AECOM

Solar PV Feasibility Study
Santa Rosa Water

City of Santa Rosa

May, 2024

Delivering a better world

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1. Background

In 2021 AECOM completed a detailed feasibility study for the City of Santa Rosa to help the city identify cost-effective opportunities for reducing greenhouse gas (GHG) emissions and improving the resiliency of the City's operations. Under this scope, AECOM performed a detailed investigation to analyze the feasibility of deploying microgrids at two City building clusters as well as identify opportunities for installation of solar photovoltaics and energy efficiency measures at all City facilities and parks.

Following that feasibility study, Santa Rosa Water requested a solar photovoltaic (PV) feasibility study for two sites: Utility Field Operations (UFO) and Laguna Wastewater Treatment Plant (LTP).

The aim of this study is to better understand the feasibility of solar PV projects at UFO and LTP initially laid out in 2019 City of Santa Rosa Water Operations Energy Optimization Plan, Technical Memorandum #9.

This report presents the key insights and results from a comprehensive analysis of the identified solar PV opportunities at the Santa Rosa Water facilities. The initial purpose of the analysis was to determine maximum solar PV generation capacity available at two sites: UFO and LTP – Pond B & C. After further discussions with the City and considering regulatory changes in the renewable energy generation and grid interaction, the scope was revised to identify the generation capacity required to offset the energy consumption at the facilities.

2. Assumptions

AECOM collected facility data through a request for information (RFI) process. Energy consumption factors and facility characteristics were identified and collected. AECOM then analyzed these combined datasets to confirm energy utility consumption baselines.

In performing the analysis, AECOM made the following assumptions:

- This report refers to the site utility field office as UFO, and to the floating solar as LTP.
- The monthly and annual electricity consumption is determined using an annual energy consumption data set file (8760 data set file) provided by the city.
- Sonoma Clean Power (SCP) provided an emissions summary for Santa Rosa Water which includes data for the two sites, UFO and LTP, along with greenhouse gas (GHG) emissions per kWh.

AECOM utilized the following tools in conducting the analysis:

- Homer Grid: The Homer Grid is a software tool used for simulation and analysis of renewable energy systems. It is used to evaluate the feasibility, design, and optimization of renewable energy projects, considering the local electrical grid, available renewable energy sources, energy storage systems, and energy consumption patterns. The Homer Grid helps to assess the economic and technical performance of microgrid projects and provides recommendations for equipment sizing, system configuration, and project financing.
- PVsyst: The PVsyst is a software tool used for the design and analysis of solar PV systems. The software models and analyzes a variety of solar system configurations, including roof-mounted, ground-mounted, and carport systems. It considers various factors such as shading, orientation, tilt angle, and location to accurately predict the expected energy production of a solar system.
- Helioscope: A software tool for designing and analyzing solar PV systems, considering factors such as shading, orientation, tilt angle, and location to predict a solar system's annual energy production accurately. It can model and analyze various solar system configurations, including roof-mounted, ground-mounted, and carport systems.

3. Utility Field Office Energy Assessment

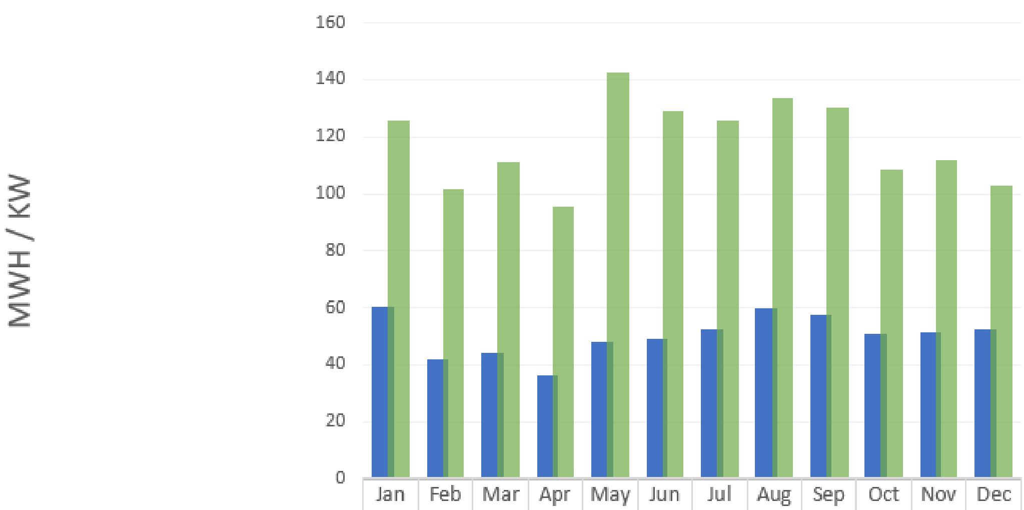
AECOM performed energy assessment for Utility Field Office (UFO) located at 35 Stony Point Rd, Santa Rosa. Energy data from January 2023 to December 2023 provided by Sonoma Clean Power (SCP) is analyzed. Billing for this site is under the E-19 Time-of-Use (TOU) tariff for SCP, expected to increase by 18.3%, as per the "January 2024 Semi-annual Business and Agriculture Rate Filings, Tools & Updates.[1]" Additionally, the E-19S tariff for PG&E also applied to this site, covering distribution costs for demand (kW) and energy (kWh), as well as other different adjustment charges such as transmission rate and nuclear decommissioning. as mentioned in the most recent E-19 electricity schedule from February 2024 on the PG&E[2] website.

Electric Consumption

Currently, the UFO site is equipped with a 125kW solar PV system, which does not fully meet its energy needs. AECOM has calculated the site's total energy consumption from the utility using the 8760 data set file provided by the city, which details the site's annual utility energy use and its own energy production. The analysis determined that the site's annual energy consumption from the utility is 604 MWh for the period from January 2023 to December 2023. The highest energy consumption was recorded in January at 61 MWh/month. The highest peak demand was recorded in May at 142 kW. These consumption and demand values can be seen in Figure 3-1.

Under the existing conditions, without incorporating any new PV or battery energy storage system (BESS), the utility's annual charges amount to $152,511. This total includes $105,681 for energy consumption and $46,831 for demand charges.

Figure 3-1: 2023 UFO Net Electric Consumption energy and demand (MWh/kW)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facility Energy Consumption (MWh)	61	42	44	36	48	49	53	60	58	51	51	52
Facility Load Demand (kW)	126	102	111	95	142	129	126	133	130	108	112	103

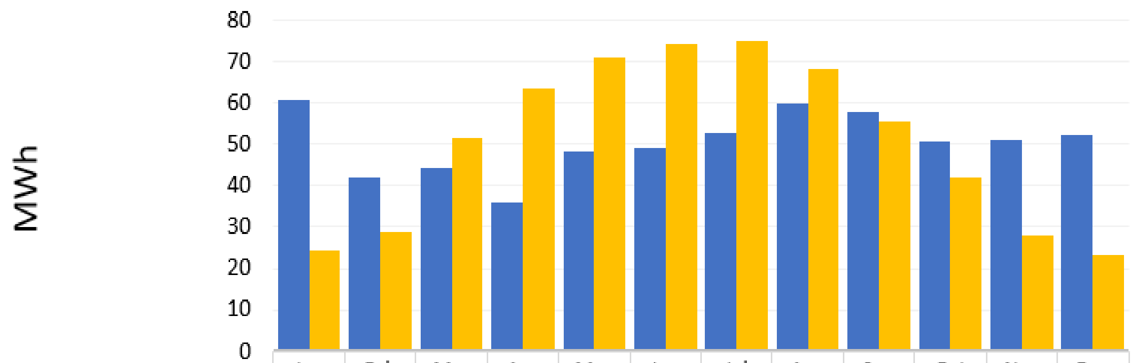
Solar PV Generation

AECOM determined that a PV system of 330 kW is necessary to fully offset the annual energy requirements. This system will produce 604 MWh of energy annually and consists of 770 carport vertical modules and 7 AC/DC power inverters. The PV modules, operating with an 85.1% performance ratio and an AC load ratio of 1.13, will be oriented at an average azimuth angle of 179.98 degrees and a fixed tilt of 7 degrees to achieve full coverage of the site's energy consumption. Figure 3-2 illustrates the estimated area that the PV system will occupy at the UFO site.

Figure 3-2: Solar PV power output and area.

Figure 3-3 shows a chart comparing monthly energy usage at the facility with the output from the proposed 330 kW solar PV system by AECOM. It aligns the facility's monthly energy use in MWh against the solar system's production. Any surplus energy generated during daylight is fed back to the grid. Annually, the solar system can generate 604 MWh, matching the facility's yearly consumption of 604 MWh.

Figure 3-3: Energy offset (by MWh) Estimate



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facility Energy Consumption (MWh)	61	42	44	36	48	49	53	60	58	51	51	52
PV Energy Generation (MWh)	24	29	51	63	71	74	75	68	55	42	28	23

The E-19 Large General Service tariff, with peak hours from 12 PM to 6 PM during summer, matches the solar panels' production times of 8 AM to 6 PM, making summer afternoons ideal for exporting energy. In winter, the tariff's peak hours from 8 AM to 9 PM overlap with solar production from 9 AM to 5 PM, also favorable for feeding surplus energy to the grid. Furthermore, the integration of a BESS with solar panels has been explored, with details provided in the Financial Section of this report.

4. Laguna Water Treatment Plant Energy Assessment

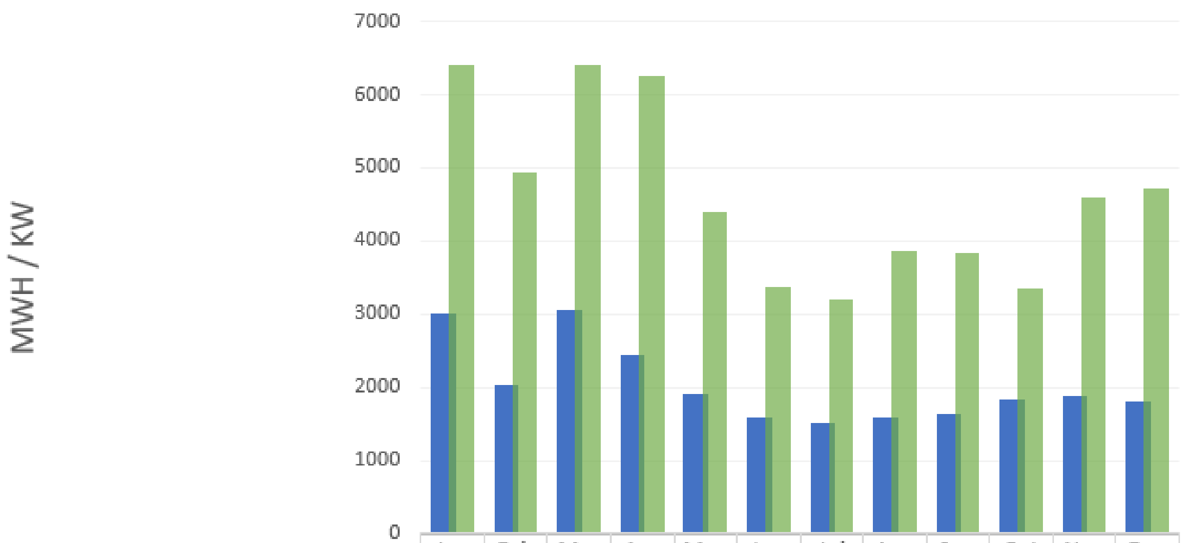
AECOM performed energy assessment for Laguna Water Treatment Plant (LTP) located at 4300 Llano Rd, Santa Rosa for Ponds B & C to check feasibility of floating solar. Energy data from January to December 2023 provided by SCP is analyzed. Billing for this site falls under the E-20 TOU tariff for SCP, expected to increase by 18.3%, as per the "January 2024 Semi-annual Business and Agriculture Rate Filings, Tools & Updates[3]." Additionally, it falls under the E-20 tariff for PG&E, covering distribution costs for demand (kW) and energy (kWh), including other charges: Transmission Rate, Nuclear Decommissioning, as mentioned in the most recent E-19 electricity schedule from February 2024 on the PG&E[4] website.

Electric Consumption

Currently, the LTP site is not equipped with either solar or a BESS system. AECOM has calculated the site's total energy consumption from the utility using the 8760 data set file provided by the city, which details the site's annual utility energy use. The analysis determined that the site's annual energy consumption from the utility is 24,266 MWh for the period from January 2023 to December 2023. The highest energy consumption was recorded in March at 3,044 MWh/month. The highest peak demand was recorded in March at 6,408 kW. These consumption and demand values can be seen in Figure 4-1.

Under the existing conditions, without incorporating any new PV or BESS, the utility's annual charges amount to $4,819,027. This total includes $3,621,153 for energy consumption and $1,197,873 for demand charges.

Figure 4-1: 2023 LTP Net Energy Consumption and Demand



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facility Energy Consumption (MWh)	3009	2025	3044	2439	1905	1583	1516	1598	1642	1828	1875	1801
Facility Load Demand (kW)	6400	4932	6408	6254	4398	3381	3190	3873	3849	3350	4606	4719

Solar PV Generation

To offset LTP's energy consumption, AECOM is estimating the capacity for a solar PV system on Ponds B and C at the LTP site, using the full available space. AECOM's estimation suggests that the area can support a 9.5 MW solar PV system, capable of generating approximately 15,000 MWh annually, which would offset 61% of LTP's current energy consumption.

This system will consist of 18,828 floatable vertical, fix angle modules for pond C and 3,528 floatable vertical, fix angle modules for pond B, along with five AC/DC power inverters for pond C and one for pond B. The PV modules are expected to operate at a performance ratio of 83%, with an AC load ratio of 1.2. The modules will be strategically positioned to face an azimuth angle average of 0 degrees and a fixed tilt average of 10 degrees. The system will cover a total area of 434,183 ft^2 for pond C and 81,350 ft^2 for pond B. Figure 4-2 provides a graphical representation of the area occupied by the solar PV modules.

Figure 4-2: Solar PV power output and area.

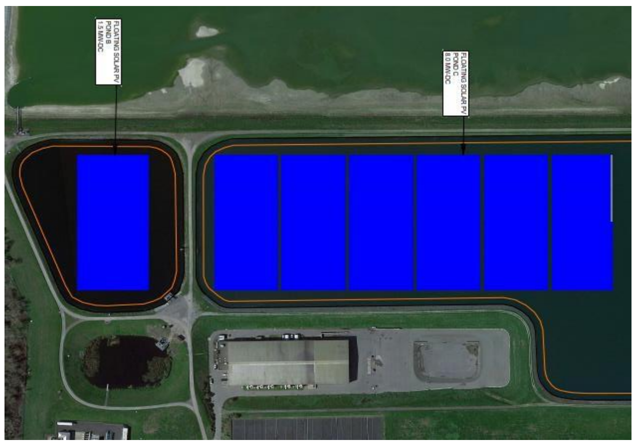
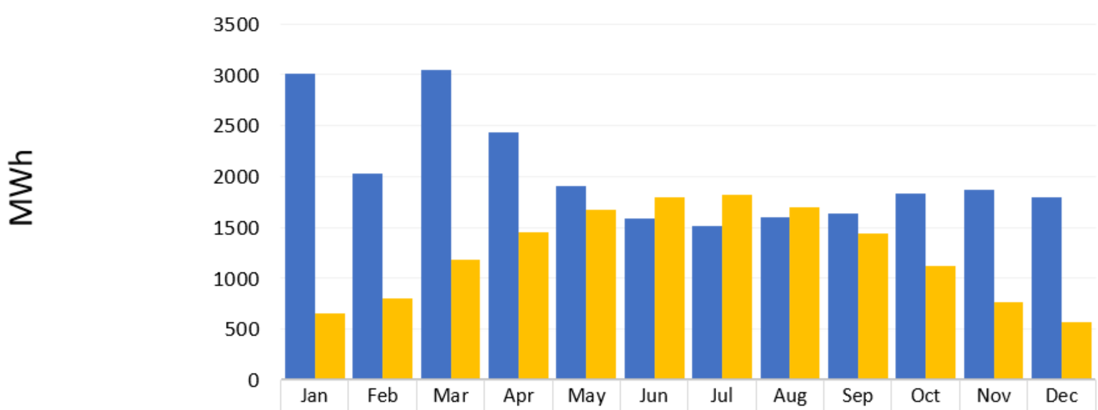


Figure 4-3 shows a chart comparing monthly energy usage at the facility with the output from the proposed 9.5 MW solar PV system by AECOM. It aligns the facility's monthly energy use in MWh against the solar system's production. Any surplus energy generated during daylight is fed back to the grid. Annually, the estimated renewable power generation at the facility can produce 15,000 MWh per year, which is equivalent to 61% of the total yearly energy consumption by LTP which is 24,266 MWh.

Figure 4-3: LTP Energy offset (MWh) Estimate



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Facility Energy Consumption (MWh)	3009	2025	3044	2439	1905	1583	1516	1598	1642	1828	1875	1801
PV Energy Generation (MWh)	657	807	1182	1448	1672	1803	1819	1703	1446	1128	768	569

The E-20 Large General Service tariff, with peak hours from 12 PM to 6 PM during summer, matches the solar panels' production times of 8 AM to 6 PM, making summer afternoons ideal for exporting energy. In winter, the tariff's peak hours from 8 AM to 9 PM overlap with solar production from 9 AM to 5 PM, also favorable for feeding surplus energy to the grid. Furthermore, the integration of a BESS with solar panels has been explored, with details provided in the Financial Section of this report.

Further investigation is required to study, engineer, and design the floating solar structural base. In general, floating solar system will be anchored to the dikes around the pond by utilizing anchor blocks or helical soil anchors, stainless steel wire cable with clips, buoys, and spreader bars. Floats provided by the manufacturer will be tied together and attached to the mooring lines. Number of anchors will be decided per manufacturer's specifications and soils report prepared by Geotechnical Engineer.

5. Financial Analysis

For the financial analysis, two scenarios and contract structures for exporting excess energy are considered. One option is to remain within a City Owned Solar System, while the other involves shifting to a contractual energy sale system through a Power Purchase Agreement (PPA).

City Owned Solar System: Sonoma Clean Power allows the sale of energy back to the utility up to 100% of the user's energy consumption. SCP buys energy at a retail price based on the electric rate to which the user is subscribed, meaning SCP will pay for the kWh at the rate at which the kWh is fed into the utility's electrical grid. SCP will reimburse a maximum of $5,000 for bill credit balances. However, this project is not anticipated to generate more energy than will be consumed and this additional compensation not being considered in the cash flow analysis.

PPA Scenario: A Power Purchase Agreement in the context of renewable energy is a financial arrangement that involves an agreement between two parties: one who generates electricity (the contractor or vendor) and one who is looking to purchase electricity (the buyer or customer). For this project, we utilize one type of PPA: Corporate PPAs, where businesses directly purchase renewable energy from producers.

In the context of the City Owned Solar market, financing can be secured through debt issuance. In a PPA, financing is obtained by the third-party contractor or vendor. This third party (Corporate PPA) would develop the project and agree to sell the energy to the city at a pre-negotiated price.

Under a PPA, the city will establish connections with both the renewable energy vendor and the utility grid. Consequently, the city will remain subject to a TOU tariff with the utility, but will benefit from a fixed Avoided Cost Energy tariff with the renewable energy plant.

Installation Cost

This section analyzes the cost of installing the Solar PV array including the cost of equipment, engineering, permits and installation. The following assumptions are considered for each site:

Laguna Water Treatment Plant:

- The estimate is a Class 4/5 estimate based on Association for the Advancement of Cost Engineering (AACE) classification.
- Labor cost for Santa Rosa, CA. was set at $110/hr. All-in for craft which includes base wage rates and fringes.
- Cost estimate considers the floating panel module system is supported with fixed soil screw anchors around the perimeter of the pond to stabilize and support the modular flotation system.
- The estimate has included 425-watt solar panels installed on tilt support system. The pricing is based on budgetary quotes from previous projects for the 425-watt panels. The system also includes buoys

at each solar panel.

- The estimate included an allowance for combiner boxes, pricing is based on being mounted on a flotation system.
- The estimate is based on all conduit to be aboveground aluminum.
- Estimate includes:
    - An allowance of $50,000 to tie into the existing electrical infrastructure.
    - Vertical sections of Non-ARC Flash 480V NEMA 3R Switchgear.
      An allowance for new grounding of the added electrical equipment.
- The estimate excludes lightning protection, CCTV, Security, lighting, receptacles & Communication systems.
- The estimated price for commercial Battery Energy Storage System (BESS) per kilowatt-hour is set at $1050.
- Indirect costs for the contractor are included based on a cost per direct hour (construction field staff, craft expenses, temporary facilities, construction equipment, small tools, overhead and profit)
- Design Engineering and Engineering support is included at 3% of the Total Installed Cost (TIC)
- Contingency is not included.
- Cost includes a 30% Investment Tax Credit (ITC), directly applied to the total cost estimate.

Utility Field Office:

- The estimate is a Class 4/5 estimate based on Association for the Advancement of Cost Engineering (AACE) classification.
- Labor cost for Santa Rosa, CA. was set at $110/hr. all-in for craft which includes base wage rates and fringes.
- The modular PV panel system is supported on a car port with piles to support the structure and a series of purlins / ribbed roof panels to support the modular panels.
- The estimate has included 534-watt solar panels installed on fixed support system. The pricing is based on budgetary quotes from previous projects for the 534-watt panels.
- The estimate included an allowance for combiner boxes.
- The estimate is based on all conduit to be PVC.
- Estimate includes:
    - A new electrical switchboard located adjected to the existing electrical building.
    - Vertical sections of Non-ARC Flash 480V NEMA 3R Switchgear.
    - An allowance for new grounding of the added electrical equipment.
- The estimate excludes lightning protection, CCTV, Security, lighting, receptacles & Communication systems.
- The estimated price for commercial Battery Energy Storage System (BESS) per kilowatt-hour is set at $1050.
- Indirect costs for the contractor are included based on a cost per direct hour (construction field staff, craft expenses, temporary facilities, construction equipment, small tools, overhead and profit)
- Design Engineering and Engineering support is included at 3% of the Total Installed Cost (TIC)
- Contingency is not included.
- Cost includes a 30% ITC, directly applied to the total cost estimate.

Capital Cost, Operations and Maintenance

Capital cost includes the upfront installation costs of the systems. Operation costs include the energy and demand cost avoidance, PV degeneration, $/kW O&M costs, and excess solar export benefits.

With approval of Net Billing Tariff (NEM 3.0), export to the grid rate will change significantly. Utilities will pay net billing customers for the electricity they export to the grid based on its value, determined by the avoided cost to the utility of buying clean energy elsewhere. Export rates will be calculated on an hourly basis and based on an Avoided Cost Calculator.

Table 5-1 Cash Flow Capital and Operational Inputs under ITC

Input	Unit	Water Treatment Plant (B+C)	UFO
Solar PV Install Cost	$	$40,822,000	$1,290,820
BESS Install Cost	$	$4,616,500	$276,990
Annual Solar PV Degradation	%	0.5%	0.5%
Annual Solar BESS Degradation	%	1.33	1.33
PV O&M Rate	$/kW	$60	$60
BESS O&M	$/kW	$36	$36

The planned equipment installation has a useful life that can be shorter than the 25-year cash flow period. These replacement periods and the corresponding cost have been accounted for in the analysis. The table below summarizes the replacement period and cost assumptions for each equipment. An important note, many of these replacements are 10 or more years into the future, and the cost is estimated.

Table 5-2 Replacement Reserves

O&M/Opex Reserve	Unit	Value
PV Panel Replacement Period	years	25
PV Panel Replacement Cost rate	$/kW	$(30)
PV Inverter Replacement Period	years	10
PV Inverter Replacement Cost rate	$/kW	$(20)
BESS Replacement Period	years	15
BESS Replacement Cost rate	$/kW	$250

The cash flow analysis assumes a 25-year contract term, with one year of construction (year 0). Annual costs and savings are estimated for each year of the period, while accounting for cost escalation rates such as increased cost of energy or O&M cost. Net value for each year is calculated and a discount rate is assumed to calculate the overall NPV (net present value) for each option.

Forecasting and Rates

To estimate the cash flow for the term of the contracts, forecasting assumptions include:

- Discount rate: the US. Department of the Treasury reports are used to estimate the annual discount rate. The daily treasury par yield curve rates averaged for the last 30 days is 5.54 %. However, it is important to note that rates are changing rapidly and cannot be guaranteed.
- Loan interest rate: At the time of the report, US. Department of the Treasury, 7-day average index rate is 4.41% for 20-year term and 4.31 % for 30-year term. The estimated 25-year index rate is 4.41%. Assuming a 1.5% spread added by the lender, the estimated interest rate is 5.91%.
- O&M and replacement costs: Replacement periods of PV panels, BESS and inverters are incorporated in the cash flow. The replacement costs are accounted for as one-time payments at the end of replacement periods.
- PPA Rates: For solar, we identified an average rate of 0.05123 $/kWh. However, this could significantly vary depending on the provider. These rates are estimates based on LevelTen Energy 2023 last quarter report.

- Utility Tariff: The billing for this study is conducted under the E-20 and E-19 TOU tariff, which is anticipated to rise by 18.3%, according to the "January 2024 Semi-annual Business and Agriculture Rate Filings, Tools & Updates". This evaluation includes a revision of the 2023 tariff to include the expected rate hikes.
- The BESS kWh price: has been calculated utilizing the most recent data available from NREL (National Renewable Energy Laboratory), incorporating the following factors: In a moderate scenario, factoring in the financial markets and a mature battery technology, the cost for storage batteries under one-hour capacity is projected to be $1,319 per kWh by 2025.

It is important to note that the PPA rates are estimates based on current project examples and market values. However, the City should collect accurate quotes form service providers before choosing between these options. AECOM has created the cash flow analysis as an overall structure, once more detailed scope and proposal specifications are available, the analysis can be updated accordingly.

Results

City Owned Solar Scenario

The evaluation encompassed three options for both the UFO and the Water Treatment Plant facilities.

- Option 1: Establishes the baseline scenario, where no PV system or BESS is installed, and all energy requirements are met through the utility grid.
- Option 2: Investigates the addition of a PV system, operating in tandem with the utility grid.
- Option 3: Further introduces a BESS for peak shaving purposes, in addition to the PV system and the utility grid.

The outcomes for the Utility Field Office and Laguna Treatment Plant are detailed in Tables 5-3 and 5-4, respectively.

Table 5-3 UFO Annual City Owned Solar System Comparison

Option	PV Size (kW)	BESS Size (kWh)	Energy Cost ($)	Demand Cost ($)	Total Cost ($)	Savings ($)
1	0	0	$105,681	$46,831	$152,511	$0
2	330	0	$0	$36,236	$36,236	$116,275
3	330	200	$0	$919	$919	$151,592

Option 1 establishes the baseline cost at $152,511 per year. The savings from implementing PV or BESS systems are seen as reductions in energy costs. Options 2 demonstrates a savings of $116,275 by comparing the cost before and after installing a PV system. Option 3 demonstrate savings of $151,592, by comparing the costs before and after installing both PV and BESS systems.

AECOM's analysis also looked at utilizing BESS for rate arbitrage activities which can result in an additional revenue stream of approximately $11,000. However, Sonoma Clean Power limits the annual compensation to $5,000 for excess energy generation. AECOM's analysis assigned a cash flow value of zero under these conditions for this assessment. BESS installation additionally reduces demand charges as it strategically discharges power during periods of high energy demand and recharges when energy costs are lower.

Table 5-4 LTP Annual City Owned Solar System Comparison

Option	PV Size (kW)	BESS Size (MWh)	Energy Cost ($)	Demand Cost ($)	Total Cost ($)	Savings ($)
1	0	0	$3,621,153	$1,197,873	$4,819,027	$0
2	9.5	0	$1,376,531	$816,846	$2,193,378	$2,625,649
3	9.5	5	$1,409,694	$598,479	$2,008,172	$2,810,855

Table 5-4 outlines that Option 1 is the annual baseline cost at $4,819,027. It highlights the cost savings achieved through the installation of PV or BESS systems in Options 2 and 3, resulting in reduced energy expenditures. The annual savings for Options 2 and 3, realized by comparing costs pre- and post-installation of PV, BESS, or a combination of both systems, amount to $2,625,649 and $2,810,855 saved, respectively.

The cost savings achieved by integrating a PV system with a BESS in Option 3, compared to the standalone PV system in Option 2, is relatively minor given the system's size, leading to an additional saving of $185,206 over Option 2. This represents a mere 4% of the baseline cost in Option 1, which amounts to $4,819,027, Nevertheless, the BESS offers additional benefits, particularly in terms of resiliency, especially during utility blackouts.

Under city management, assessing the O&M costs, along with accounting for degradation of the PV solar and BESS systems, is crucial. Using NREL's conservative figures, annual degradation rates are set at 0.5% for solar panels and 1.33% for batteries. These considerations reveal that operational costs surpass direct energy expenses.

Initial annual O&M costs are outlined for two sites: the UFO site incurs $7,000 for BESS and $4,000 for PV, with annual replacement costs of $6,000 for PV and $3,500 for BESS. The LTP site sees higher annual O&M costs: $180,000 for BESS, $570,000 for PV, and annual replacement costs of $205,000 for PV and $61,000 for BESS. These costs, subject to a 2% US economy inflation and a 3% energy cost inflation annually, are expected to increase each year. Meanwhile, PV and BESS technologies are projected to decrease in cost by 2.28% and 1.33% annually, respectively for the next 25 years based on NRLE commercial trends.

Financing both sites over 25 years at a 5.9% interest rate leads to annual payments of $120,000 for UFO and $3.5 million for LTP, totaling $86,998,889 for LTP and $3,001,741 for UFO by the end of the term. These figures, representing the systems' purchase prices, are distinct from energy, demand, O&M, and degradation costs, emphasizing the necessity for thorough financial planning, especially when compared to a PPA where the city isn't the system owner and financier.

Table 5-5 outlines the annual costs for years 1, 10, 25, and 29, covering kW and kWh charges, O&M expenses, costs associated with system degradation replacement, and repayments for the system installation loan. Conversely, Table 5-6 presents the cumulative total of these costs over 25 and 29 years. The detailed description of the columns in Table 5-5 & 5-6 is as follows:

- Current Utility Cost: Column shows the baseline utility costs for kW and kWh charges only, offering a point of comparison with other systems.
- Energy Cost: Column outlines the annual energy and demand-related costs in a city owned solar contract under a NEM 3.0 agreement.
- O&M Cost: Column indicates the annual expenses for operation and maintenance, alongside the annual cost for system degradation replacement under a city owned solar scenario.
- System Loan Repayment: Column illustrates the annual loan repayment amounts for the renewable energy system installation under a city owned solar system.
- Total City Owned Solar Cost: This column aggregates all other solar costs, providing a reference point for the total costs of acquiring and operating the system under the city owned solar system.

When assessing the total cost of the system's loan, including O&M, replacement, and energy costs, against the expenses of remaining connected to the utility without adopting any renewable energy system, and factoring in inflation and technology cost trends, our analysis predicts a positive cash flow by year 29. In a base case scenario over this period, maintaining a connection to the non-renewable utility system would incur costs of $217,910,845. This contrasts with the cumulative expenses of $214,557,122 for the financing, installation, operation and maintenance of a city owned solar system. This analysis indicates that by year 29, not only will adopting the renewable system result in a positive cash flow for the city, but the city will also gain ownership of the system, enhancing its long-term financial and infrastructural assets.

Table 5-5 LTP City Owned Solar System Annual Cost Over a 29-Year Period

Year	Current Utility Cost	Energy Cost	O&M Cost	System Loan Repayment	Total City Owned Solar Cost
1	$4,819,027	$2,008,172	$1,015,509	$3,479,876	$6,503,557
10	$6,287,737	$2,620,209	$1,159,561	$3,479,876	$7,259,646
25	$9,796,089	$4,082,200	$1,466,361	$3,479,876	$9,028,437
29	$11,025,584	$4,594,552	$1,587,237	$0	$6,181,789

Table 5-6 LTP City Owned Solar System Accumulated Cost Over a 25 & 29-Year Period

Year	Current Utility Cost	Energy Cost	O&M Cost	System Loan Repayment	Total City Owned Solar Cost
25	$175,698,167	$73,216,474	$30,588,362	$86,996,889	$190,801,724
29	$217,910,845	$90,807,229	$36,753,004	$86,996,889	$214,557,122

Table 5-7 & 5-8 replicates the data from Table 5-5 & 5-6, adapted for the UFO site to reflect the economic outlook of a city owned solar system across a 25-year loan span. The analysis indicates an expected shift to positive cash flow starting from year 1. Over the 25-year period, continuing with the existing utility connection without renewable energy solutions is expected to cost $5,560,456. In contrast, the cumulative expenses for the financing, installation, operation and maintenance of a city owned solar system are calculated to be $3,657,206. The projections show that by the end of the 25th year, adopting a renewable energy system is anticipated to not only result in a positive cash flow for the city but also culminate in system ownership, yielding substantial savings compared to the current utility rates.

Table 5-7 UFO City Owned Solar System Cost Over a 25-Year Period

Year	Current Utility Cost	Energy Cost	O&M Cost	System Loan Repayment	Total City Owned Solar Cost
1	$152,511	$919	$21,958	$120,070	$142,947
10	$198,993	$1,098	$24,272	$120,070	$145,440
25	$310,024	$1,478	$29,198	$120,070	$150,746

Table 5-8 UFO City Owned Solar System Accumulated Cost Over a 25 Year Period

Year	Current Utility Cost	Energy Cost	O&M Cost	System Loan Repayment	Total City Owned Solar Cost
25	$5,560,456	$29,441	$632,487	$3,001,741	$3,663,668

PPA Scenario

Under Power Purchase Agreements the City involves a third-party investor which assumes the upfront expenses of the project, selling the generated electricity to the city at a predetermined rate. By utilizing a PPA, the City connects to the utility grid via a NEM 3.0 agreement while also integrating a renewable PV solar system. This dual connection ensures a reliable power supply to meet the site's full energy needs.

Table 5-9 presents the annual energy consumption in MWh for each site, along with the contribution of the PV system installation. PV offset less than 100% indicates that a portion of the site's energy will be met at the standard utility rate, while the remainder will be covered at the corporate PPA rate.

Table 5-9 Annual PV System Energy Offset Impact

Site	Current Site Energy Consumption (MWh)	PV Energy Production (MWh)	PV MWh Offset (%)
LTP	24,266 MWh	15,000 MWh	61%
UFO	604 MWh	604 MWh	100%

The LevelTen Energy[7] report for Q3 2023 reveals the average price of PPA solar energy to be approximately $51.23 per MWh, a figure that has been factored into the energy cost calculations. Table 5-10 details two separate costs: one associated with the PPA and the other with energy supplied by the utility to make up the difference in energy not covered by the PPA.

Table 5-10 Annual Combined Energy and Demand Costs: PPA and Utility Integration

Site	Utility Energy Non-Offset Cost ($)	Utility Demand Charges ($)	PPA Energy and Demand Charges ($)	Total Cost ($)
LTP	$1,412,250	$742,681	$768,450	$2,923,381
UFO	$0	$27,630	$30,943	$58,573

Table 5-11 displays the anticipated yearly costs for energy and demand charges, comparing the current utility system costs with those of a combined utility and PPA system. This table illustrates potential PPA savings compared to the current utility costs. Utilizing a corporate PPA over acquiring a loan to develop the system presents multiple advantages, including capital outlay and O&M costs. Furthermore, the benefits of reduced demand and energy charges are quickly realized once the installation is complete.

Table 5-11 Annual Energy Cost Comparison: PPA vs. Current Utility Connection

Site	Current Utility Cost ($)	PPA & Utility Cost ($)	PPA Savings (%)	PPA Savings ($)
LTP	$4,819,027	$2,923,381	39	$1,895,646
UFO	$152,511	$58,573	62	$93,938

6. Conclusion

The city owned solar scenario report outlines potential configurations for the LTP and UFO: one featuring a standalone PV system, and the other combining a PV system with a BESS. Opting for the BESS addition incurs higher costs and extends the return on investment (ROI) period. Despite this, the integration of a BESS offers not just economic benefits but also significant resilience, particularly for critical operations like those at the water treatment plant. Given these technical advantages, the BESS- inclusive option is deemed more appropriate, even with the slight increase in ROI timeframe, due to the enhanced reliability it provides.

Evaluating the city owned solar scenario independently shows it offers more savings on energy and demand charges than opting for a PPA contract. Choosing this path means the city is responsible for construction, financing, addressing system degradation, and managing operations and maintenance, which will inevitably raise the project's costs over time. In contrast, a PPA agreement has significant advantages as the vendor assumes these responsibilities. A typical PPA agreement has a 25-year term, during which the service provider owns the system while the city can experience stable energy costs, shielding it from major market swings. After the duration of the PPA contract, the City can purchase the system at fair market value or renew the contract. This contrasts with the city owned solar approach, where the city immediately becomes the owner of the renewable power system, thereby enhancing its asset portfolio from the outset.

Table 6-1 displays the existing costs for energy and demand charges, alongside forecasts for these costs under a PPA contract and for a city owned solar system operating exclusively within a NEM 3.0 agreement over the 1st Year.

Table 6-1 1st Year Annual Demand & Energy Cost: Different Energy Models

Site	Current Annual Utility Cost	PPA Annual Cost	City Owned Solar Annual Cost	PPA Annual Savings	City Owned Solar Annual Savings
LTP	$4,819,027	$2,923,381	$6,503,557	$1,895,646	$-1,684,530
UFO	$152,511	$58,573	$142,947	$93,938	$9,564

Table 6-2 through 6-5 present a cash flow analysis comparing two scenarios: one where the city enters into a contract with a PPA vendor and another where the city directly owns and operates the system under a city owned solar system, with specific focus on years 1, 10, and 25. This includes considerations for inflation rates applicable to both city owned solar and PPA frameworks, as well as the costs associated with O&M and system degradation under the NEM 3.0 model. The analysis demonstrates that the city owned solar scenario typically requires higher cash outflows compared to a PPA contract. It's important to highlight that in the city owned solar approach, the City will ultimately maintain ownership of the renewable energy installations.

Table 6-2 LTP Annual Cash Flow: PPA vs City Owned Solar Alone

Year	Current Annual Utility Cost	PPA Annual Cost	City Owned Solar Annual Cost
1	$4,819,027	$2,923,381	$6,503,557
10	$6,287,737	$3,814,349	$7,259,646
25	$9,796,089	$5,942,632	$9,028,437
30	$11,356,352	$6,889,139	$6,351,370

Table 6-3 LTP Cumulative Cash Flow: PPA vs City Owned Solar Alone

Year	Current Annual Utility Cost	PPA Annual Cost	City Owned Solar Annual Cost
25	$175,698,167	$106,584,329	$190,801,724
30	$229,267,197	$139,081,078	$220,908,492

Table 6-4 UFO Annual Cash Flow: PPA vs City Owned Solar Alone

Year	Current Annual Utility Cost	PPA Annual Cost	City Owned Solar Annual Cost
1	$152,511	$58,573	$142,947
10	$198,993	$76,424	$145,440
25	$310,024	$119,067	$150,746
30	$359,403	$138,031	$33,869

Table 6-5 UFO Cumulative Cash Flow: PPA vs City Owned Solar Alone

Year	Current Annual Utility Cost	PPA Annual Cost	City Owned Solar Annual Cost
25	$5,560,456	$2,135,528	$3,663,668
30	$7,255,797	$2,786,634	$3,826,503

LTP Conclusion: AECOM recommends entering into a Power Purchase Agreement (PPA) for LTP site. The advantages of the PPA approach include immediate cost savings starting from year 1, a substantial reduction in energy consumption costs by 40% in the first year, and the benefit of having the system owned and maintained by a third party. This reduces the financial and operational burden on the city. While the self-funded city-owned contract might only start generating positive cash flow after 29 years, the PPA provides significant financial benefits much sooner. Moreover, the comparative analysis suggests that owning the system would lead to higher costs over 30 years compared to both the PPA scenario and the current costs associated with maintaining a utility connection. Thus, the PPA is a more financially viable and efficient solution for reducing energy costs at the LTP site.

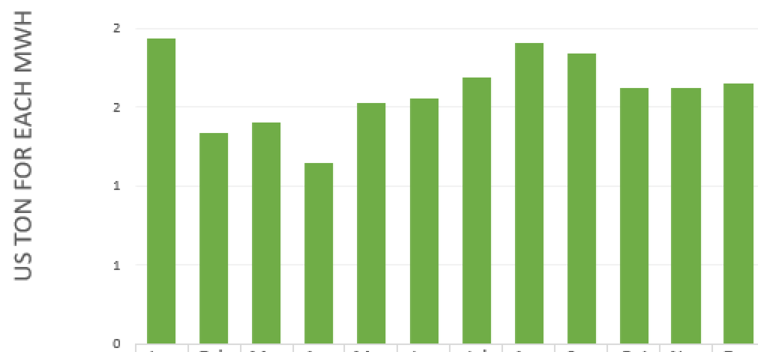
UFO Conclusion: AECOM recommends implementing City Owned Solar at the UFO site as a strategic long-term investment. This option is projected to yield positive cash flow from the first year when compared to the current utility expenses. With a 25-year loan term, City Owned Solar is expected to result in a 50% reduction in energy costs by year 25 and up to a 90% reduction by year 30. Although the Power Purchase Agreement (PPA) offers a quicker recovery of capital costs, the City Owned Solar provides superior long-term capital cost savings and the benefit of accumulating a valuable asset. In terms of long-term financial benefits, City Owned Solar is more advantageous than PPA, offering lower energy costs and greater savings over an extended period. This makes City Owned Solar a highly beneficial investment for sustainable and significant financial returns over time.

7. Electric Greenhouse Gas Emissions

The reduction in greenhouse gas (GHG) emissions was calculated based on the 2023 Emissions Summary from Sonoma Clean Power EverGreen, which indicates a CO_2 equivalent (CO_2e) emission rate of 0.035 US Ton for each megawatt-hour (MWh) produced. SCP EverGreen service delivers 100% local renewable electricity. This calculation involved multiplying the total power consumption from the systems by the specified CO_2e emission rate.

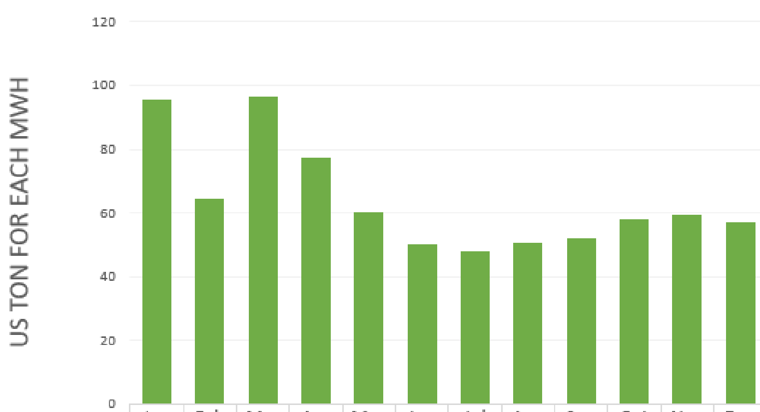
According to estimates, the UFO system emits approximately 21.18 US Tons of CO_2e to the total GHG emissions, while the LTP system accounts for around 849 US Tons of CO_2e annually. Figures 7-1 and 7-2 depict the monthly GHG emissions for both the UFO and water treatment plant systems.

Figure 7-1: UFO GHG reduce emissions.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CO2e (UST)	2	1	1	1	2	2	2	2	2	2	2	2

Figure 7-2: LTP GHG reduce emissions.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CO2e (UST)	96	64	97	77	60	50	48	51	52	58	60	57

8. Glossary of Technical Terms and Concepts

Understanding Net Energy Metering: Key Differences between NEM 2.0 and NEM 3.0 Policies

Net Energy Metering (NEM) in California is a billing arrangement that allows residential and commercial customers who generate their own electricity, primarily through solar PV systems, to receive credit for the surplus energy they contribute to the grid. This system is designed to incentivize the use of renewable energy sources by offsetting the cost of electricity consumption with the energy produced by these installations.

Under NEM, when a solar system generates more electricity than is consumed, the excess energy is sent back to the utility grid, and the customer earns credits. These credits can then be used to offset the cost of energy drawn from the grid when the solar system isn't producing enough to meet the customer's demand, like during nighttime or cloudy days. The rules, rates, and credits under NEM can vary over time, with different iterations such as NEM 1.0, 2.0, and the latest NEM 3.0, each having specific regulations and compensation structures for solar energy production and exchange.

The transition from NEM 2.0 to NEM 3.0 in California, which was effective on April 14, 2023, introduced significant changes in the net metering policies for utility customers with PV systems. These changes impact several aspects, particularly the economics of energy arbitrage between PV system owners and the utility. Here's a summary of the key changes:

1) Reduction in Export Rates: Under NEM 3.0, there's a substantial reduction in the rates for excess electricity exported onto the grid by solar systems. This rate has been reduced by approximately 75%, thereby lowering the overall savings for solar systems and increasing the payback period. This change is a shift from the traditional one-to-one offset of net metering policies, where the price of a kWh of electricity pushed onto the grid was equal to the price of a kWh pulled off the grid.
2) Implementation of Electrification Rates: Customers enrolling in NEM 3.0 are required to use electrification rates instead of regular TOU rates. These electrification rates feature higher on-peak charges and lower off-peak charges, along with a fixed charge of $15 per month. The peak rate period remains from 4 pm to 9 pm.
3) Export Compensation Based on Avoided Cost Calculator (ACC): Export compensation under NEM 3 is determined by California's ACC, with specific export rates for every combination of Month, Hour, and Weekday or Weekend. The export value is lowest in the middle of the day when solar energy is abundant on the grid and highest during peak summer demand periods. Notably, the export rates are significantly lower than retail rates during the hours when PV systems are most productive (10 am – 3 pm). To maintain the financial viability of solar PV systems, customers in PG&E and SCE service territories receive an adder on top of the ACC rate, ranging between 2.2 and 9 cents depending on location and customer class.
4) Shift to a Cost Avoidance System: NEM 3.0 introduces a cost avoidance system for exported electricity. This system pays customers the lowest amount a company can pay under the Public Utility Regulatory Policies Act of 1978 (PURPA), which is significantly less than the typical retail rate. This results in customers receiving, on average, 75% less for the electricity they sell back to the grid, with rates varying by month and by hour.
5) Grandfathering NEM 2.0 under NEM 3.0: Under the recent NEM 3.0 policy in California, existing customers with a PV system installed under NEM 2.0 can retain the benefits and terms of their NEM 2.0 agreement, a process known as "grandfathering." However, these customers are restricted from replacing or adding capacity to their PV systems if they wish to maintain their NEM 2.0 status, as any significant modifications would require transitioning to the terms of NEM 3.0.

Sonoma Clean Power Net Metering Program (NetGreen) Explained:

The NetGreen program, operated by Sonoma Clean Power, functions within the NEM 3.0 framework to support renewable energy production. It's crucial to understand that while City of Santa Rosa sources its energy from SCP, it still faces demand, transmission, and distribution charges from PG&E, since PG&E owns the electrical grid. However, SCP oversees the fees associated with energy consumption. Under the SCP NetGreen Program, customers who generate renewable energy receive compensation as follow:

Offsetting Annual Utility Bills: Customers generating their own electricity are credited at the retail CleanStart rate. These credits are used to offset their annual utility bill. This implies that the energy generated by the customer will be compensated at the same rate as the utility's selling price during the specific hour of production, in accordance with the TOU tariff to which the customer is subscribed.

Compensation for Excess Energy: After the utility bill is offset, surplus energy is paid at SCP's Net Surplus Compensation (NSC) Rate, up to $5,000. Any excess value over $5,000 is credited for future energy use. The NSC Rate includes PG&E's average rate from the previous 12 months plus $0.01/kWh. In 2023, this rate was on average $0.07030/kWh.

It's important to note that The City of Santa Rosa is enrolled in the Evergreen program, guaranteeing that all energy consumed by the facility is sourced entirely from renewable energy. EverGreen includes an extra charge of $0.025/kWh, applicable whenever there is net electricity consumption, but this charge is not applied during energy generation periods. Consequently, the Evergreen premium can decrease the amount of generation credits accrued through the NetGreen program.

Enhanced Incentives for Battery Energy Storage Systems Under NEM 3.0: Maximizing the Value of Solar Energy

The NEM 3.0 policy introduces transformative changes, particularly enhancing the value of utilizing BESS for owners of solar power systems. A significant aspect of NEM 3.0 is the reduction in compensation rates for surplus electricity fed back into the grid by solar systems, now down to 75%. This adjustment shifts the financial dynamics, making it less lucrative to export excess solar energy to the grid. Instead, storing this surplus energy in a BESS and utilizing it when energy costs are higher becomes a more financially savvy approach.

The utility of BESS extends beyond merely optimizing the use of solar energy. It offers several additional advantages, such as providing backup power during utility blackouts, mitigating charges associated with demand peaks, and enabling energy arbitrage. Energy arbitrage under this system allows for the charging of BESS not only with excess solar energy but also with cheaper grid energy during low-cost periods. This stored energy can then be used in lieu of more expensive grid power at peak times, effectively reducing reliance on utility-supplied energy. Consequently, NEM 3.0 not only promotes more efficient use of solar energy but also broadens the scope of BESS applications, contributing to a more versatile and resilient energy management strategy.
There are numerous financial incentives available for acquiring BESS, making them an attractive investment beyond the benefits of the NEM 3.0 policy. These incentives, subject to specific conditions, include:

Self-Generation Incentive Program (SGIP):

a) The SGIP in California is a significant incentive for PV system owners who wish to add a solar battery to their solar panel system.
b) Administered by the California Public Utilities Commission (CPUC), SGIP offers an upfront rebate based on the storage capacity of the installed battery. The rebate amount decreases as more batteries are installed, following a tiered rate structure.

c) The incentive rate varies depending on the project's nature, such as the scale of the battery installation. A large-scale installation at a factory, for instance, will have a different incentive amount compared to a small battery in a residential home.
d) The Equity Resiliency Budget within SGIP focuses on aiding customers in high fire risk areas, those affected by Public Safety Power Shutoffs (PSPS), low-income customers, and critical facilities serving disadvantaged communities. Eligibility includes commercial, industrial, agricultural, and residential customers.

Federal Investment Tax Credit (ITC):

a) The Inflation Reduction Act's incentives for energy storage projects, effective from January 1, 2023, include the availability of an ITC for standalone energy storage facilities.
b) Previously, the ITC was only available for storage systems paired directly with solar PV. Now, the standalone option allows for charging directly from the grid, making it applicable to more storage projects. Energy storage projects of 5kWh or more are eligible.
c) The ITC can reduce the capital cost of investment by about a third, or more, depending on whether projects use domestically produced materials or equipment and whether they employ unionized and local labor. The ITC, extended for clean energy technologies like solar, lasts until 2034, although incentive levels will decrease towards the end of the regime.

Power Purchase Agreement (PPA)

A Power Purchase Agreement is a financial arrangement between a power generator (the vendor) and a power purchaser (the customer), typically to facilitate the production and sale of electricity. In the context of renewable energy projects, PPAs are crucial for securing long-term purchase commitments that can help finance the upfront costs of developing solar, wind, and other renewable energy sources. There are two common types of PPAs: Corporate PPAs and Utility PPAs, each serving different needs and stakeholders. In this instance, for the City of Santa Rosa, the Corporate PPA is the relevant framework for this analysis report.

Corporate PPA: A Corporate Power Purchase Agreement involves a direct agreement between a renewable energy generator and a corporate buyer, rather than a traditional utility company. This setup allows corporations to purchase renewable energy directly from producers at a negotiated price, often to offset their own electricity consumption from non-renewable sources and to achieve sustainability goals. Corporate PPAs can help companies stabilize their energy costs over time, reduce their carbon footprint, and demonstrate a commitment to renewable energy. These agreements are typically long-term, ranging from 10 to 20 years, and can be structured in various ways, such as physical PPAs where the electricity is physically delivered to the buyer, or virtual/synthetic PPAs where the financial aspects of the energy production are exchanged, but the electricity itself is not directly delivered to the corporate buyer.

Energy General Definitions

8760 Data set file: refers to a file that records hourly demand and consumption data for an entire year, with 870 data points representing the hours in a year.

Energy consumption: is the amount of energy used, measured in kilowatt-hours (kWh) or megawatt-hours (MWh), by devices or systems over time.

Utility non-offset energy charges: costs associated with charges for energy purchased from the utility outside of the PPA agreement.

Utility demand charges: costs applied to both city owned solar or PPA agreements from utility providers

Facility load demand: is the total energy demand of a building, measured in kW or MW, at any given moment.

LevelTen Energy: is a Seattle-based company that offers a platform to streamline renewable energy transactions. They publish quarterly Power Purchase Agreement (PPA) price indices, providing critical data on renewable energy pricing trends to help inform market participants.

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9. References

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