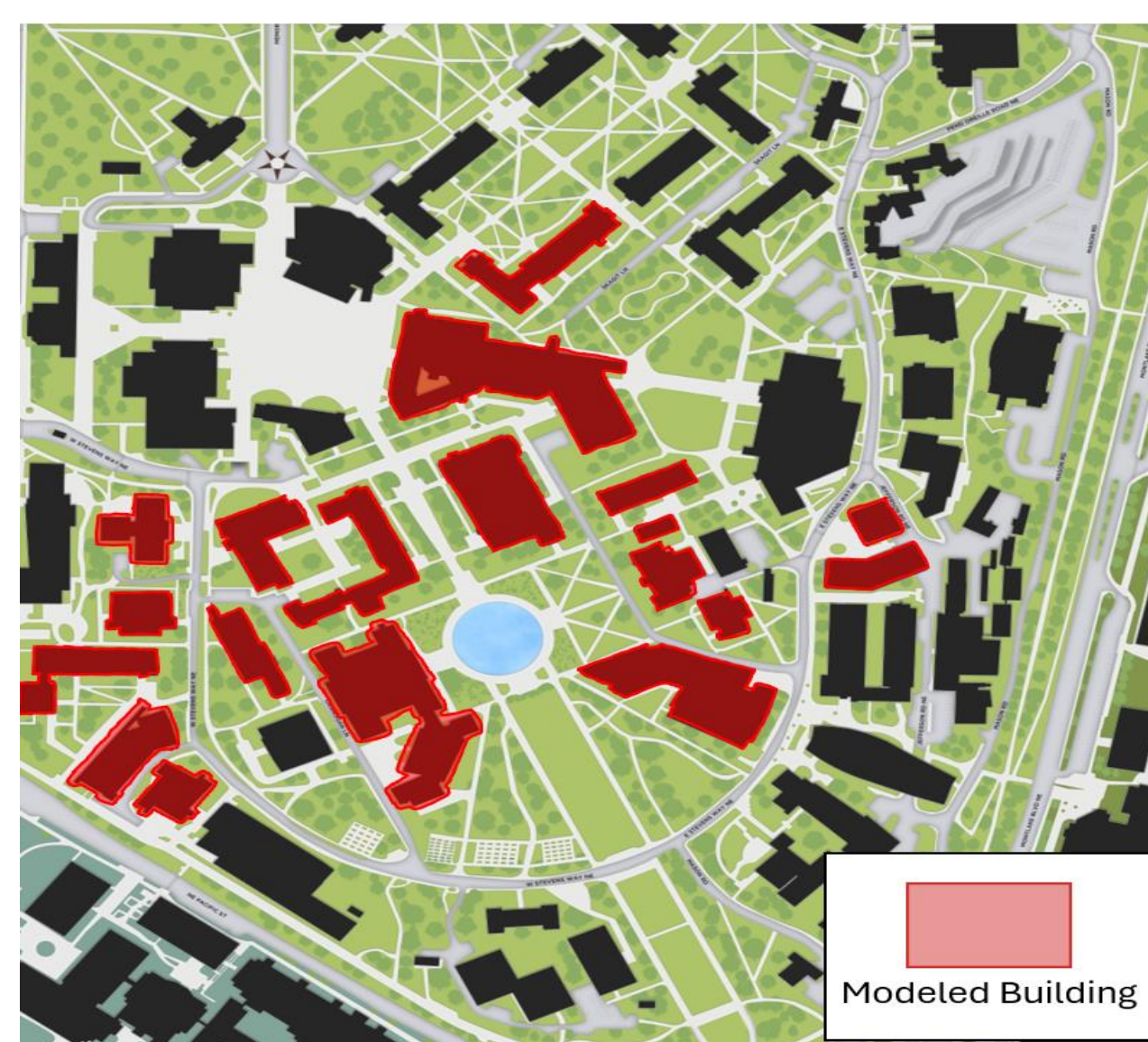
- Electrical demand on the University of Washington Seattle campus changes throughout the day, resulting in time-varying power flow conditions across its distribution system.
- Peak demand periods can lead to congestion on campus feeders and cause thermal stress on electrical cables and switchgear.
- Peak-period energy rates are up to 2x higher than off-peak rates, creating an opportunity for cost savings through better load management.
- Climate-driven reductions in hydroelectric power output and increasing electricity demand may further increase regional electricity prices.

Project Overview



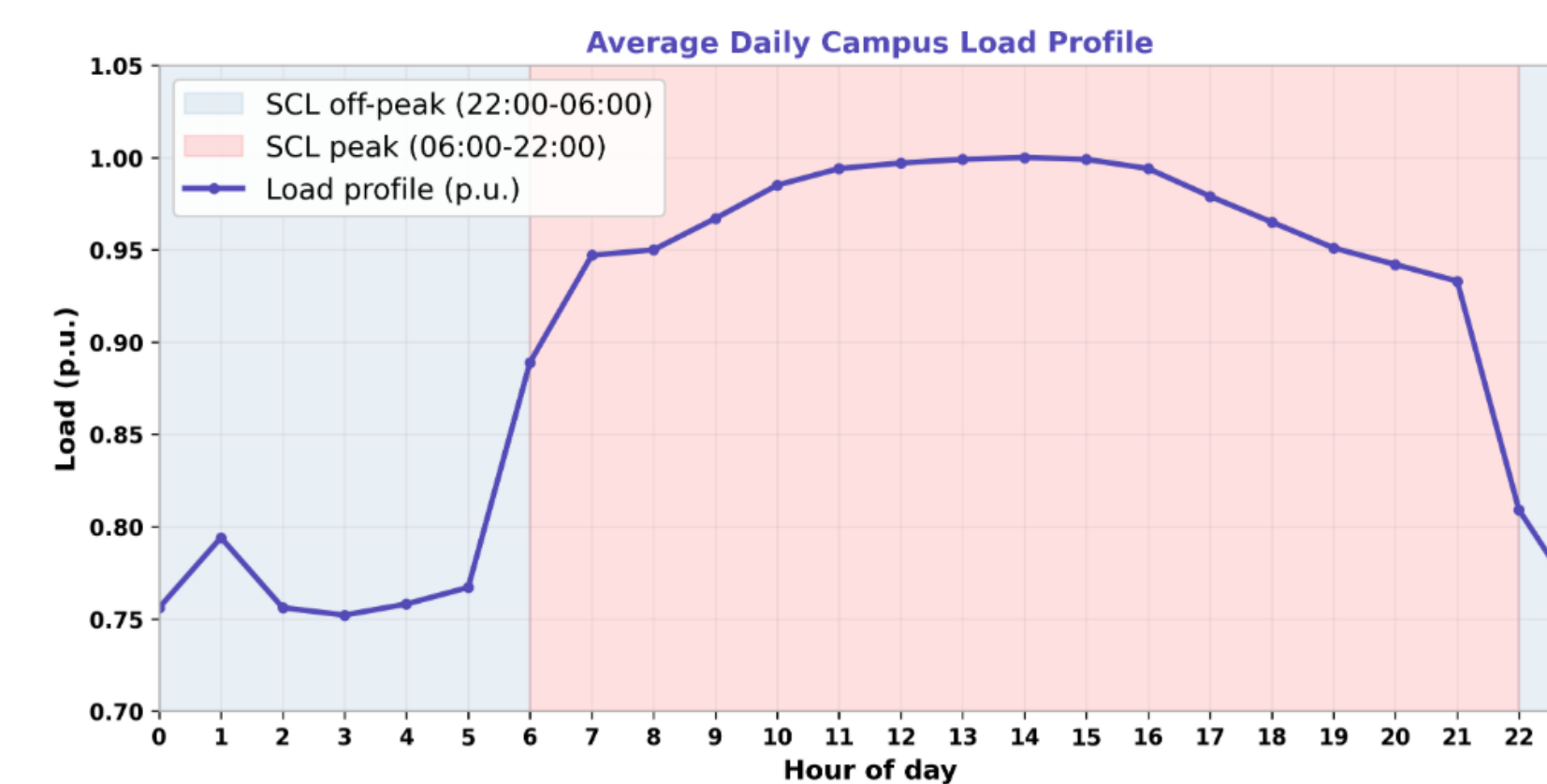
Modeling Assumptions & Parameters

- The UW campus network was modeled in OpenDSS as a 13.8-kV distribution system with 19 building loads, including primary feeders, transformers, and load buses, based on the campus one-line diagram.



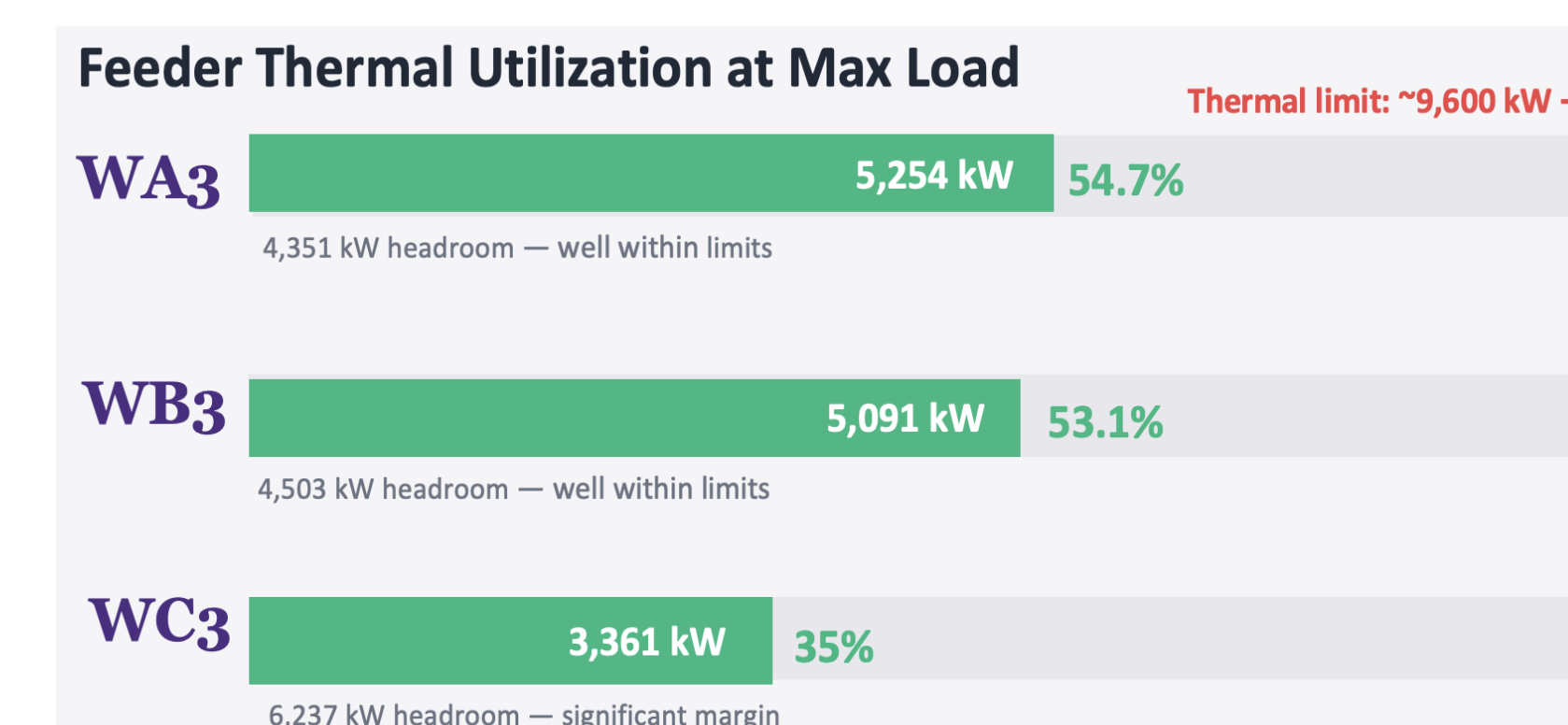
Load Shape Modeling

- 2024 hourly CSE building data used to create an 8,760-hour normalized load shape with a peak campus load of 13.6 MW.
- Peak campus demand falls between 12:00–18:00 — squarely inside Seattle City Light's (SCL) peak window (06:00–22:00), when demand charges are highest.

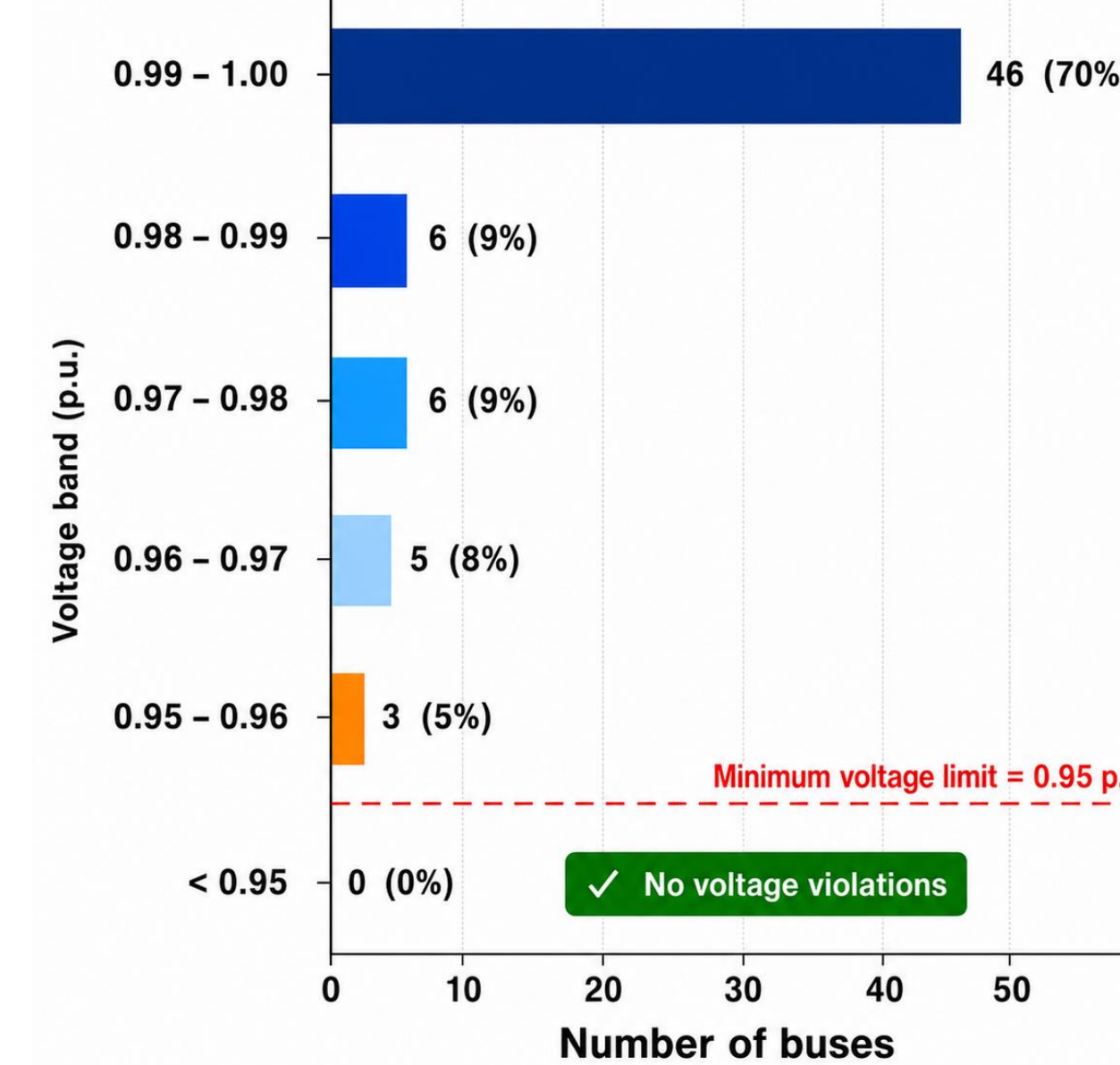


Power Flow & Peak Demand Analysis

- During peak loading conditions, all bus voltages remained within the acceptable operating range (> 0.95 pu).
- All three feeders operate below the 9,600 kW thermal limit, with no immediate congestion risk.



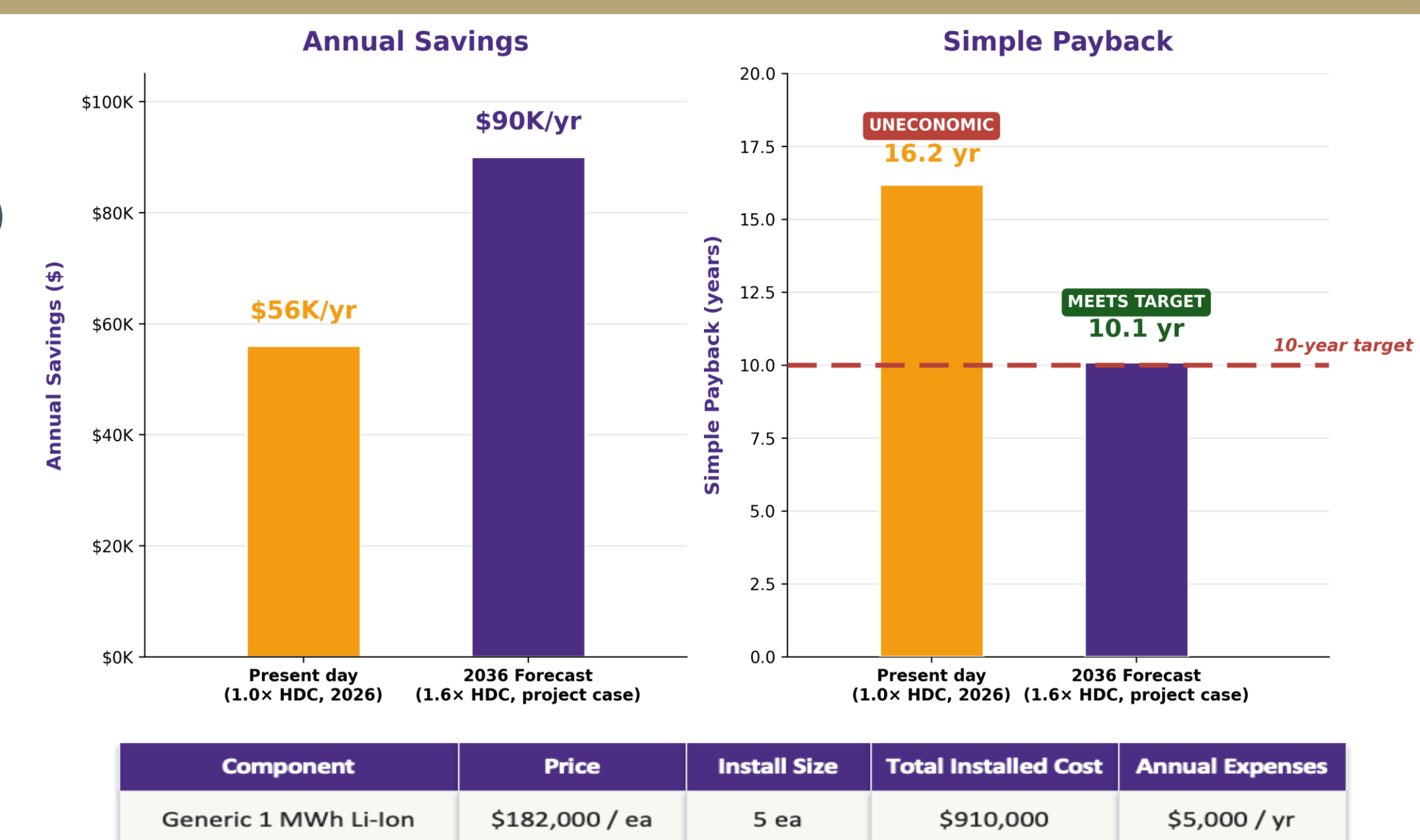
System Voltage Profile at Max Load



Battery Design & Scenarios (HOMER)

- Two tariff scenarios:
- Present day** (1.0x HDC)
- 2036** (1.6x HDC per the SCL Strategic Plan)

- HOMER Grid design:
- 5 MWh lithium-ion** (5 x 1 MWh modules)
- 525 kW symmetric charge/discharge**

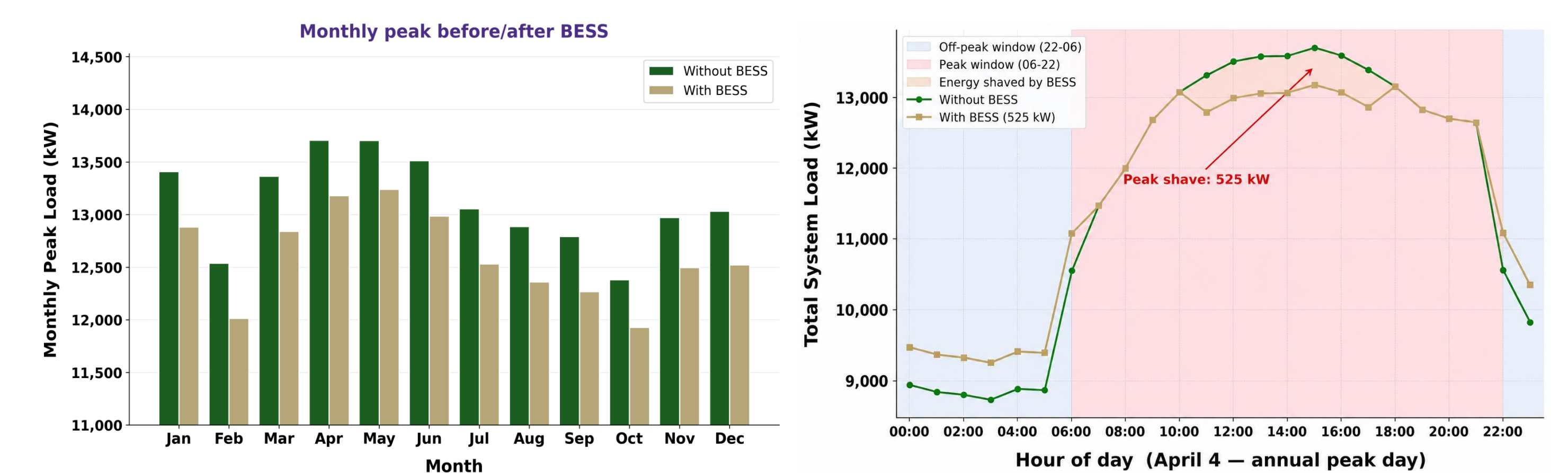


- Battery cost was modeled using the NLR (National Laboratory of the Rockies) real-cost decline, from \$255/kWh in 2026 to \$145/kWh in 2036.
- With 2% annual inflation, this becomes about \$182/kWh in 2036 dollars.
- At today's rates: ~\$56 K/yr savings → 16.2-year payback — uneconomic.
- At the 2036 forecast tariff: ~\$90 K/yr savings → 10.1-year payback — meets 10-year target.

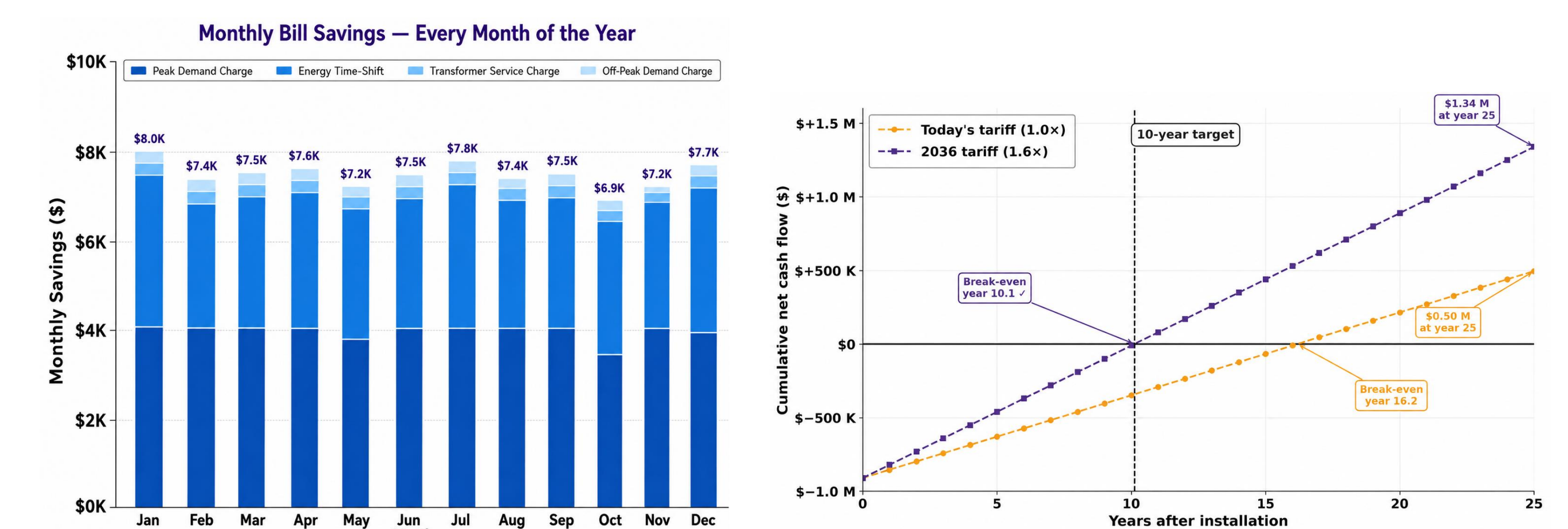
Battery Operation & Results

Results shown for the projected 2036 tariff scenario

- The battery was modeled as a **daily peak-shaving system**, with 10 hours of off-peak charging and 7 hours of peak-period discharging.
- The BESS reduced monthly peaks in all 12 months, with an average peak reduction of 509 kW/month.



- 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 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.