Darrington Community Microgrid: Planning and Design of a Resilient Community Microgrid

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SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

Background, Motivation, and Requirements

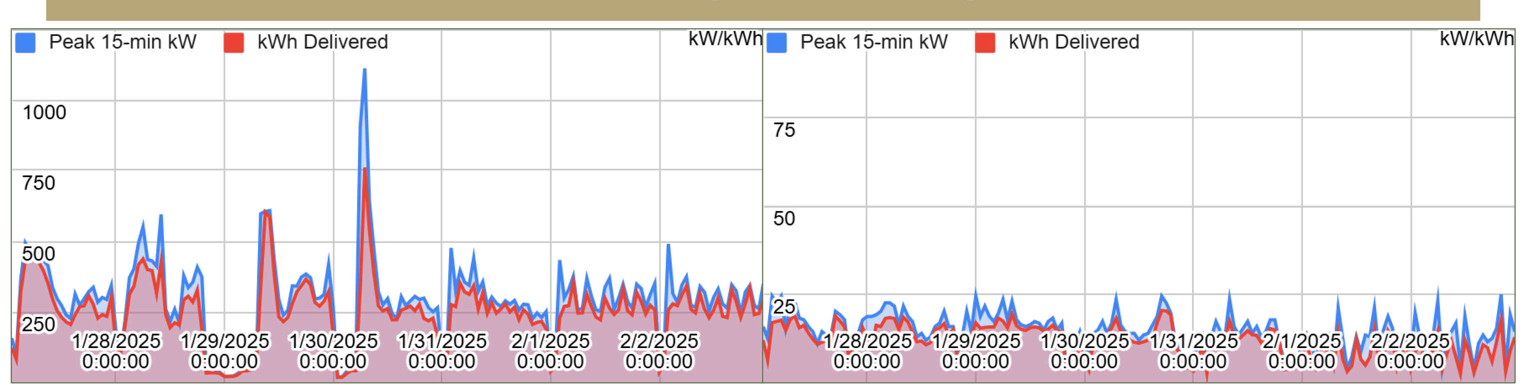
Darrington School District is in a remote area vulnerable to natural disasters and has been experiencing financial strain due to their high utility bills. To resolve these issues, a solar microgrid can be utilized to:

Peak Shaving
- Reduce high morning peaks
- Reduce peak demand charge
- Sell excess energy back to the grid

Resiliency
- Store energy for backup power in case of outages for at least 4 hours
- Operate in grid-connected and islanded modes
- Have a backup generator

A preliminary 30% system design will be created to help start the process of potentially installing a microgrid. The preliminary design includes an electrical one-line diagram, economic analysis, and multiple recommendations.

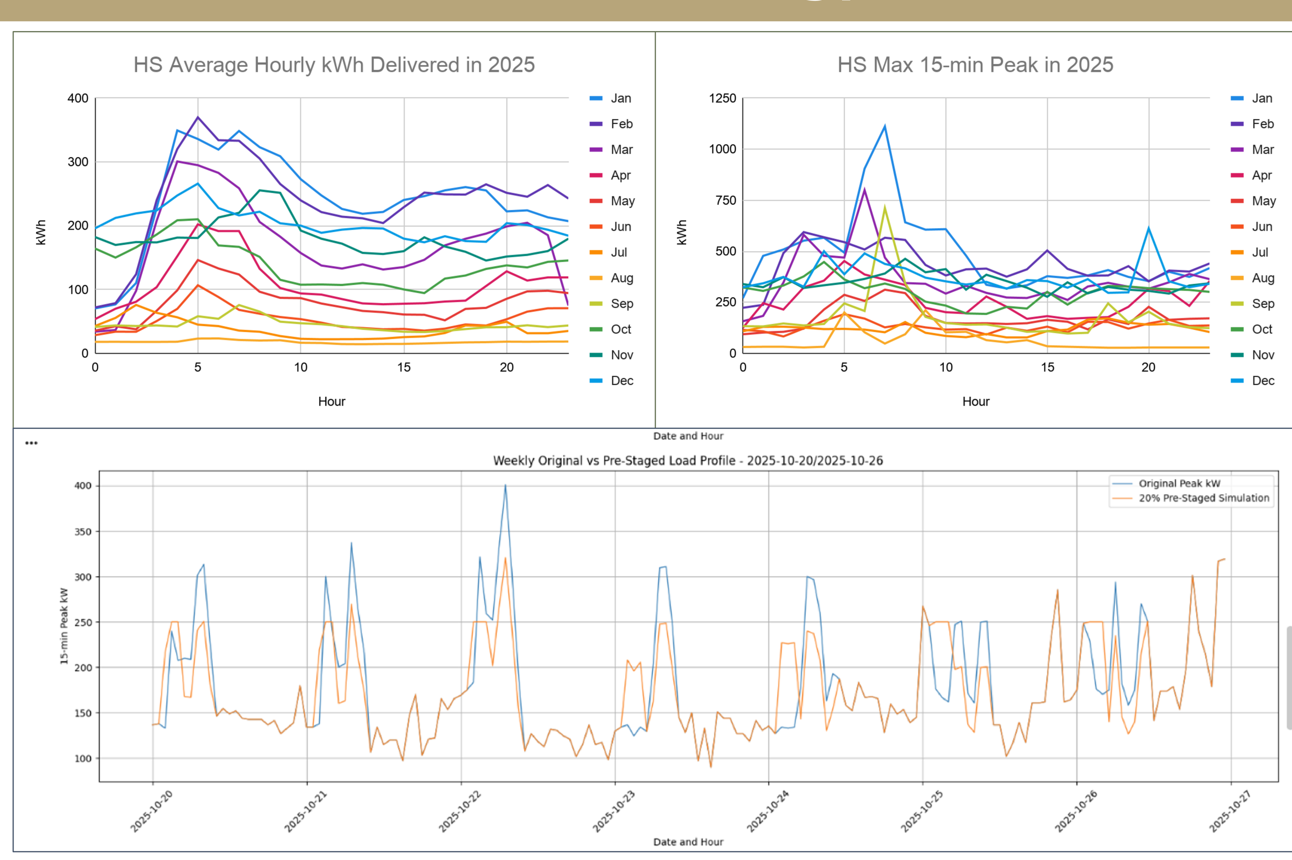
Load Drives Design & Outage Analysis



High School — Community Center

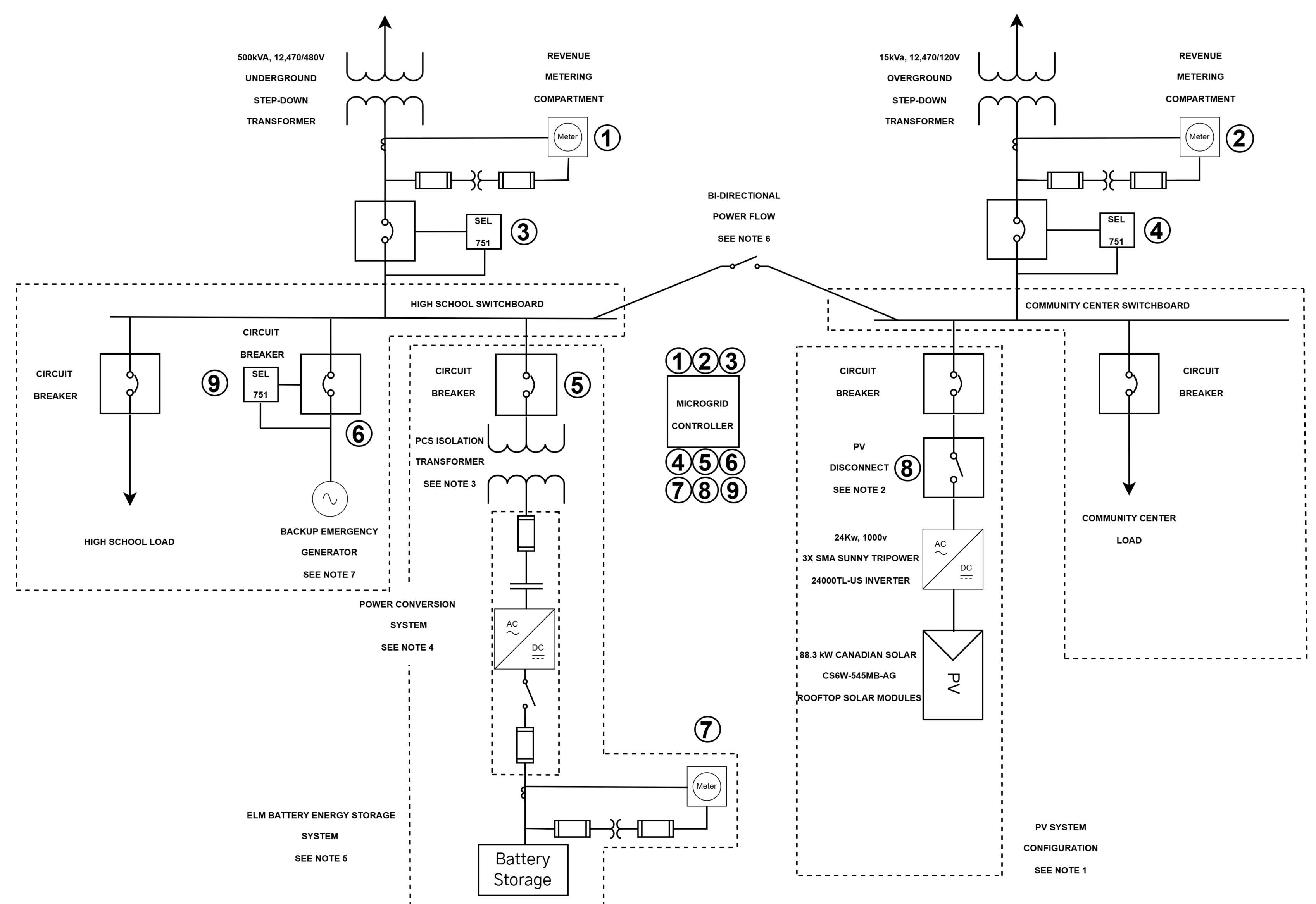
- Because the high school's load profile is magnitudes larger than the community center's, the HVAC load is likely not metered on the community center's meter.
- Eliminating this morning peak load seen in the high school would require an incredibly large battery, but even reducing this peak by 125 kW could save the school a considerable amount of money.
- Resiliency with this type of load is much more challenging. Supporting this type of load profile would once again require an incredibly large battery.

HVAC Dominates Energy Demand



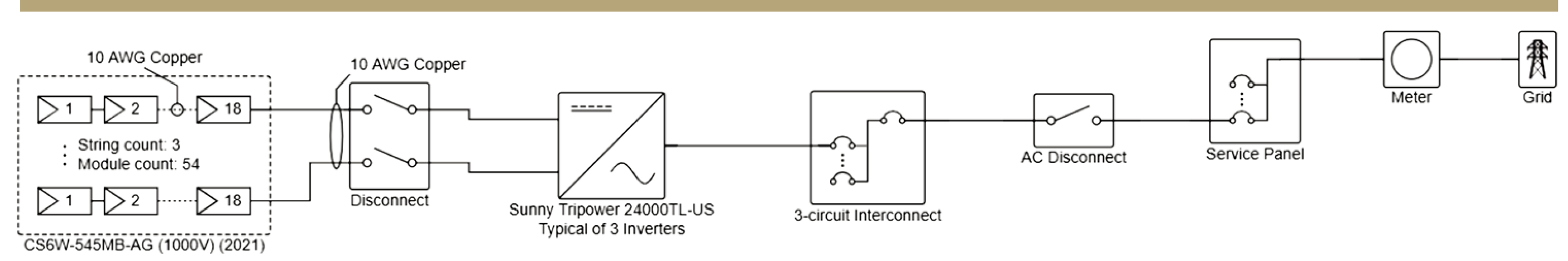
- Approximately 76.68% of the total total load measured from the high school is solely due to the HVAC system.
- The high winter HVAC peaks can be avoided with a control system that pre-stages the boiler, spreading the peak into earlier in the morning.

System Overview

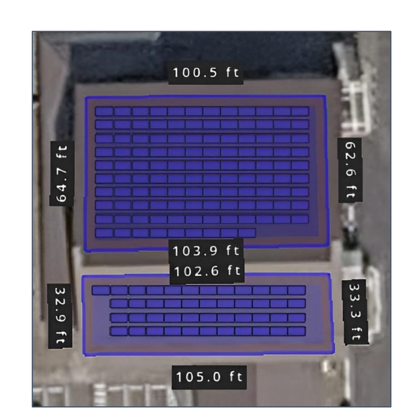


1. Final solar equipment to be confirmed by solar vendor and Darrington community board
2. PV disconnect and breaker ratings to be determined by solar vendor
3. Final isolation transformer and circuit breaker ratings to be determined by BESS vendor
4. Final ratings determined by BESS vendor, contains UL 1741 sb inverter
5. BESS will contain either ELM CMG 125 kW/939 kWh, MG 500 500kW/1672 kWh or MG 1500 1000 kW/10,032 kWh.
6. Power flow will go from the community center to high school switchboard in charging operation and will flow from high school to community center in islanded operation
7. The emergency backup generator will be a Cummins powered 250 kW or 700 kW generator depending on the case

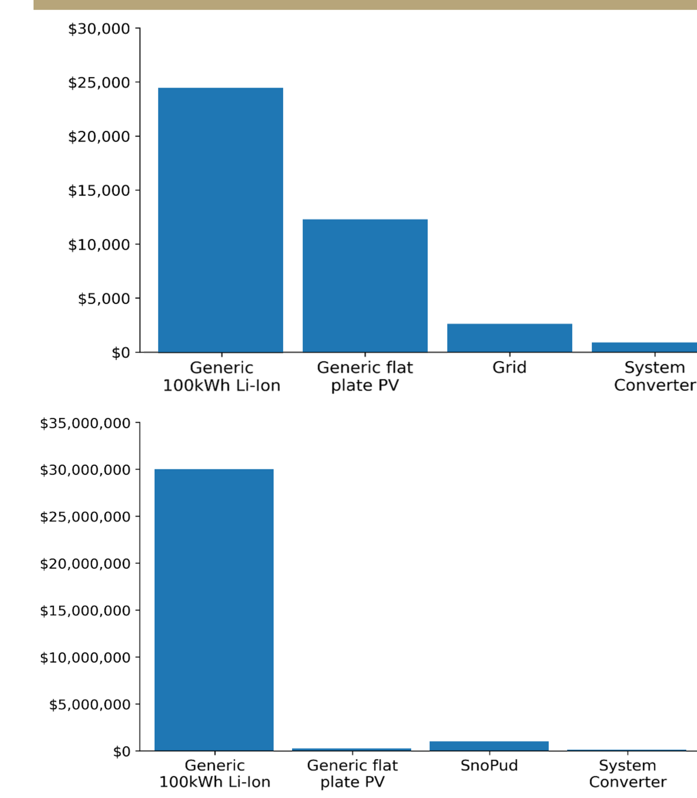
Battery & Solar



- 88.3 kW PV system contains 162 545W panels and 3 24kW inverters.
- Depending on specific case, the battery is a 125 kW/939 kWh, 1000 kW/10,032 kWh, or 500 kW/1672 kWh for the peak shaving, large battery, and HVAC control conditions respectively.
- The BESS discharges to either support islanded operation or cut the peak 100kW + loads in the high schools load profile. The kW ratings are designed to account for the worst case 15 minute peak as seen in the load data.



System Design Results (HOMER) & Economic Analysis



Full HVAC backup was economically infeasible, requiring a 28.3 MWh battery, 500 kW converter, and $30M capital cost. The reduced-load scenario was more feasible, requiring a 300 kWh battery, 31.4 kW converter, and 60–80 kW PV array.
- Optimal solar sizing was 88.3 kW, costing $155k–$191k ($1.71–$2.21/W).
- Small battery installation costs were estimated at $408k.
- Medium battery installation costs were estimated at $785k.
- Large battery installation costs were estimated at $4.36M.
- Generator costs were estimated at $300k–$350k for 700 kW and $70k for 250 kW.
- A 12% contingency fund was included in all cost estimates.

Key Result, Feasibility, and Impact

- Supporting full HVAC load as-is would make the system unfeasible
- HVAC controller exists on site that allows for the staging of the boiler output that matches the required temperature setpoint using the least amount of energy.
- A properly configured controller would significantly reduce the HVAC load
- The last 2 recommendations provide desired outage support for the community center

Recommendations

Cost/Savings	2025	CMG 125	MG 500	MG 1000
Annual Bill	$127,882.65	$109,032.93	$94,786.33	$101,299.30
Annual Savings		$18,849.72	$33,096.32	$26,583.35
Battery Cost		$407,714.00	$784,670.00	$4,355,894.00

CMG 125
- 125 kW/939 kWh
- No backup power

MG 500 (Recommended)
- 500 kW/1,672 kWh
- ~9 hours of backup power

MG 1000
- 1000 kW/10,032 kWh
- ~55 hours of backup power

Monthly Electricity Bill = ($2.10/day) + ($0.08365/kWh) + ($7.16 x (peak kW – 100 kW))

Future Work, References, and Acknowledgements

Future Work
- Evaluate alternative heating systems (heat pumps, thermal energy storage, improved controls)
- Develop real-world controller logic for peak shaving and islanded operation
- Perform utility-grade engineering studies (protection, interconnection, safety)
- Refine HOMER and economic analysis with higher-resolution operational data
- Investigated phased implementation and funding opportunities

Special thanks to Snohomish County PUD, Alex Chorey, June Lukuyu, Aya Alayli, and the Darrington School District and Community Center for their guidance, technical support, and collaboration throughout this project

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