Tumwater Fire Department Headquarters

Solar Plus Storage Feasibility Study

311 Israel Rd SW, Tumwater, WA 98501

Parcel #82700100100

Prepared by Cascadia Renewables for the City of Tumwater

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CASCADIA RENEWABLES

About Cascadia Renewables

Cascadia Renewables is a technical consultant based in Washington state, specializing in designing and deploying solar and storage assets. We leverage our combined decades of industry experience to support public and private entities as they pursue their clean energy goals. Our team has led regional clean energy policy initiatives focused on equality, transparency, and affordability.

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Acknowledgments

Community Stakeholders and Representatives:

- Brian Hurley – *Fire Chief* – Tumwater Fire Department
- Shawn Crimmins – *Assistant Fire Chief* – Tumwater Fire Department
- Mason Rolph – *Executive Director* – Olympia Community Solar
- Chris Graham – *Facilities Manager* – City of Tumwater
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Letter From the Field

Dear Brian Hurley,

We are pleased to present the City of Tumwater with this study, which examines the feasibility of constructing a solar plus storage system to enhance resiliency at the Tumwater Fire Department Headquarters.

The purpose of this study is to convey a clear, detailed, and accurate description of the design for a potential solar plus storage system to enhance community resilience, taking into account geographical, infrastructural, economic, environmental, and social context. This report is the culmination of an extensive design project, the goals of which include:

- Understanding community needs
- Assessing trends in energy usage and conditions of the site
- Determining the optimal system size and architecture
- Assessing the benefits, challenges, and risks of proceeding with the proposed system
- Identifying next steps

FUNDED BY WASHINGTON'S CLIMATE COMMITMENT ACT

This report is supported with funding from Washington's Climate Commitment Act. The CCA supports Washington's climate action efforts by putting cap-and-invest dollars to work reducing climate pollution, creating jobs, and improving public health. Information about the CCA is available at www.climate.wa.gov.

We intend this document to concicely convey the technical aspects of the design to those with experience reading such information. It is separated into three levels of detail:

1. A high-level summary of our findings and recommended design *(found on page 5)*
2. Detailed specifications of our design and design process *(pages <?>–46)*
3. An appendix of calculations and ancillary documents for cross-referencing, as well as the findings and photos from our original site visit *(found in separate PDFs)*

To determine the feasibility of a solar plus storage system, it is necessary to specify equipment, equipment locations, system design, and hourly labor/services estimates. Though we provide this high level of fidelity, please note that this feasibility study is conceptual– it is not intended for construction purposes. It supports stakeholder decision-making, fundraising efforts, and future designs. To determine the final product specifications, equipment locations, system design, and hourly cost/estimates, Cascadia Renewables recommends a thorough 3+ bid RFP process.

Please direct yourself to any sections appropriate and relevant to your needs. If you have questions about this report, please contact us at info@cascadiarenewables.com.

Sincerely,

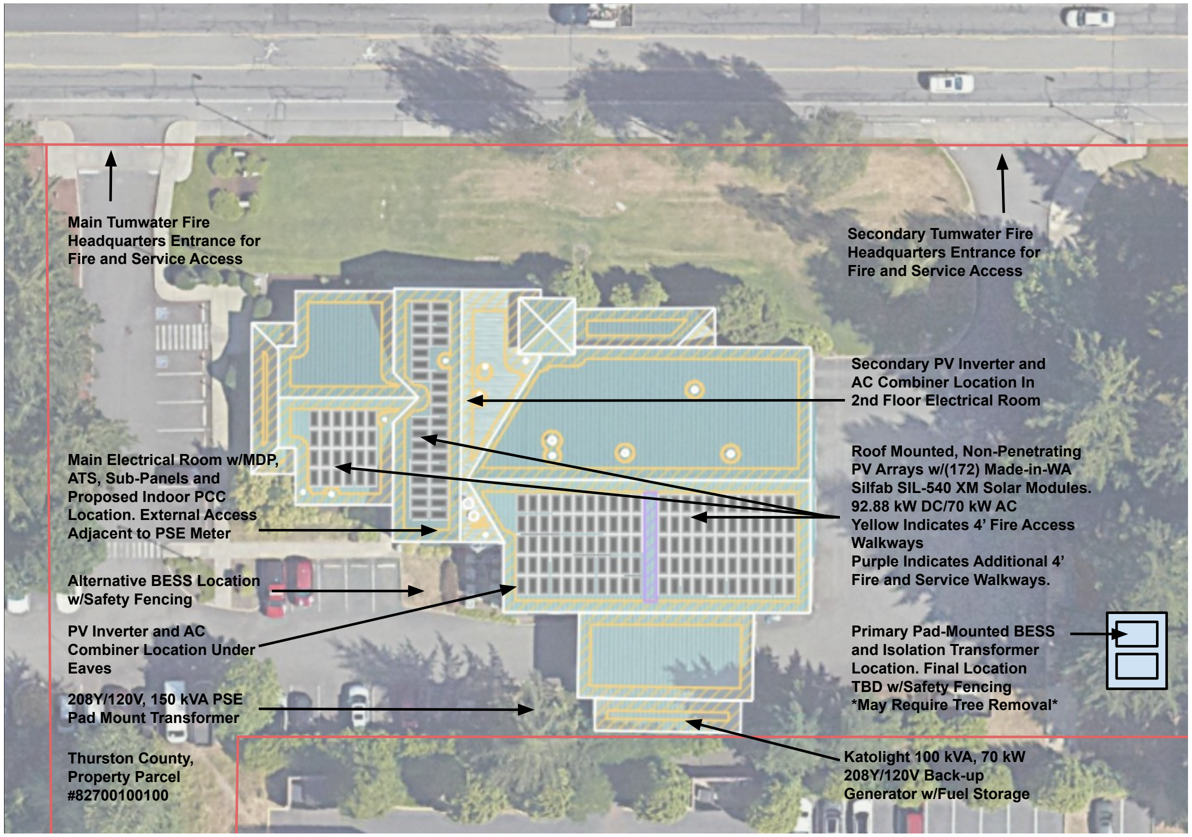
Cascadia Renewables

Design Abstract

The solar plus storage system conceptualized for the Fire Headquarters has a dual purpose. Primarily, it serves as a resilient backup power source during emergencies, allowing the facility to operate as an Emergency Operations Center during seasonal outages or natural disasters. This functionality increases the building's autonomy and reduces the reliance on diesel fuel. Secondarily, the system realizes financial savings over its lifetime. Offsetting utility energy costs with photovoltaic (PV) productions and lower building demand charges with the strategic dispatch of the battery energy storage system (BESS) during high building demand periods.

The solar system is designed to be mounted on the building's shade-free standing seam metal roofs. This choice was influenced by the minimal shading risks involved, optimizing the system's performance. The system attaches to the structure without penetrating the roofing, maintaining its warranty.

Overall, the project's feasibility is high. The community, which has a population of around 27,000 people, would be afforded resilient fire prevention and emergency medical services by constructing this system. Steps have been planned to ensure compliance with construction standards, fire codes, and permitting requirements.



PV System Size	92.88 kW DC/70.00 kW AC
BESS Size	125 kW/516 kWh
Estimated Annual Electric Production	91,643 kWh
Estimated Percentage of Annual Consumption Offset	69.86%
First Year Bill Savings	$10,455.00
Period of Autonomy	**June:** 100% Demand - Continu-ous 150% Demand - 53 hrs 200% Demand - 35 hrs **January:** 100% Demand - 18 hrs 150% Demand - 8.5 hrs 200% Demand - 6 hrs

Design Specifications and Process

Introduction to the Site

Type of Building: Two-story building with garage bays for the fire apparatus, and an attached administrative wing that houses the Emergency Operations Center.

Surrounding Conditions: Centrally located in the City of Tumwater, with multiple access locations for easy access by the public and fire personnel during an extended emergency.

Typical Purpose of Site: Fire station and Emergency Operation Center for the Fire Department.

The site typically has 13 people at the station during normal business hours, and never have less than 6. The site also has both city staff and community groups that utilize the training room. During extreme events or disasters, it could potentially hold 20+ people.

Emergency Function: In addition to its standard function as the Fire Department Headquarters, the facility operates as the primary Emergency Operations Center.

Project Goals

In conversation with stakeholders, the community had the following goals:

- To continue providing emergency fire services for the City of Tumwater throughout an ongoing emergency event where grid power may not be available and generator fuel supplies are limited or unavailable.

In service of those goals, the system was designed with the following priorities:

1. Provide backup power, enabling the building to remain operational during short, seasonal power outages
2. Provide long-term back up power, enabling the building to remain operational during extended emergencies
3. Increase redundancy of existing backup generator system, reducing generator runtime and fuel use
4. Reduce the station's operational costs through the reduction or elimination of monthly electrical bills, allowing internal funds to be realocated

Stakeholder Engagement

Key stakeholders included:

- Brian Hurley – *Fire Chief* – Tumwater Fire Department
- Shawn Crimmins – *Assistant Fire Chief* – Tumwater Fire Department

- Mason Rolph – *Executive Director* – Olympia Community Solar
- Chris Graham – *Facilities Manager* – City of Tumwater
- Alyssa Jones Wood – *Sustainability Manager* – City of Tumwater

Differing needs of stakeholders were voiced through the following interactions, summarized below.

Engagement Activities and Objectives:

December 23, 2024: Members of Cascadia Renewables conducted a comprehensive site assessment with personnel from the department.

February 24, 2024: A kickoff meeting was conducted between Cascadia Renewables and representatives of fire department, the City of Tumwater, and Olympia Community Solar. The goal of the meeting was to inform the stakeholders about the upcoming process, to make plans to aquire the necessary information to perfom a site analysis, and to get an impression of the goals of the stakeholders.

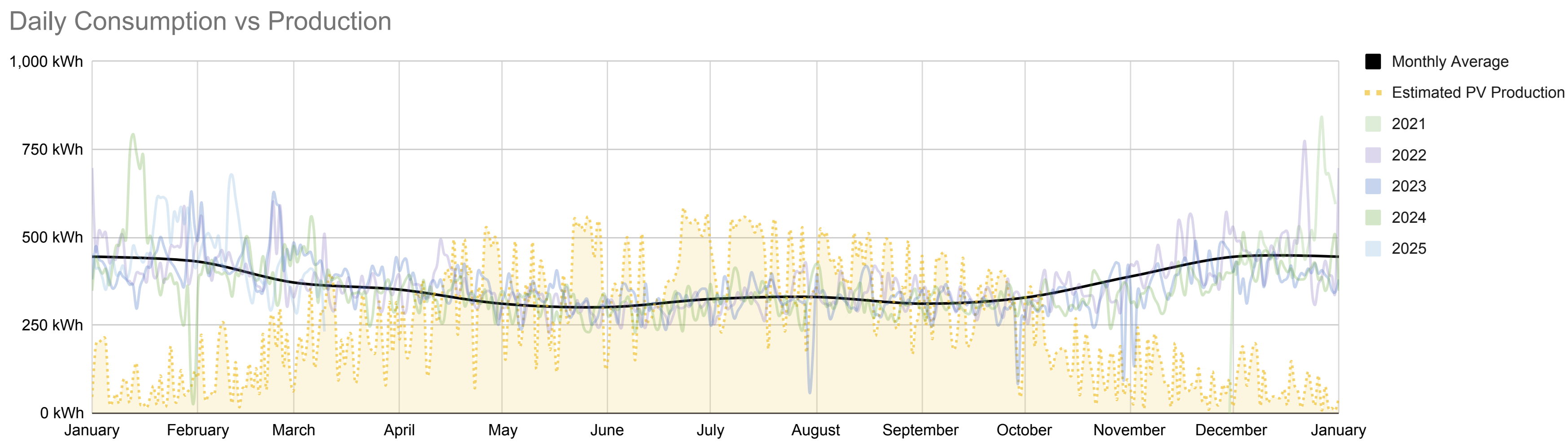
April 17, 2025: Cascadia Renewables held a design review meeting with members of the fire department, the City of Tumwater, and Olympia Community Solar to present the in-progress conceptual design. We received feedback on the design, and responded to the concerns of the organizations.

Preliminary Electrical Usage Analysis

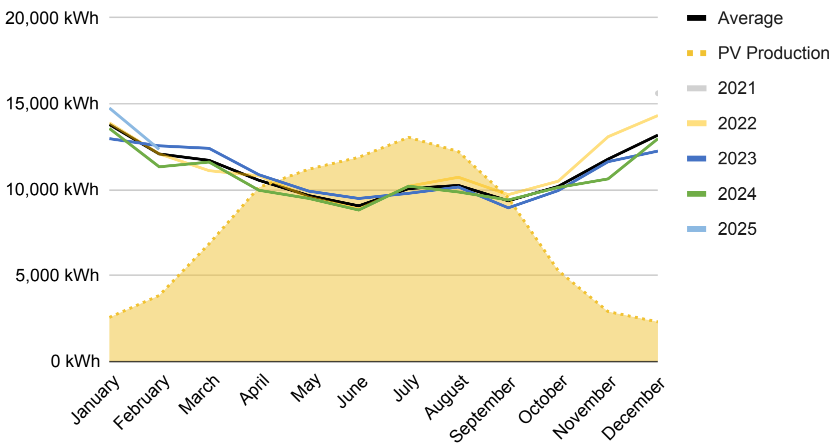
The electrical usage analysis determines the optimal solar and battery system sizes for meeting the needs of the site. We consider this electrical analysis in tandem with information collected on site to inform the conceptual design and verify the installability of the project if it is funded.

This analysis covers electricity consumption from December 2021 to March 2025. The data from this period was used to model the site's electricity usage. The data demonstrates slight seasonal fluctuations, with peak usage occurring in the winter and minor peaks at 8:00 AM and during dinner time. Electrical consumption sees minimal hourly changes, despite these small peaks. There are some planned electrical infrastructure changes, such as upgrading the elevator, which may impact the building's future consumption or demand patterns.

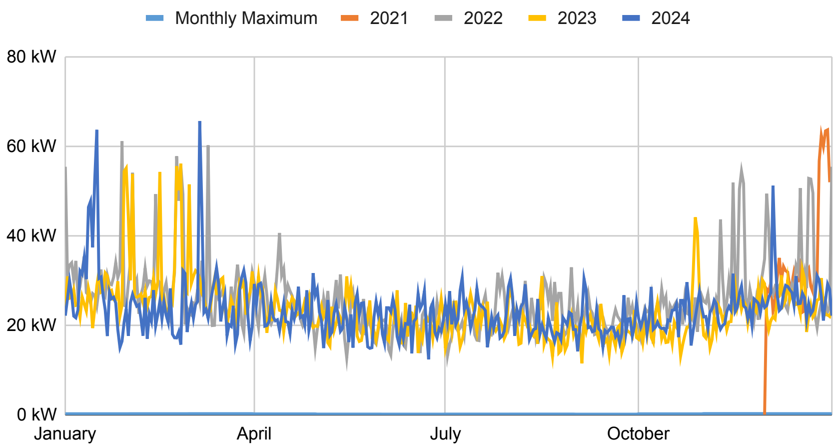
Estimated Annual Electric Consumption	131,172 kWh
Seasonal Fluctuation	52.39% fluctuation between minimum consumption in June and maximum consumption in January
Estimated Maximum Peak Demand	66 kW
98-Percentile of Consumption During a Single Day	579 kWh



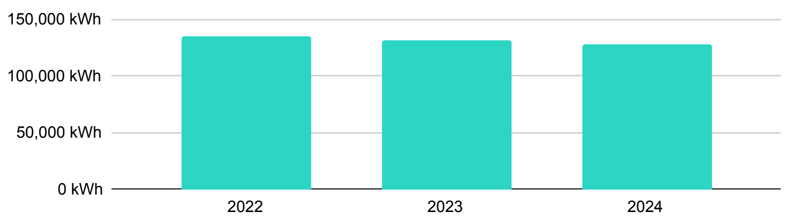
Monthly Consumption vs. PV



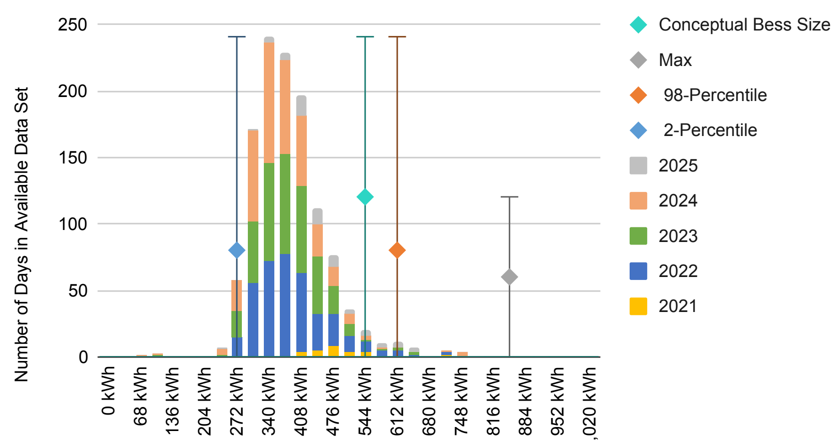
Monthly and Daily Peak Demands



Total Consumption by Year



Frequency of Consumption Occurrence



Comprehensive Site Visit

Following the preliminary electrical analysis and an initial review of the available building plans and satellite imagery, members of the Cascadia Renewables' design team assess the real-world conditions through a comprehensive site visit.

Roof:

Condition of the roof

Roof Quality	The standing seam metal roof is in excellent condition, and is ideal for the installation of a non-penetrating mounting system. However, there is a reported history of leakage issues that will require caution in the system design and installation.
Roof Type	Standing Seam Metal
Roof Angle	Roof 1: 14 degrees (3:12), Roof 2: 22 degrees (5:12), Roof 3: 22 degrees (5:12)
Roof Age	25 years
Date After Which Roof Should Be Replaced	2040+

Structure:

Structure Type	The building is a two-story facility consisting of primarily a steel framed structure from Star Building Systems, with limited wood-frame construction.
Assessment of Structure Quality	The structure appears to meet all building requirements to support a flush-mounted PV system on the standing seam metal roofs.
Availability of Plans	Both structural and electrical plan sets were available onsite.
Soil Conditions	The Fire Headquarters is surrounded by concrete sidewalks and paved parking and access roads, with landscaping adjacent to the building.

Meter

MDP and Subpanels

Electrical:

Service Utility	Puget Sound Energy (PSE)
Main Service Type	208Y/120V, 3-Phase

Electrical Topology	The Fire Headquarter's electrical infrastructure is primarily located in a main electrical room that is located on the south central interior of the building, with access from a south-facing exterior door. The infrastructure includes a 1200 A Main Distribution Panel that feeds six sub-panels and a dedicated elevator disconnect. Three of the Sub-panels are backed up a 100 kVA Katolight Power System Solutions automatic generator, that is not designated as an emergency power system for permitting purposes.
Line Side Infrastructure	The Fire Headquarter's 3-Phase 208V power is fed from a pad-mounted 150 kVA PSE transformer located centrally on the south property border, across the rear driveway from the main electrical room.
Electric Utility Hosting Capacity	Generation Hosting Capacity of 1.21 MW

Location of Main Electrical Service	The main electrical room is located just behind the PSE meter, which is centrally located on the south exterior.
Locations of Current Infrastructure	The PSE transformer and backup generator are located along the south property border, with the PSE meter mounted on the south exterior, directly outside of the main electrical room that houses the main distribution panel, ATS and sub-panels.
Main Transformer Rating, Voltage, and Phase	150 kVA, 208Y/120V, 3-Phase, pad-mounted PSE transformer
Main Service Bus Capacity	1200 A
Main Service Bus Voltage	208Y/120V
Main OCPD Rating	1200 A
Main Distribution Center Type	Switchboard
Amps Available for PV Interconnection Under 120% Rule	240 A

Generator:

Generator Brand	Katolight Power System Solutions
Generator Size	100 kVA, 70 kW, 208Y/120V, 3-Phase
Generator Fuel Type	Diesel with 140 gallons of onsite storage
Generator Interconnection Method	The generator is connected to the Main Distribution Panel, via a 400 A ASCO Automatic Transfer Switch.
Generator Backup Configuration	Partial Building

Other:

Description of Accessibility: The Fire Headquarters is centrally located in the City of Tumwater with easy access from multiple surrounding public streets and site access points. The roofs are accessible from a single-story ladder on the south, west and north sides, and a two-story ladder or man-lift on to the primary upper south-facing array location.

Description of Shading: The primary roofs are shade-free, with significant shading from trees along the south edge of the property limited to the lower south-facing roof section above the covered south entrance, that is not being considered for a PV installation location as part of this feasibility study.

Photovoltaic (PV) System Design

Overview:

The conceptual 92.88 kW DC PV array would be installed on the upper standing seam metal roofs. The system was designed using a max fit methodology, meaning it aims to maximize the use of available roof space to increase energy production. The PV layout was designed to increase annual system output by avoiding areas of shading from trees along the south edge of the property and rooftop vents. The panels are installed on the lower south-facing roof, the upper primary south-facing roof, and the upper west-facing roof sections.

The PV system production was modeled using Aurora, a software that uses irradiance data, LIDAR data, and 3D models of buildings to determine PV output over the course of the day and the year.

In this report, specific products names are used. These recommendations are to be considered typical–comparable equipment may be substituted. When making substitutions, pay attention to all technical specifications, as some products that initially appear comparable may be different in key ways.

Solar irradiance visualized across the array

Estimated Annual Electric Production	91,643 kWh
Estimated Percentage of Annual Consumption Offset	69.86%
Total Solar Efficiency	85.0% TSRF
Number and Models of Inverters	(2) SolarEdge SE 10K-US, (1) SolarEdge SE 50K-US, 208V Commercial 3-Phase Inverters

Specifications:

PV System Size	92.88 kW DC, 70.00 kW AC
PV Module	Silfab SIL-540 XM, 540 Watt Module
Number of Modules	172

Location of Inverters	The PV inverters may be installed under the covered walkway to the east of the ground-mounted location of the Headquarters HVAC units.

Design Considerations:

Trenching, Cutting, and Wall Penetrations Trenching and pavement cutting will be required to connect the requested BESS location along the south edge of the property, across the asphalt driveway and concrete curbs, to the main electrical room located on the southwest corner of the Headquarters. There will be a limited number of wall penetrations to allow for the integration of the PCC into the existing electrical infrastructure in the main electrical room.

Maintenance and Fire Access 4' commercial fire setbacks will be provided on all roof locations to allow for easy maintenance and fire access. An additional fire access walkway has been included along the center path of the primary south facing PV installation location.

Wire Run The externally mounted DC PV wire runs will vary from 30' from the primary PV array location above the PV inverter location, to 80' from the westernmost south facing PV array.

Roof Shading The trees along the south edge of the property provide substantial hard shading that could affect the annual system performance. The conceptual PV array layout avoids the lower south facing roof in order to minimize these shading effects.

Required Upgrades Prior to PV Installation None

Interconnection Method for PV The SolarEdge inverters will have their 208Y/120V output combined in a PV combiner panel, that will feed the PV input in the Point of Common Coupling (PCC) panel that will be installed nearby with the BESS system.

Roof Loading and Mounting:

The following assessment is intended to suggest whether the structure will support the load of the PV system. Before installation, final engineering should be conducted to guarantee structural sufficiency.

PV SYSTEM DETAILS

GENERAL INFORMATION

Facility: Meter #1
Address: 311 Israel Rd SW Tumwater WA 98501

SOLAR PV EQUIPMENT DESCRIPTION

Solar Panels: 92.9 kW-DC Standard Modules

SOLAR PV EQUIPMENT TYPICAL LIFESPAN

Solar Panels: Greater than 30 Years
Inverters: 15 Years

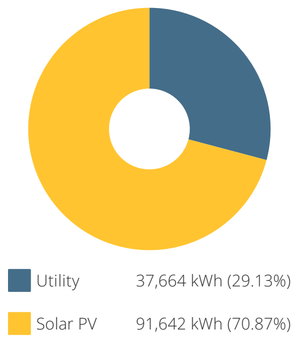
Solar PV System Cost and Incentives	
Solar PV System Cost	$292,000
Grant Amount	-$292,000
Net Solar PV System Cost	**$0**

SOLAR PV SYSTEM RATING

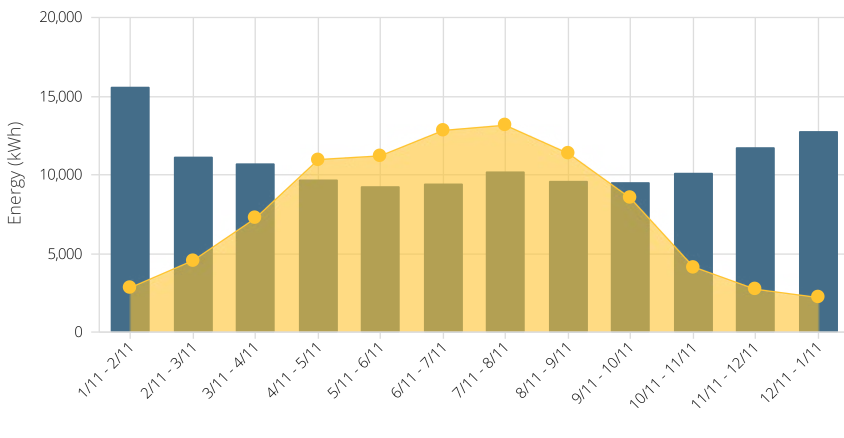
Power Rating: 92,880 W-DC

ENERGY CONSUMPTION MIX

Annual Energy Use: 129,306 kWh



MONTHLY ENERGY USE VS SOLAR GENERATION



Mount Location	The PV modules will be installed on the lower south-facing roof, the upper primary south-facing roof, and the upper west facing roof sections.
PV Racking System	IronRidge Aire Rail System
PV Mounting System	Flush-mounted
Roof Penetrations	The system will be installed using a metal standing seam compatible, non-penetrating S-5-T clamping system.
Roof Loading Capacity	25.0 psf
Additional Available Roof Loading	5.0 psf
Estimated PV System Roof Loading	2.4 psf
Assessment of Whether the Roof Will Support the System	Yes

Battery Energy Storage System (BESS) Design

Specifications:

BESS Size	125 kW/516 kWh
Peak Demand for Modeling Purposes	66 kW
Source of Peak Demand	Observed
% of Building Demand used in Modeling	100%, 150%, 200%

Overview:

The conceptual 125 kW/516 kWh BESS will be installed on a concrete pad, approximately 8' x 12', located on the south-east corner of the property. This location was chosen to meet fire code requirements for setbacks and to provide access for maintenance while considering environmental impacts. The system is designed with a 125 kW inverter, allowing it to handle both the building's peak demand and any future increases, such as from electric vehicle chargers. To model the BESS's effectiveness, various scenarios were considered, including conditions with different levels of energy demand and solar availability. These scenarios help demonstrate how the BESS can continue powering the facility during outages, contributing to community goals of increasing resilience and ensuring uninterrupted essential services.

Potential BESS Location

Example of a Containerized BESS Unit

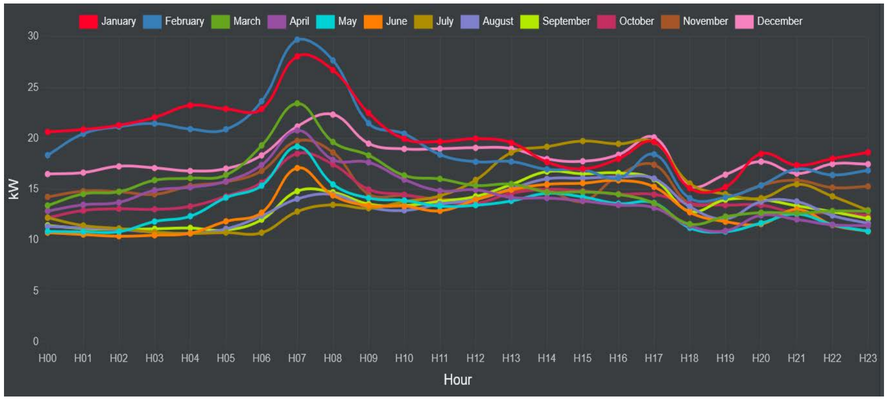
The BESS will backup entire facility and serve as the primary backup power source, allowing the building to ride through seasonal outages and medium duration outages without the need for the generator. If, during island/off-grid operation, the BESS reaches a low state of charge it will cease to supply backup power to the building and the existing standby generator turn on and provide backup power to the existing essential loads. If the BESS and PV systems can be isolated from the rest of the building loads, the PV system can remain operational and recharge the BESS. Once the BESS is recharged, it can be utilized once again to provide whole building backup power and the standby generator will turn off.

BESS dispatch performance is modeled in a program called Xendee, which considers many sources of data, including PV production, estimated site consumption, and grid energy pricing, to optimize a BESS for a variety of desired characteristics, including resiliency and financial benefit.

Demand Modeling:

For the BESS modeling, we utilized the interval data from March 9, 2024 to March 9, 2025 to create a daily building load profile in our system modeling software. This is representative of the actual historical daily load profile throughout the year and provides the most accurate basis for our system performance modeling.

Before constructing a system, we recommend conducting a month long meter study, collecting 1-minute interval data to identify transient peaks in demand.



Building Load Profile based on 15-min Utility Interval Data

BESS Design Considerations:

Although utility data showed a building peak demand of 66 kW, we specified a 125 kW BESS inverter to ensure that the system can meet building demand and transient demand surges during an outage. This also allows for future load growth at the facility if new electrical loads like EV Chargers are added or the building demand increases when utilized as the Emergency Operations Center. We also designed the system to facilitate integration of a larger whole building standby generator if desired in the future. A larger standby generator available for whole building backup and BESS recharging would help to increase the resiliency and backup power redundancy of the microgrid system.

The BESS will need to be installed on an concrete pad approximately 8' x 12' and, per discussions with fire and permitting officials, a security fence will be required around the BESS since it is in a visible, high traffic area. This will increase the area required for the BESS to approximately 14' x 18'. The proposed BESS location in the SE corner of the property in the grassy area with nearby trees will need to adhere to Washington State Fire Code requirements for setbacks. If a 10’ vegetation free perimeter around the BESS cannot be established then trees/vegetation removal will be necessary (WA Fire Code 1207.5.7). The client communicated that should any trees need to be removed, the preference is for the removal of deciduous trees in that area. The Washington State Fire Code also requires that the BESS has a 10’ setback from exposures (1207.8.3) including public ways and lot lines, so this will need to be considered when siting the pad mounted BESS near sidewalks and any adjacent property lines. Setback exemptions can be pursued through a fire official and AHJ review if necessary. It is important to note that the required clearances are from the BESS enclosures only (5’ x 8.5’) and not measured from the outer dimensions of the concrete pad or fence perimeter.

Generator Supplementation:

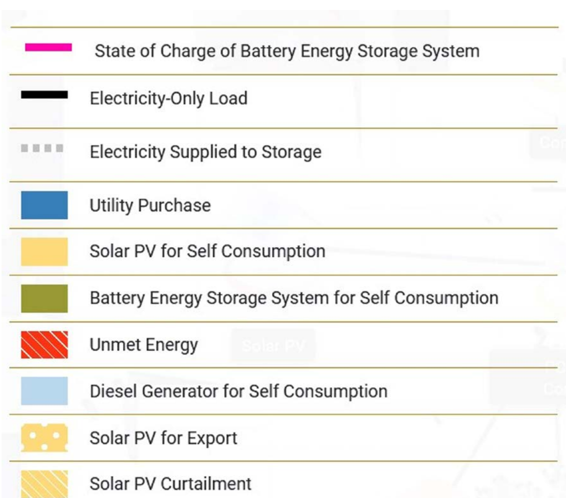
Though not part of a solar plus storage system, a standby generator can be a hugely beneficial complement to a BESS as it will allow a site to maintain extended autonomous operation in the winter. Additionally, a BESS complements a generator by allowing it to run less often and more efficiently than if the generator was installed alone. The existing 70 kW generator is undersized to be reconfigured to provide whole building backup and recharge the BESS. The conceptual system keeps the existing generator in it’s currently configuration, providing backup power to the essential loads and isolated from the solar plus storage system.

Generator Recommendation	Upgrade Existing Generator (if funding can be secured)
Upgraded Generator Size	100 kVA, 70 kW, 208Y/120V, 3-Phase
Upgraded Generator Fuel Type	Diesel with build-in fuel storage compartment
Proposed Generator Interconnection Method	Into the new PCC via a motorized breaker and SEL751 relay
Proposed Upgrade Generator Backup Configuration	Whole Building Backup and BESS Recharging Capabilities

Low-PV Outage Simulation:

The BESS design was based on 100% of historical energy demand. Additional modeling was performed at 150% and 200% of historical energy demand in order to illustrate system performance in the event that building usage increases during an emergency. Modeling was also performed showing how a larger 125kW generator could be utilitized within the microgrid system and the resulting average hours of generator runtime during a longer duration outage.

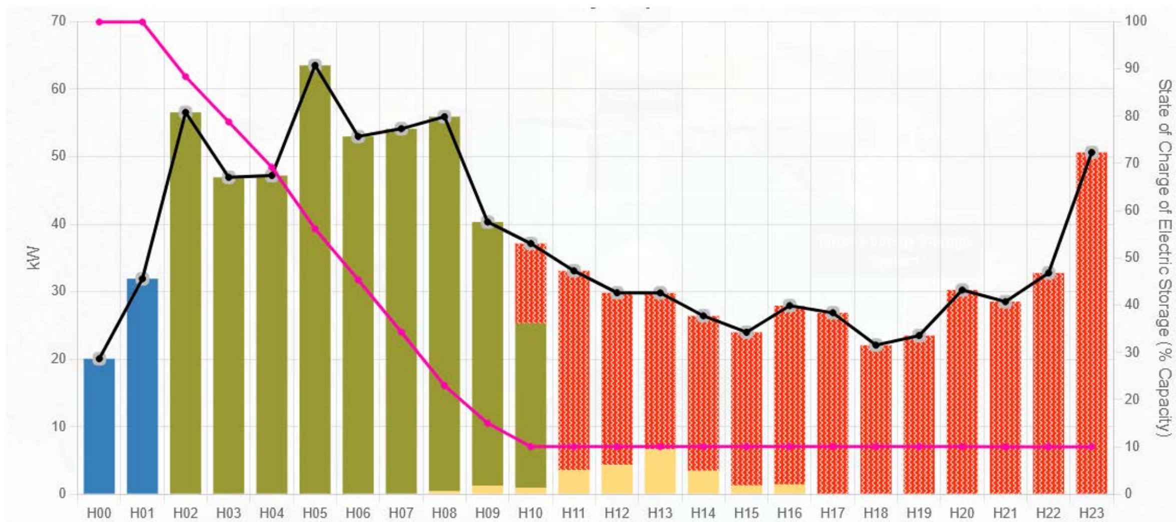
In operation, the period of autonomy of the microgrid system will depend on numerous factors, including available solar resources, BESS state of charge,



Dispatch Graph Key

January Outage Scenario Electricity Dispatch – 100% Demand

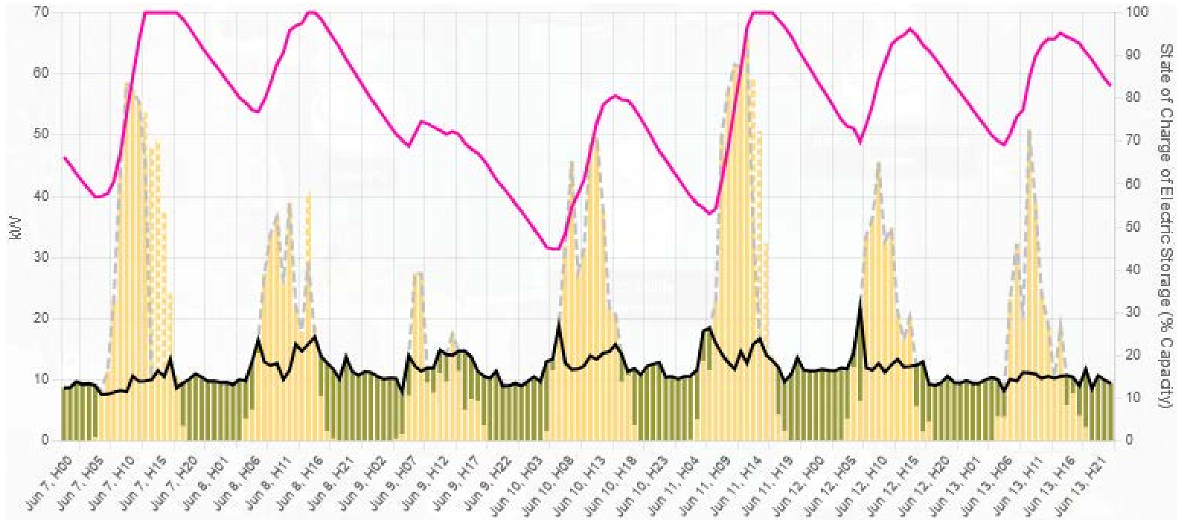
January Outage Scenario Electricity Dispatch – 150% Demand



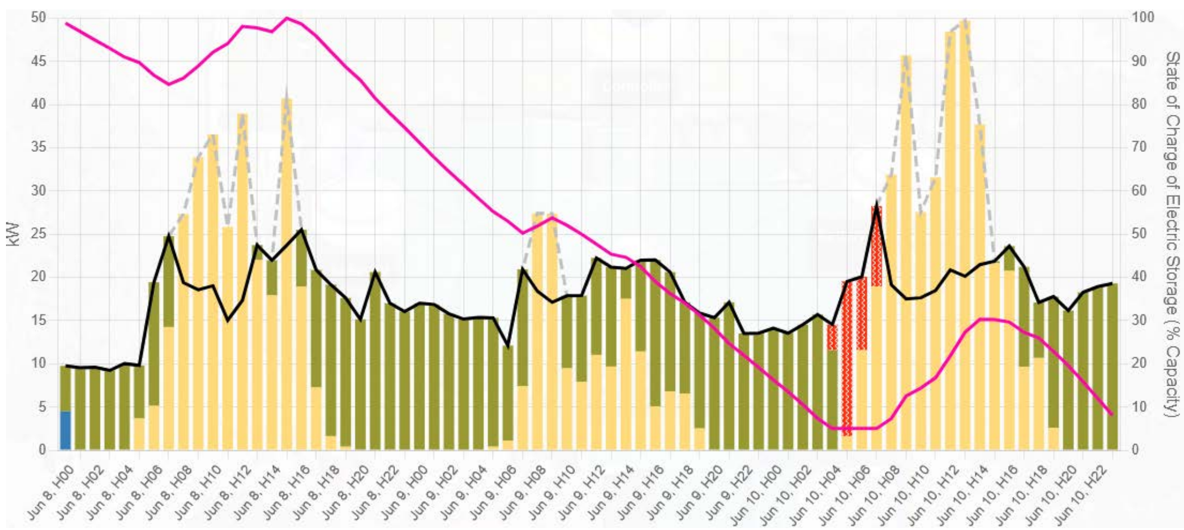
and building loads during an outage. A change in any of these factors will impact these estimates.

January Period of Autonomy	100% Demand = 18 hrs 150% Demand = 8.5 hrs 200% Demand = 6 hrs
Daily Generator Runtime Required for Continuous Site Uptime in January	125kW Generator Upgrade: 100% Demand = 30 hrs/week 150% Demand = 47 hrs/week 200% Demand = 67 hrs/week

June Outage Scenario Electricity Dispatch – 100% Demand



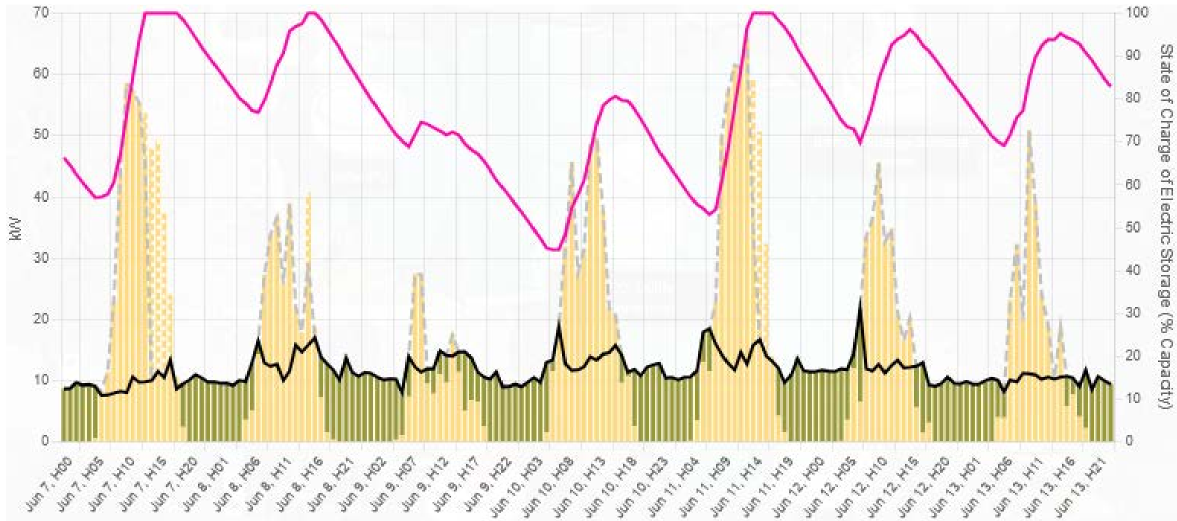
June Outage Scenario Electricity Dispatch – 150% Demand



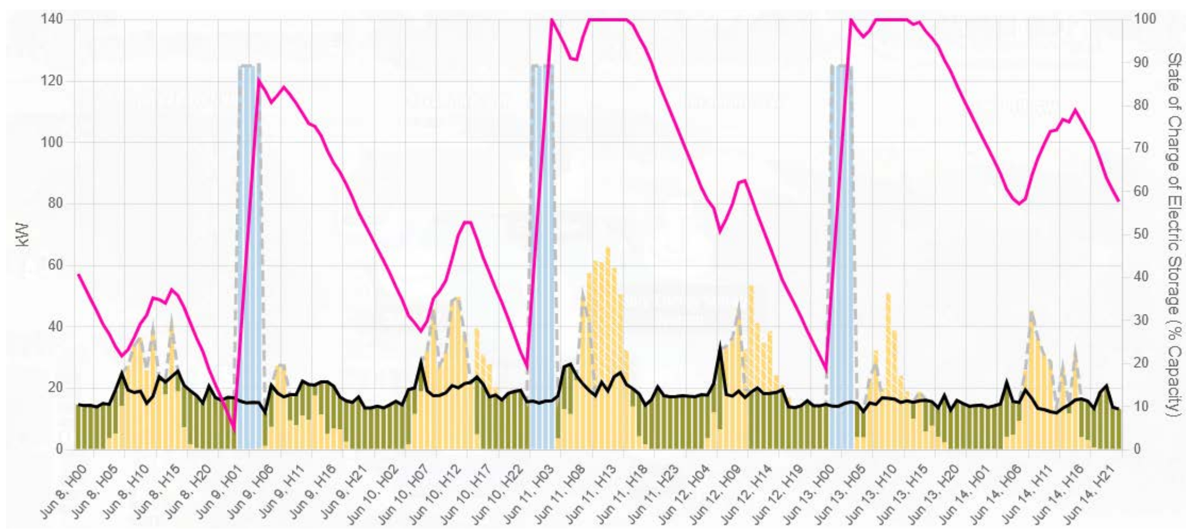
High-PV Outage Simulation:

June Period of Autonomy	100% Demand = Continuous 150% Demand = 53 hrs 200% Demand = 35 hrs
Daily Generator Runtime Required for Continuous Site Uptime in June	125kW Generator Upgrade: 100% Demand = 0 hrs/week 150% Demand = 12 hrs/week 200% Demand = 20 hrs/week

June Outage Scenario Electricity Dispatch – 100% Demand, 125 kW Generator



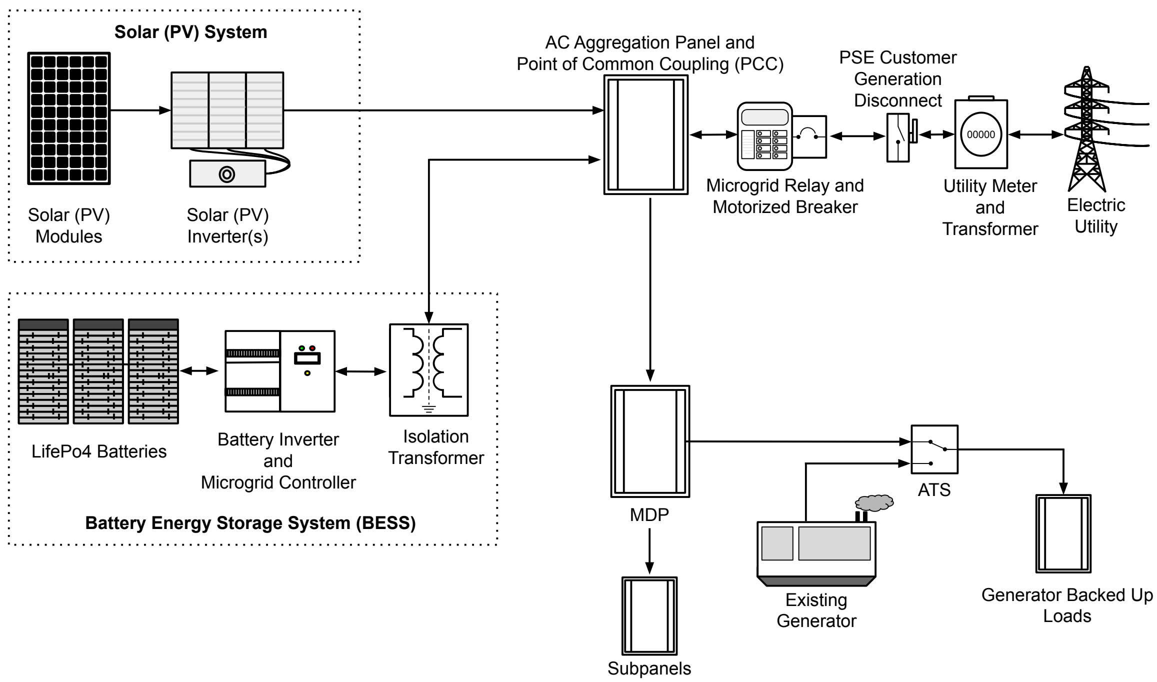
June Outage Scenario Electricity Dispatch – 150% Demand, 125 kW Generator



Interconnection

Topology:

The Tumwater Fire District Headquarters' power supply consists of an 1200A, 208Y/120V incoming service from a 150kVA PSE pad-mounted transformer on the south side of the property. The existing 1200A-rated main distribution panel (MDP) is not suitable for the point-of-common coupling (PCC) of the microgrid system due to limited available space in the electrical room. Our conceptual design utilizes a new 1200A AC Aggregation Panel that would be pad mounted on a pedestal in the landscaped area adjacent to the exterior HVAC units on the south side of the building and would serve as the PCC. The existing buried primary conductors running from the utility transformer to the main distribution panel would need to be excavated and re-routed to the new PCC equipment pedestal. Included on this pedestal would be a new CT enclosure and meter, a 1200A fused utility knifeblade disconnect (required for distributed generation systems), and finally the PCC. The PCC combines the incoming utility feed, BESS, PV, and feeds the existing MDP in the electrical room. Additional provisions can be added to the PCC to accommodate a future whole building generator system at a later date. The PCC also includes a microgrid interconnect device (MID), which consists of an 1200A rated motor controlled breaker and a SEL751 relay. The MID device automatically isolates the PCC from the utility during an outage, allowing the PV system and BESS to operate as a microgrid and supply power to the facility. The existing standby generator would be not be reconfigured and would remain in place as a redundant backup power supply for the existing essential loads at the facility. This microgrid system utilizes an Energy Management System to ensure that the distributed energy resources are dispatched efficiently



PCC Location

and that the capacity of the electrical equipment bussing is never exceeded.

Given the substantial amount of electrical reconfiguration required for this system, including the excavation of the buried primary service feeders from the utility, additional costs were factored into the system pricing. At this phase of the project, utility locates were not performed so this interconnection strategy is based on the assumption that the service conductors can be located and rerouted to the PCC. If this is deemed infeasible at a later date than an alternate interconnection plan and system configuration will need to be determined.

This configuration meets the goal of powering the entire building during seasonal outages as well as increasing the period of autonomy to allow the facility to be used as an Emergency Operations Center during a long term outage or natural disaster. This system also helps to reduce the runtime of the existing standby generator, conserving fuel reserves and increasing the building resiliency. The interconnection is a crucial element that affects the project's feasibility, budget, and timeline. Cascadia Renewables recommends that an electrical engineer verify the final system design before implementation.

Locations of New Infrastructure:

The conceptual design envisions the following locations for the new electrical equipment associated with this system:

PV Inverters - Exterior wall, under covered area to the east of HVAC units

BESS and Isolation Transformer - Pad mounted on SE corner of property, in grassy area adjacent to trees.

AC Aggregation Panel/PCC - Installed on pedestal in landscaped area to the west of HVAC units and near existing meter location.

New CT Meter - Installed on pedestal with new AC Aggregation Panel/PCC

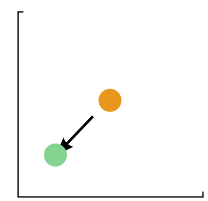
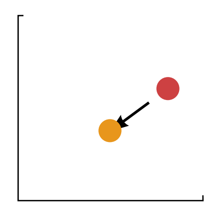
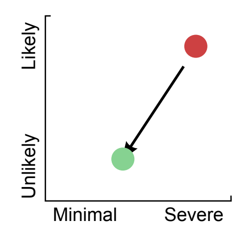
Utility Customer Generation Disconnect - Installed on pedestal, between meter and new aggregation panel.

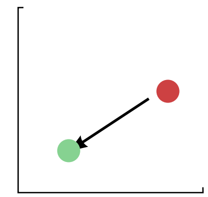
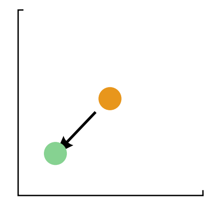
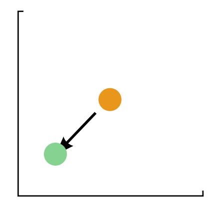
Microgrid Interconnect Device (SEL 751 Relay and Motorized Breaker) - Integrated into the new AC Aggregation Panel/PCC.

PCC Location

Project Risks

Developing a solar plus storage system comes with uncertainties, from incomplete information and market fluctuation. This feasibility study aims to mitigate some risks while identifying how others might be addressed. Risks have varying levels of severity and likelihood, which can be reduced by varying degrees through the proposed mitigation strategies.

Risk	Impact	Mitigation	Risk Before and After Mitigation
Construction projects often encounter unforeseen challenges, including site-specific conditions, environmental constraints, and permitting issues.	Delays in project timelines, increased costs, potential legal disputes, and strained relationships with stakeholders.	Regular site assessments, proactive stakeholder engagement, and a robust project management approach can help identify and address potential hurdles early. Engage in thorough due diligence before finalizing a contractor to ensure they are sufficiently qualified and experienced to take on a complex solar plus storage project. Ensure that contracts have clear clauses regarding delays, with penalties or incentives for timely completion.	
Geopolitical events can impact supply chains, project financing, and overall project feasibility.	Disruption in material or equipment delivery, increased costs, potential project cancellation, or delays due to financing issues.	Diversifying supply chains, monitoring global events closely, and having contingency plans in place can help navigate these challenges. Consider insurance or hedging options that protect against geopolitical risks.	
The industry can experience shortages in critical equipment due to high demand or manufacturing constraints.	Project delays, the potential need for equipment substitutions leading to design modifications, and increased costs.	Seek contractors with established relationships with multiple suppliers, who maintain a strategic inventory and who monitor industry trends to anticipate shortages. Consider contracts allowing equipment substitution or alternative solutions in case of shortages.	

Risk	Impact	Mitigation	Risk Before and After Mitigation
The availability and cost of skilled labor can fluctuate based on market conditions.	Delays in project timelines, potential compromise in work quality, and increased labor costs.	Consider prioritizing contractors with a strong track record of workforce management and training or with established partnerships with local training institutions. Ensure contracts have provisions for labor continuity and quality assurance. Consider the timeline of construction and allowance for longer construction periods or delaying construction until more workforce development for the large-scale solar plus storage industry has occurred.	
Detailed engineering and site-specific surveys may reveal conditions or requirements that impact cost and timeline.	Potential redesign requirements, increased costs, and project delays.	Engage experienced engineering firms, conduct thorough preliminary surveys, and allocate resources for potential additional studies. Consider engaging independent third-party reviewers for critical project milestones. Allocate a portion of the budget for potential additional studies or modifications.	
Prices for materials, equipment, and services can be subject to market volatility.	Unpredictable project costs, potential financial strain, and challenges in budgeting and forecasting.	Negotiate fixed-price or capped-price contracts where possible. Maintain a contingency budget for unexpected price fluctuations and ensure transparency in cost adjustments.	

Logistical and Financial Analysis

Hurdles Presented by Existing Conditions

Below are construction challenges and setbacks that could arise while implementing this conceptual design and potential mitigation strategies for them. Overcoming certain hurdles may create additional expenses, while other hurdles necessitate further validation of the final design before incurring significant costs.

BESS installation location will be in close proximity to areas that are accessible and/or visible

For safety reasons, the BESS system will need to be housed in a substantial outdoor metal enclosure at the location shown on the feasibility study's site plan. This is in a highly visible, high usage zone, and may impact the aesthetics or assesibility of this area.

Mitigation Strategy 1: An alternative location may be available and coordinated with the installing contractor at the time of final design. Additional costs may arise from this change.

Mitigation Strategy 2: Additional fencing may be installed to mitigate visibility and access to the BESS system. Electrical and property setbacks must be followed.

Utility locates may alter the trenching route

Underground utilities could require altering the conceptual trench route, requiring additional labor and potential concrete cutting and repair. This could increase system costs.

Mitigation Strategy 1: Locate utilities ahead of bid solicitation and document this for potential contractors to design around.

Mitigation Strategy 2: Require itemized costs for trenching and concrete cutting per foot and NTE clauses on bids to ensure that construction costs are understood and cannot balloon beyond established contingencies.

Fire Control Systems may activate during a power outage

Reviews of installed BESS systems show that some building Fire Control Systems may activate temporarily when the power goes out and the change from grid to battery power is occuring due to the millisecond delay.

Mitigation Strategy: On-site personnel must be trained as to the proper operation and required steps for building and BESS operation during and extended emergency.

The standing seam metal roof has reported leakage issues in past years

Chief Hurley informed CR staff that there have been past issues with leakage and water intrusion that will require careful planning, system layout, and installation methods.

Mitigation Strategy 1: A pre-contracting roof review should be completed by the installing solar contractor in conjunction with the original roofing installer to locate potential leaks and verify the installation methods required to maintain the current roof warranties.

Mitigation Strategy 2: If it is determined that the solar project cannot be installed with the roof in its current condition, the Fire Department will need to conduct repairs and/or replacement of roof sections at their expense in order to ensure the integrity fo the roof surface.

Mitigation Strategy 3: The solar contractors warranties should be reviewed and approved prior to awarding an installation contract.

Limited available space for BESS given Fire Code Setback Requirements

The 2021 Washington State Fire Code requires the BESS to have a 10’ clearance from exposures including buildings, lot lines, public ways and hazardous materials. In addition, areas within 10’ of a BESS much be cleared of combustible vegetation. These clearance requirements limit the available locations that a BESS can be located on the property.

Mitigation Strategy 1: Seek an exposure clearance exemption from the fire code official based on the BESS large scale fire testing results and Hazard Mitigation Analysis report to open up more potential BESS installation areas.

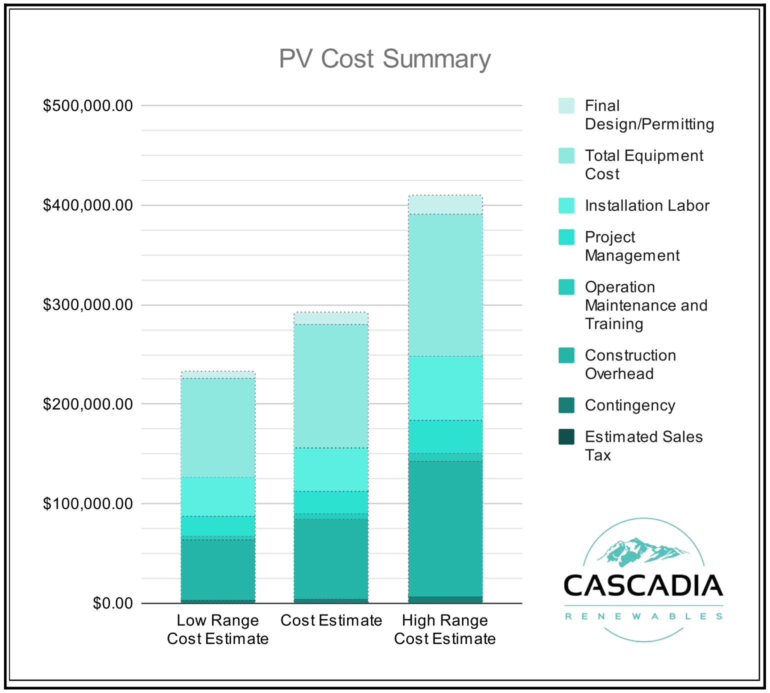
Mitigation Strategy 2: If a location cannot be found with the required 10’ vegetation perimeter, then tree/vegetation removal may be required. Based on client feedback the preference would be to remove deciduous trees if necessary and then replant elsewhere.

System Budget

Cascadia Renewables included current Davis Bacon prevailing wage rates, contractor direct pricing, permitting, and consulting/engineering fees to determine the conceptual system pricing. The labor rates and equipment pricing used in the provided budgetary information are relevant to and compliant with local, regional, and federal grant programs to give the applicant access to an array of funding opportunities. The estimated installation cost excludes any required architectural or structural improvements, the internal organizational cost of procurement, and administration. This cost estimate also excludes future storytelling and community engagement efforts.

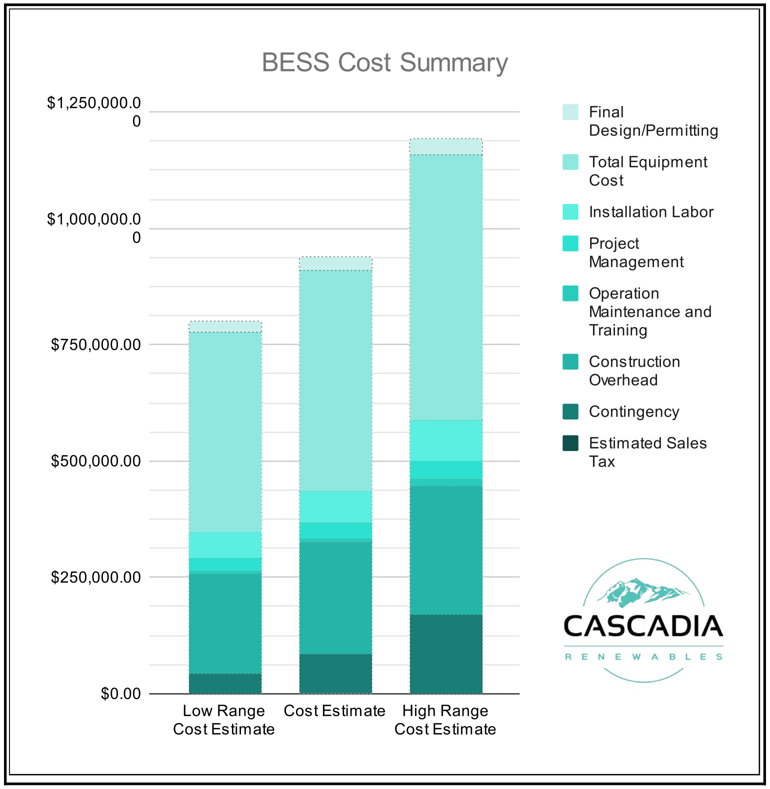
We advise applicants to consider these budget items separately and designate suitable resources for each. The cost estimate provided is based on market conditions, availability of labor, and equipment costs at the time of writing.

Since it is a well-established and competitive market, there is limited opportunity to reduce these costs further. The projected increase in the demand for BESS projects over the coming years may outpace the current supply. This may inflate equipment costs in the short term, which we reflect in our estimated budget. Final pricing may vary based on the chosen installation partner, final engineered solution, on-site soil, and geotech studies, which are not available within the scope of this feasibility study. We recommend establishing a comprehensive 3+ bid RFP process that encourages contractor participation, value engineering, and competitive pricing. We recommend periodic system price updates during the project development and construction.

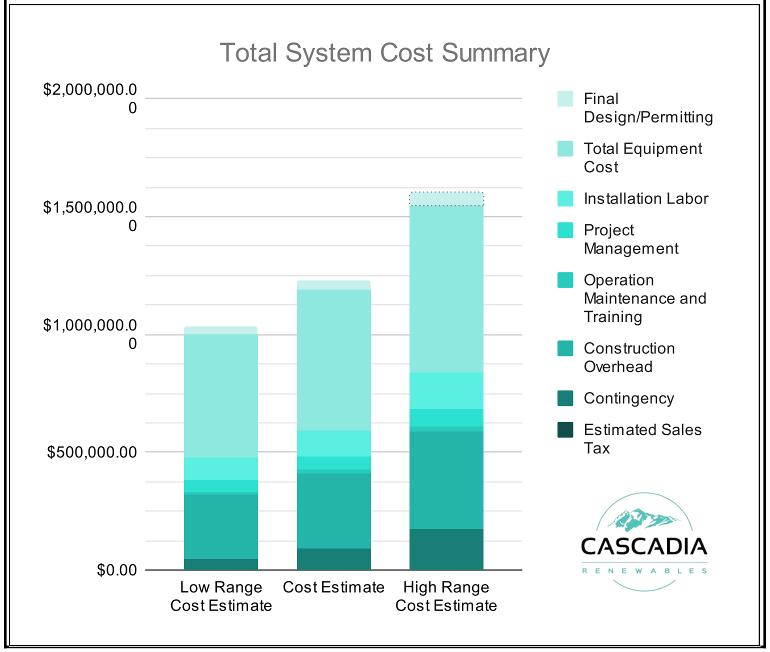


PV - COST SUMMARY

Total Costs	Low Range Cost Estimate	Cost Estimate	High Range Cost Estimate
Final Design/Permitting	$5,900.00	**$11,800.00**	$17,700.00
Total Equipment Cost	$99,360.00	**$124,200.00**	$142,830.00
Installation Labor	$38,880.00	**$43,200.00**	$64,800.00
Project Management	$20,160.00	**$22,400.00**	$33,600.00
Community Outreach	TBD By Applicant	**TBD By Applicant**	TBD By Applicant
Operation Maintenance and Training	$4,250.00	**$5,000.00**	$7,000.00
Construction Overhead	$60,300.00	**$80,400.00**	$136,680.00
Contingency	$3,500.00	**$5,000.00**	$7,000.00
Estimated Sales Tax	$0.00	**$0.00**	$0.00
Total PV System Cost Estimate	**$232,350.00**	**$292,000.00**	**$409,610.00**
Cost/Watt ($/w)	**$2.50**	**$3.14**	**$4.41**



BESS - COST SUMMARY			
Total Costs	**Low Range Cost Estimate**	**Cost Estimate**	**High Range Cost Estimate**
Final Design/Permitting	$25,075.00	**$29,500.00**	$33,925.00
Total Equipment Cost	$427,230.00	**$474,700.00**	$569,640.00
Installation Labor	$57,120.00	**$67,200.00**	$87,360.00
Project Management	$26,880.00	**$33,600.00**	$40,320.00
Community Outreach	TBD By Applicant	**TBD By Applicant**	TBD By Applicant
Operation Maintenance and Training	$7,000.00	**$10,000.00**	$14,000.00
Construction Overhead	$215,280.00	**$239,200.00**	$275,080.00
Contingency	$42,750.00	**$85,500.00**	$171,000.00
Estimated Sales Tax	$0.00	**$0.00**	$0.00
Total BESS System Cost Estimate	**$801,335.00**	**$939,700.00**	**$1,191,325.00**
Cost/Kilowatt Hour ($/kWh)	**$1,552.97**	**$1,821.12**	**$2,308.77**



Total System - COST SUMMARY

Total Costs	Low Range Cost Estimate	Cost Estimate	High Range Cost Estimate
Final Design/Permitting	$30,975.00	**$41,300.00**	$51,625.00
Total Equipment Cost	$526,590.00	**$598,900.00**	$712,470.00
Installation Labor	$96,000.00	**$110,400.00**	$152,160.00
Project Management	$47,040.00	**$56,000.00**	$73,920.00
Community Outreach	TBD By Applicant	**TBD By Applicant**	TBD By Applicant
Operation Maintenance and Training	$11,250.00	**$15,000.00**	$21,000.00
Construction Overhead	$275,580.00	**$319,600.00**	$411,760.00
Contingency	$46,250.00	**$90,500.00**	$178,000.00
Estimated Sales Tax	$0.00	**$0.00**	$0.00
Total System Cost Estimate	**$1,033,685.00**	**$1,231,700.00**	**$1,600,935.00**

Economic Benefit

This is a detailed breakdown of the cash flow of the system. Please note that this breakdown does not include the cost of operations and maintenance, as that cost is challenging to predict. Cascadia Renewables does not want to offset the confidence we otherwise have in these financial estimates by overshadowing our conclusions with less reliable data. To that effect, Cascadia Renewables recommends requesting an estimate for annual operations and maintenance as part of the contractor selection RFP.

Maintenance Considerations

An operations and maintenance plan should be enacted by internal personell or an external contractor. When designing this plan, consider the following:

- The PV system will require regular annual or bi-annual PV module cleaning to remove any built-up debris in order to maintain the peak system performance and maximum BESS charging capabilities. The maintenance schedule will vary depending upon the site conditions, frequency of rain events, and build up of season debris such as fall leaves or needles.
- The BESS will require regular maintenance to maintain it's equipment warranty and ensure proper system functionality. The required maintenance steps and frequency will be defined by the equipment manufacturer but typically include servicing the BESS HVAC and fire protection systems, internal/external visual inspections, loose connections check, and a functional battery test on an annual basis.

Assumptions and Key Financial Metrics

Discount Rate	5.0%	Federal Tax Rate	0.0%	State Tax Rate	0.0%
Average Annual Utility Escalation	3.0%	PV Generation (kWh/kW-DC)	987 kWh/kW-DC	Average PV Degradation Rate	0.56%
Average ESS Degradation Rate	5.00%				

Years	Project Costs	Electric Bill Savings	Grant Amount	PV Generation (kWh)	Total Cash Flow	Cumulative Cash Flow
Upfront	-$1,231,700	-	-	-	-$1,231,700	-$1,231,700
1	-	$10,455	$1,231,700	91,643	$1,242,155	$10,455
2	-	$10,750	-	91,130	$10,750	$21,205
3	-	$11,052	-	90,616	$11,052	$32,257
4	-	$11,363	-	90,103	$11,363	$43,620
5	-	$11,683	-	89,590	$11,683	$55,304
6	-	$12,012	-	89,077	$12,012	$67,316
7	-	$12,350	-	88,564	$12,350	$79,666
8	-	$12,698	-	88,050	$12,698	$92,363
9	-	$13,055	-	87,537	$13,055	$105,418
10	-	$13,422	-	87,024	$13,422	$118,840
11	-	$13,800	-	86,511	$13,800	$132,639
12	-	$14,188	-	85,998	$14,188	$146,827
13	-	$14,587	-	85,484	$14,587	$161,414
14	-	$14,997	-	84,971	$14,997	$176,410
15	-	$15,418	-	84,458	$15,418	$191,829
16	-	$16,201	-	83,945	$16,201	$208,030
17	-	$16,585	-	83,432	$16,585	$224,615
18	-	$16,978	-	82,918	$16,978	$241,593
19	-	$17,379	-	82,405	$17,379	$258,972
20	-	$17,789	-	81,892	$17,789	$276,760
Totals:	-$1,231,700	$276,760	$1,231,700	1,735,350	$276,760	-

Community Benefit

The Tumwater Fire Department Headquarters plays a crucial role in serving the City of Tumwater. This facility operates as both a fire station and an emergency coordination hub. It supports daily Fire Department operations and serves as the primary Emergency Operations Center during major events or disasters. The site ensures that emergency services remain available during power outages, providing backup power to maintain operations and support the community's safety needs.

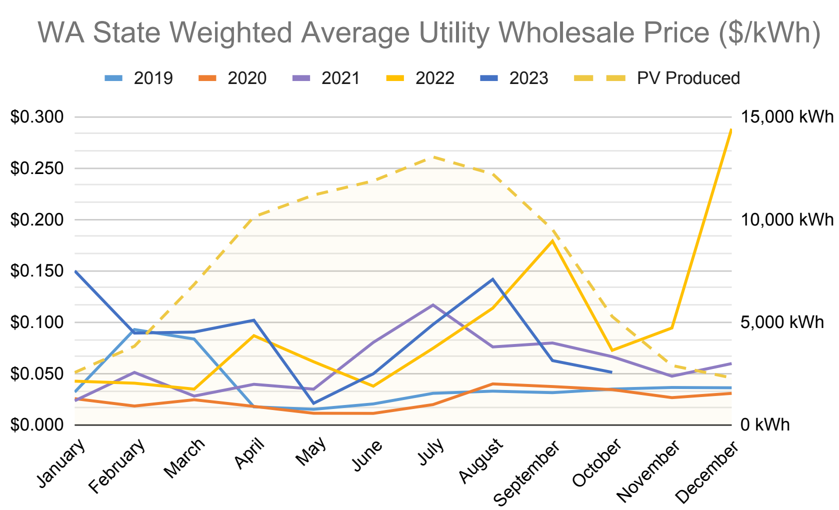
Approximately 27,000 people live in the range of the fire district. The City of Tumwater has only two fire stations: its headquarters and the North End station. If one or both of these stations were to become inoperable, the effect on the city's emergency response capacity would be immediate and severe.

By specifying local contractors and utilizing union labor and apprenticeship programs, the workforce local to the area can be trained. This increases the local capacity to develop future resiliency projects.

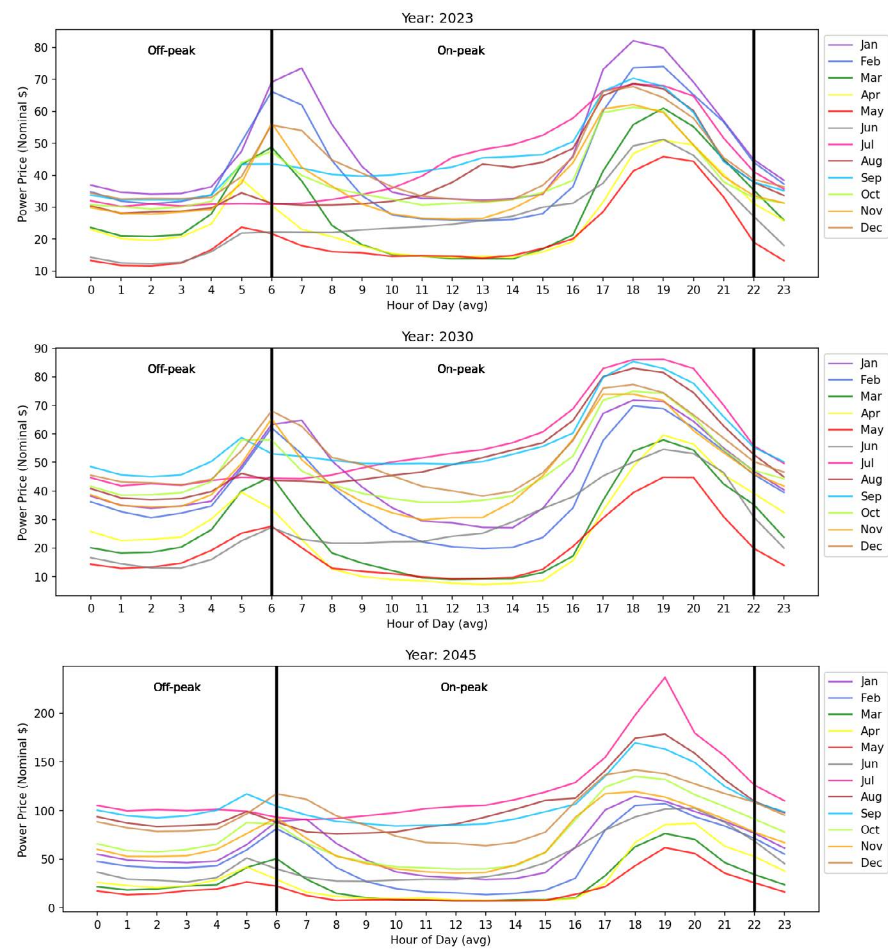
Over the warrantied lifetime of the PV array, the system will offset 1,436 tons of carbon, equivalent to planting 21,536 trees.

Grid Benefit

At a national level, the US electric grid is one of the world's largest and most complex machines, with aging infrastructure facing increased demand due to the electrification of transportation and buildings, population growth, and migration. Distributed Energy Resources (DERs) play a crucial role in strengthening existing grid infrastructure and moving toward a more equitable and sustainable electric grid. Washington State has historically relied on hydroelectric power to balance energy demand. However, climate change is reducing snowpack and our available hydro resources, making it necessary to explore alternative options. Regional electricity prices, represented in the middle Columbia WA State Weighted Average Wholesale Price graph below, have been increasingly volatile during late summer afternoons. The largest investor-owned utility (IOU) in WA, PSE, anticipates that this price volatility will increase in coming years (see graph below). In Washington State, solar generation can help address the energy shortfall during summers, and energy storage can provide balancing services and further reduce demand during peak periods.



Monthly production of the system vs average wholesale energy pricing. Coincidence of high production to high pricing is financially beneficial.



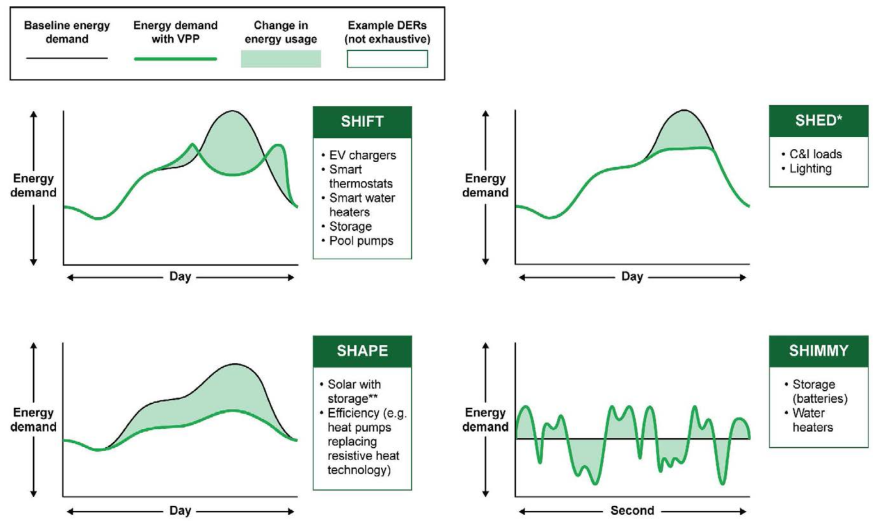
Daily price volatility by month for the years 2023, 2030, and 2045.

The US Department of Energy's September 2023 report titled "The Pathway To Commercial Liftoff: Virtual Power Plants" suggests integrating solar panels, battery storage, and micro-grid projects to optimize energy resource usage and manage grid stability. Virtual Power Plants (VPPs) and networked energy storage solutions are cost-effective alternatives to natural gas peaker plants, offering substantial benefits and low costs. The report highlights the importance of adopting innovative technologies to meet the growing energy demand sustainably and cost-effectively. Ultimately, strengthening the grid benefits the entire community. This project can play a part in improving regional energy infrastructure by reducing energy demand and providing grid-balancing services.

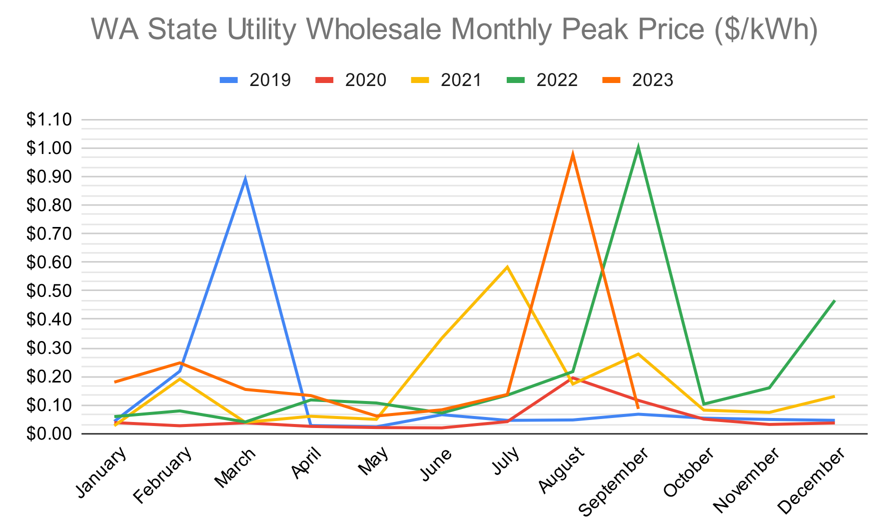
Energy pricing can serve as an effective method for utilities to encourage efficient energy dispatch from flexible resources such as solar and storage. A well-optimized system can use stored energy during high-demand periods, contributing to grid stability and economic efficiency. By implementing an appropriate demand response program, unused BESS capacity can be deployed to reduce peak demand across the service territory on a grid scale. This section aims to evaluate the potential benefits of the conceptual system in terms of reducing demand, exporting energy, and providing grid-balancing services.

PSE does not currently have a demand response program, so we have conducted optimizations to showcase the maximum demand reduction on-site while ensuring battery cell longevity.

To illustrate the effects that the conceptual system could have on the site's demand, we have simulated the conceptual system with a model of predicted consumption patterns. These charts depict the days on which the peak demand for January is predicted to occur, according to our simulation



Illustrations of the various ways DERs can influence demand. "Shape" (bottom left) is the most likely result of a solar plus storage system. Graphs by the US Department of Energy.

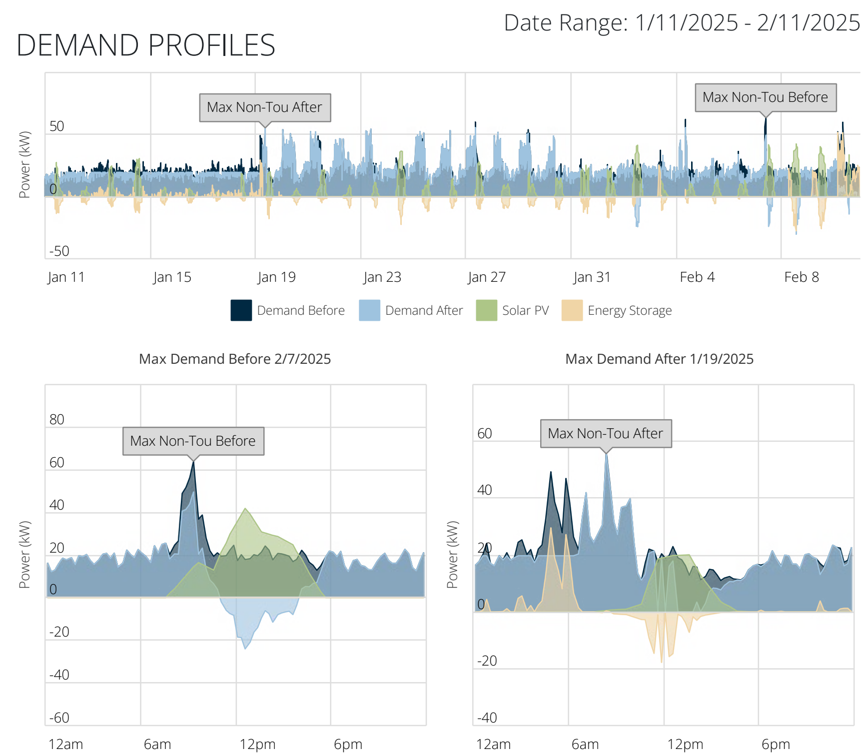


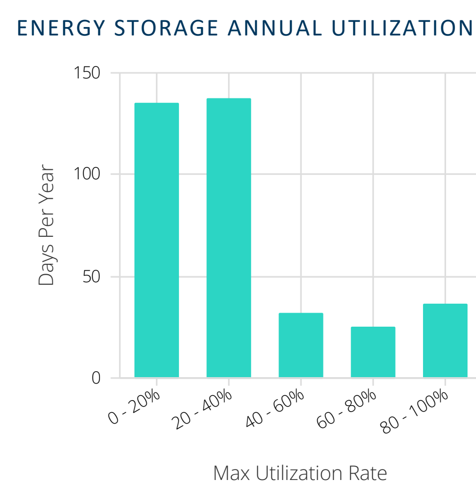
The highest wholesale costs can be mitigated by dispatching unused BESS capacity, given appropriate programs.

of the conceptual system. The demand of the site before accounting for the system is shown in dark blue, while the demand that would result from its implementation is shown in light blue. The difference between the demand before and the demand after is the sum of the PV generation (shown in green) and the BESS's flow (shown in yellow). The chart on the left displays the day of maximum historical demand, while the chart on the right displays the day of maximum simulated demand accounting for the effects of the conceptual system. The appendix provides the same series of charts relevant to each month throughout the year. Note that any smoothing or demand reduction on site represents a reduced burden on the local grid.

To promote system health and longetivity, the BESS should be configured to partially discharge each day. This discharge can be coordinated with times of peak building demand, which will reduce and flatten the demand profile of the building. Based on utility bills this facilitity is subject to monthly peak demand charges so the BESS could be strategically dispatched during times of peak building demand to lower monthly demand charges, providing additional economic benefits from the system.

The bar chart shows how many days each quintile of the BESS is used for on-site demand management throughout the year. It is worth noting that increased utilization of the BESS could result in a faster degradation rate.





Above: Dispatch graphs showing the effects of the conceptual solar plus storage system on peak demand for the month of January.

Left: Histogram of the distribution of BESS utilization over a year.

Permitting and Utility Agreements

If this project proceeds to installation, it will be the responsibility of the installer to verify the relevant authorities having jurisdiction (AHJs) and ensure all necessary permits and agreements are in place. As it pertains to this conceptual design, Cascadia Renewables has identified the following AHJs and has documented our interactions to date.

Laobr & Industries - Electrical Permitting:

The conceptual PV system and BESS design will require electrical permitting and a possible plan review from the Washington Department of Labor & Industries to verify that they meet all current WAC and NEC code reviews. Code revisions may occur in the NEC and WAC and will need to be verified during the final system design.

Puget Sound Energy - Interconnection:

The conceptual PV system is designed to align with Puget Sound Energy's standard interconnection rules, with a capacity of 100kW AC or less per customer meter. This classification ensures the system adheres to the established approval procedures for Net Metering. To proceed, a Schedule 150 Application and Agreement for Interconnection, Net Metering, and Production must be submitted.

Department of Archeology and Historic Preservation:

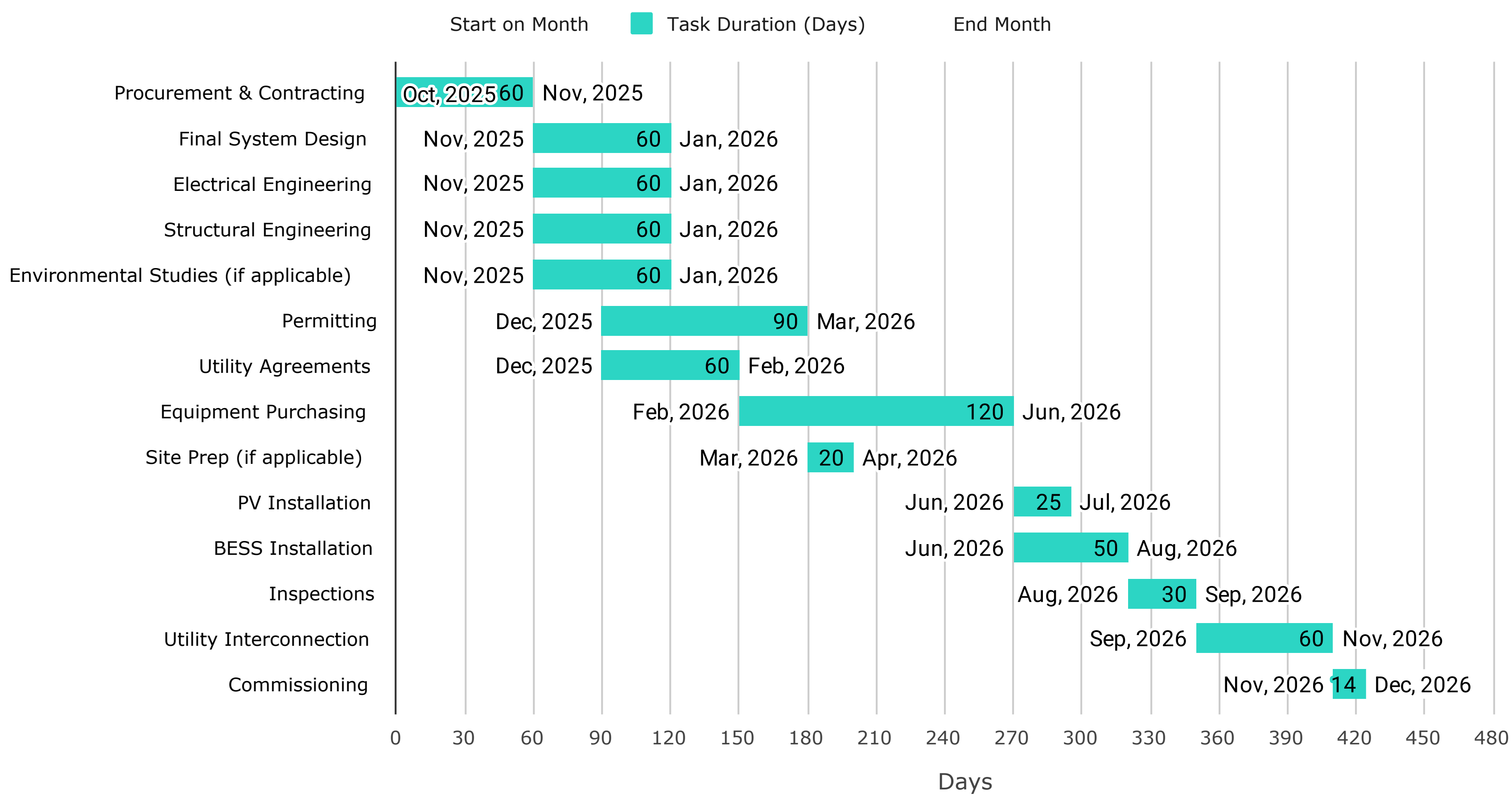
This permit is required any time there is soil disturbance. DAHP does not charge a fee to process or issue a permit; however, there are penalties for failing to obtain or comply with a permit.

Solar, BESS, Building, and Fire Review/Permitting:

The City of Tumwater Community Development Department will provide single point review and permitting for the rooftop solar arrays, the BESS installation location, BESS pad and fire code compliance. Al Christensen, the Building and Fire Safety Official at the Department provided an initial review of the project on 3/25/2025 to determine permitting requirements. The rooftop solar array will require a standard Building Permit Application that includes a site plan, rooftop array layout drawing, stamped engineering letter or plans showing compliance to snow/wind loading requirements, and equipment specification sheets.

The BESS installation can be included in this single permit application, with additional documentation showing compliance to NFPA/NEC required setbacks and fire safety requirements. Planning will require that the BESS be shielded from public view by a solid wall or fence and that a Foundation Plan be submitted. Chainlink fences are not acceptable as shielding. The initial review indicated that no land use, or additional special use permits will be required. All fire reviews for the BESS and PV system will be included in the Building Permit review, with no additional permit applications required. Please note that the Department indicated that the "rules may change by the time of installation. The Department is currently reviewing other ongoing installations in the County and may be updating permitting requirements or BESS installation policies."

Schedule


Start on Month
Task Duration (Days)
End Month
Procurement & Contracting
Oct, 2025 60 Nov, 2025
Final System Design
Nov, 2025 60 Jan, 2026
Electrical Engineering
Nov, 2025 60 Jan, 2026
Structural Engineering
Nov, 2025 60 Jan, 2026
Environmental Studies (if applicable)
Nov, 2025 60 Jan, 2026
Permitting
Dec, 2025 90 Mar, 2026
Utility Agreements
Dec, 2025 60 Feb, 2026
Equipment Purchasing
Feb, 2026 120 Jun, 2026
Site Prep (if applicable)
Mar, 2026 20 Apr, 2026
PV Installation
Jun, 2026 25 Jul, 2026
BESS Installation
Jun, 2026 50 Aug, 2026
Inspections
Aug, 2026 30 Sep, 2026
Utility Interconnection
Sep, 2026 60 Nov, 2026
Commissioning
Nov, 2026 14 Dec, 2026
0 30 60 90 120 150 180 210 240 270 300 330 360 390 420 450 480
Days

Summary of Feasibility and Next Steps

A solar plus storage system at the Fire District headquarters offers resiliency benefits by ensuring power availability during outages. Designed to support an entire facility, the system provides backup power for periods ranging from medium-duration outages to extended ones. During winter months, when solar power generation may be reduced due to weather conditions, the solar + storage system offers a shorter duration period of autonomy without an additional distributed generation resource, such as a larger whole building backup generator. The integration of a larger 125kW whole building generator would increase the systems resiliency benefits and would ensure that essential operations continue smoothly and uninterrupted, even in less favorable conditions.

This site does pose some additional challenges when considering adding a solar plus storage microgrid system. These include complex electrical work to install the new equipment required for the microgrid integration into the existing electrical system, limited available space for the BESS according to fire code requirements, and the lack of an adequately sized generator to recharge the BESS during long term outages. However, these hurdles have been identified and included in the system cost estimates. It would still be feasible to integrate a solar plus storage microgrid system at this facility.

Next Steps:

- Evaluate the available space and proposed locations for the pad-mounted BESS.
- Explore possible alternative funding opportunities for a whole building generator upgrade.
- Consider funding pathways and potential grant writing efforts.
- If successful in grant requests and negotiations, construct project.

Additional Reference Information

General Site Information

Managing Organization	City of Tumwater
Site Address	311 Israel Rd SW, Tumwater, WA 98501
Parcel Number	82700100100
Organization Contact	Brian Hurley, Fire Chief
Organization Contact Phone Number	(360) 754-4170
Organization Contact Email	BHurley@ci.tumwater.wa.us

Utility Information

Service Electric Utility	Puget Sound Energy (PSE)
Electric Utility Meter Number	P166329611
Electric Utility Tariff Structure	Commercial 25
Electric Utility Hosting Capacity	Generation Hosting Capacity of 1.21 MW

Minimum Equipment Recommendations

The conceptual system has been designed assuming specific named products. These choices are based on the current market, and the named equipment may not be the best choice for the project or may not be available at the time of hypothetical construction. When evaluating bids, we recommend considering the following criteria to be the acceptable minimums.

PV Modules:

Warranty: Minimum of 12 years for the product, extending to 25 years, covering parts and labor.

Performance Guarantee: A linear performance warranty that guarantees at least 86% of nominal power rating after 25 years.

Manufacturing Standards: Modules should be Tier 1 qualified, preferably assembled in the USA.

Cell Type: Monocrystalline cells.

Frame and Weight: Anodized aluminum frame with an average system weight not exceeding 2.6 pounds per square foot (psf).

Certifications: Compliance with UL 1703/UL 61730; PID Resistance (IEC 62804); Salt Mist (IEC 61730) when PV system is within 2 kilometers of shoreline; and Fire Classification matching that of the existing roof.

PV Inverters:

Efficiency and Warranty: Minimum efficiency of 96%, with a 10-year limited warranty, extendable up to 5-15 years.

Compliance and Compatibility: Must comply with IEEE 1547/ UL1741SB standards; suitable for output voltages of 120/240V Single-Phase, 120/208V 3-Phase, or 277/480V 3-Phase as dictated by the BESS design and existing electrical infrastructure; FCC Part 15 Class A; SunSpec Modbus Compliant.

Safety Features: UL1699B; NEC 2020 Rapid Shutdown Compliant; Ground Fault Detection and Interruption, AC and DC Surge Protection

PV Monitoring:

Monitoring Level: Module-level monitoring

Connectivity: Connection options should include hard-wired Ethernet, Wi-Fi, or a cellular connection.

User Interface: A web-based portal accessible to customers, displaying real-time and historical data on PV power, energy production, system alerts, and module status.

Mounting System:

Warranty and Design: A minimum of a 25-year manufacturer warranty. The mounting system design should be suitable for the specific roof type and capable of withstanding local wind, seismic, and snow loading requirements.

Compatibility with Roof Materials: For standing seam metal roofs, use non-penetrating clamps. The mounting system must comply with UL2703 and local building codes, as well as maintain the roof's warranty and fire classification.

Examples of Mounting Systems for Standing Seam Metal Roofs.

BESS Specifications:

Warranty: Minimum 5-year manufacturer's warranty with 5-10-year warranty extension options.

Standards Compliance: Must comply with UL 9540 and UL 9540A for safety. Must adhere to NFPA 855 standards for installation and safety.

Battery Chemistry: Lithium Iron Phosphate (LFP/LiFePO4) is preferred for its stability, safety, and longevity.

Compatibility: Should be compatible with a range of third-party inverters and microgrid control systems. Should include generator compatibility and black start capability.

Enclosure Rating: A minimum NEMA 3R rating is required for outdoor installations to ensure protection against weather elements. If the system is to be installed near salt water, the enclosure must be suitable for the environment, and warranties must not be voided.

Fire Suppression: Active chemical fire suppression and exterior ventilation is recommended for all indoor and outdoor installations.

Battery Heating/ Cooling Equipment: Integrated HVAC or alternate active temperature control system to maintain ideal battery operating conditions and temperature.

Country of Origin: Must meet any specific country of origin requirements as per the funding source's guidelines.

Energy Capacity and Power Output: Specified based on the project's energy storage needs, considering peak demand shaving, load leveling, and backup power requirements.

Multimodal BESS Inverter: Should have the following listings and certifications, including but not limited to: UL 1741SB, IEEE 1547, IEEE 519, NEMA 3R Enclosure, Minimum efficiency of 95% with a minimum 10-year limited warranty, extendable up to 5-15 years

Efficiency and Performance: High round-trip efficiency and low degradation rate over the system's operational life.

Safety Features: Advanced Battery Management System (BMS) for monitoring cell voltage, temperature, state of charge, and overall system health. Overcharge, deep discharge, overcurrent, and short-circuit protection.

Scalability: Ability to scale up the system with additional energy storage modules or integrate with existing renewable energy systems.

Installation Flexibility: Suitable for various installation environments, including ground mount, rooftop, or integrated within existing infrastructure.

Maintenance: Low maintenance requirements, with remote monitoring and diagnostics capabilities.

Microgrid Controller:

Functionality: Highly recommended to include a microgrid controller for advanced management capabilities.

Integration: Should offer interoperability with third-party Virtual Power Plant (VPP) providers.

Features: Capable of real-time monitoring, demand response, load management, and predictive analytics.

User Interface: Intuitive, user-friendly interface for system management and data visualization.

Grid Support: Ability to monitor grid voltage and frequency to initiate power quality correction measures using distributed energy assets when needed.