Item No. 20
Town of Atherton

CITY COUNCIL STAFF REPORT – REGULAR AGENDA

TO:	**HONORABLE MAYOR AND CITY COUNCIL** **GEORGE RODERICKS, CITY MANAGER**
FROM:	**ROBERT OVADIA, PUBLIC WORKS DIRECTOR**
DATE:	**MAY 20, 2020**
SUBJECT:	**RECEIVE A REPORT, DISCUSS AND PROVIDE DIRECTION REGARDING THE POPOSED PHOTOVOLTAIC AND MICRO-GRID SYSTEM FOR THE NEW ATHERTON TOWN CENTER**

RECOMMENDATION

Receive a report, discuss and provide direction regarding the proposed photovoltaic and micro-grid system for the new Atherton Town Center

BACKGROUND

The Town is currently in the process of constructing its new Town Center and Library complex. When the project was initially designed, the complex included provisions for rooftop and parking canopy solar infrastructure as well as a micro-grid power back-up system as additive alternates. Construction bids received for the overall project were significantly higher than the available budget for the project. Per the direction of Council, the project was redesigned to reduce some of the project complexities and project costs while maintaining the intent of the project. As part of the redesign, the project scope was modified to make the facilities "solar ready," including basic infrastructure to support the solar and microgrid systems, with the final installation of the systems deferred to a later contract.

The Council recommended that staff evaluate the possibility of entering into a Power Purchase or other similar agreement that would allow for the installations by a third-party at no upfront costs to the Town, with the system being paid for over time including energy cost offsets. As a municipality, the Town is ineligible to receive certain incentives that are available to private parties. Utilizing a third-party provider would allow for a potential cost reduction associated with incentives that the third-party may be able to obtain.

The City Council, at its February 19, 2020 meeting, approved a professional services agreement with Sage Energy Consulting, teamed with Clean Coalition, for procurement assistance to secure such a provider. The initial phase of work by the Sage/Clean Coalition Team was to conduct an economic feasibility analysis of the proposed photovoltaic and micro-grid system and develop appropriate metrics for decision-making and to form the basis for competitive procurement.

ANALYSIS

Sage Energy Consulting and Clean Coalition evaluated the photovoltaic (PV) layout outlined in the original project documents, completed their initial review and preliminary economic analysis, and has made some recommendations to improve the efficiency and economics of system.

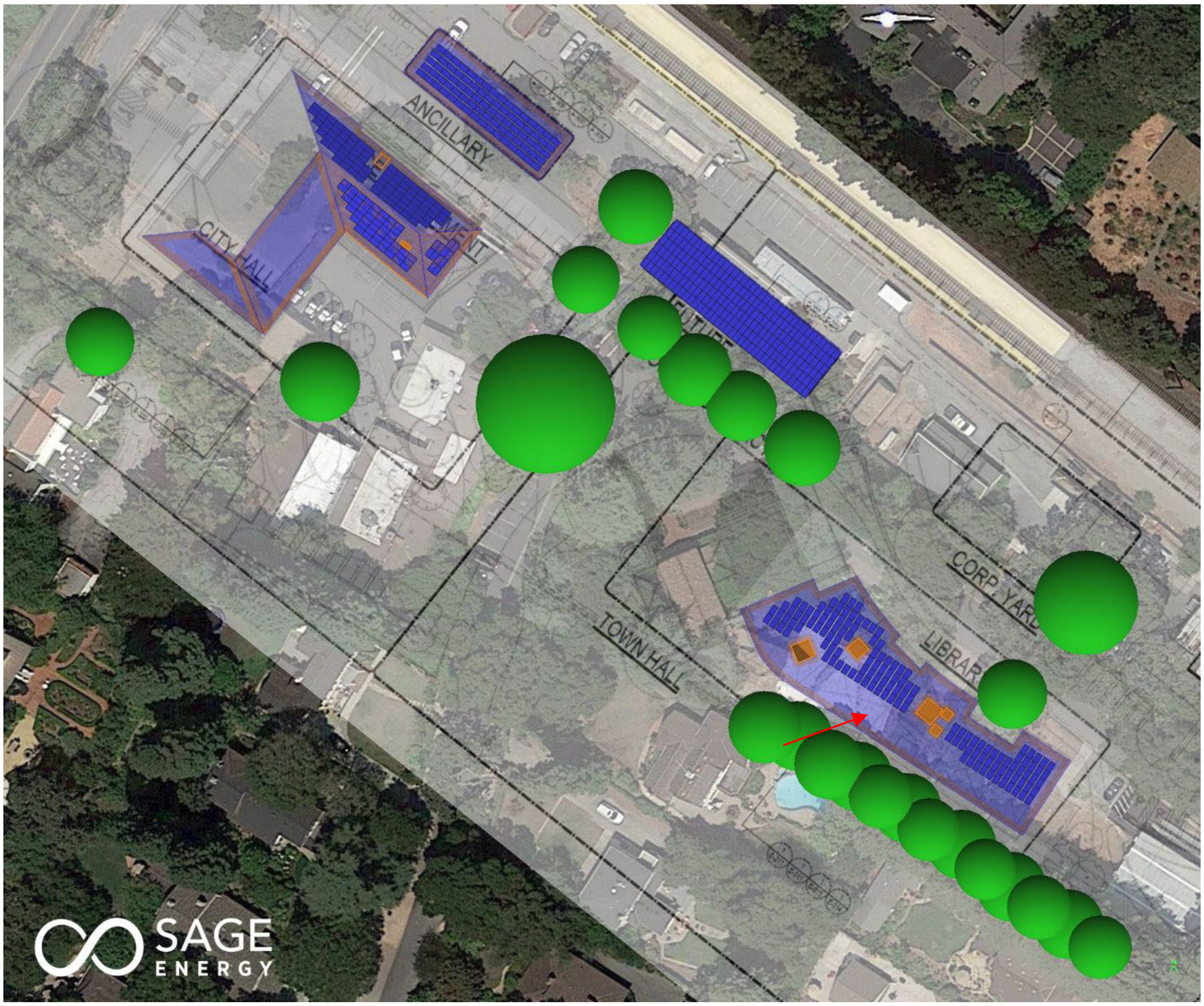
The original PV system design for the Town Center and Library project by WRNS and Integral group was designed as a Zero Net Energy system and was not specifically designed for the economics of a Power Purchase Agreement. The original design also included PV panels on various structures and components that are no longer part of the project. The current project under construction is PV ready and provides for PV panels to be installed on the Administration/Police Department Building, Ancillary Structure, Library Building and a carport structure.

Sage reviewed the original design associated with the current project components and updated the design to better comply with current code and to eliminate some panel areas on the Library that are projected to predominantly shaded to improve the costs and efficiency (2020 Update Design). For analysis and comparison purposes, the 2020 Update Design retains the general PV layout. Due to the orientation and the significant amount of shading associated with the redwood trees behind the Library building, Sage is recommending that the PV panels be removed from the roof of the new Library. They indicate that the limited efficiency of the panels placed in this location do not make it economically feasible for a private investment. Sage also recommends that the panels atop the Administration/Police Department building be reoriented to improve the efficiency of the system and has provided two alternative layouts for consideration.

Sage developed two alternate layout options that improve the efficiency of the PV system for consideration by the Town. The layouts associated with the 2020 Update Design and the alternate options are presented as follows:

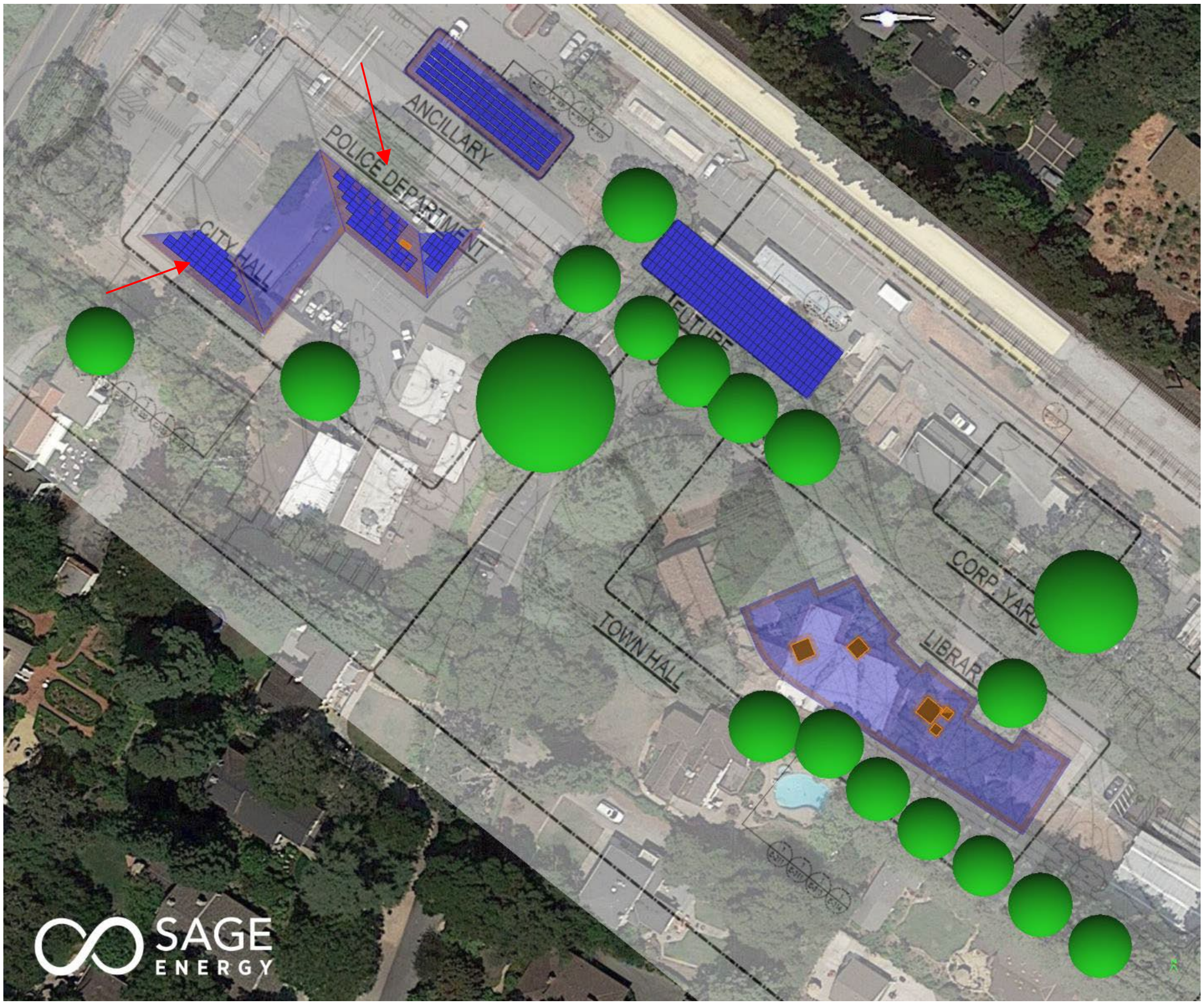
<u>2020 Update Design</u>

Retains same general layout as the project design for the included structures but eliminates some panel locations on the library that are majority shaded.



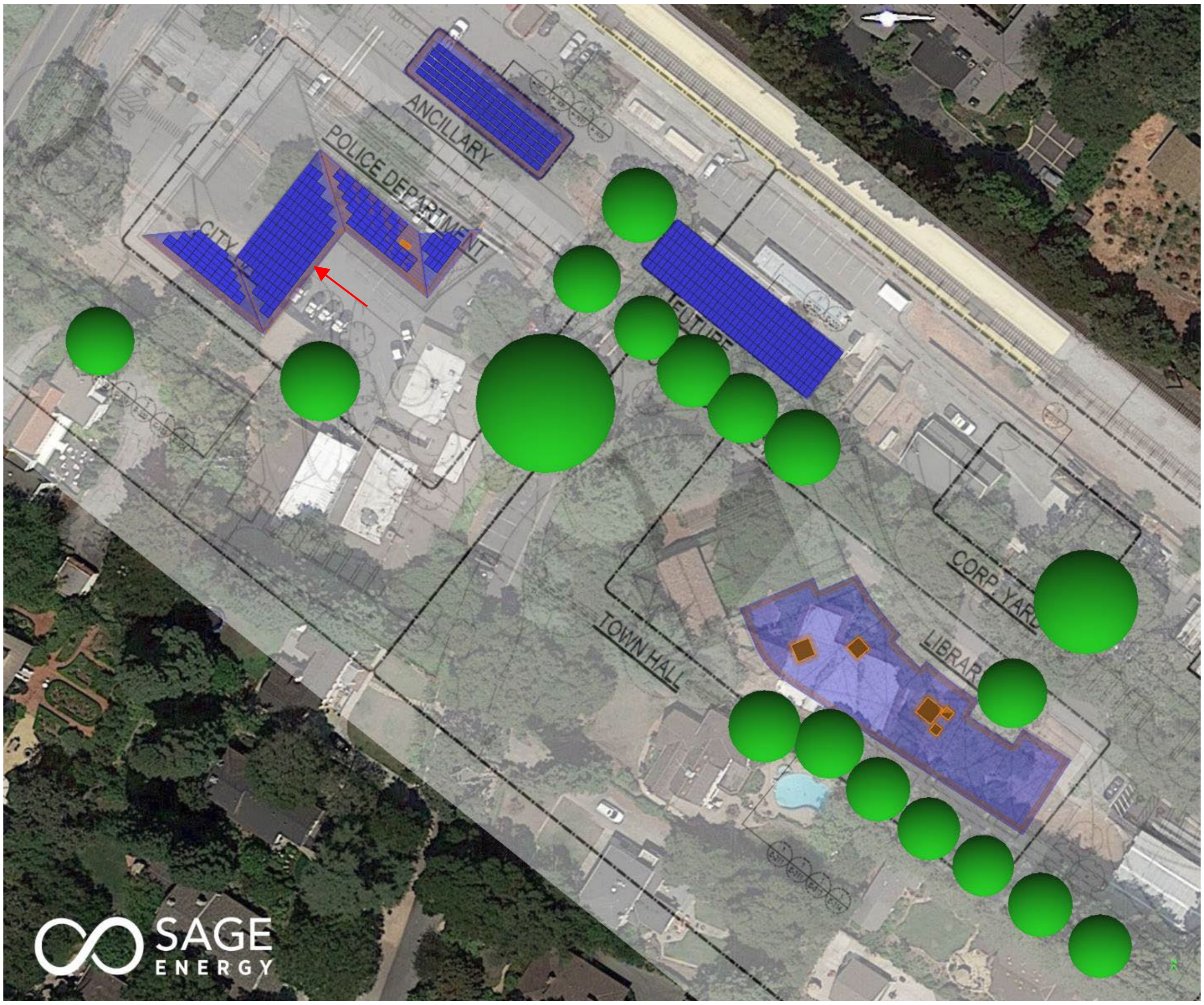
<u>Option 1</u>

Removes panels from the library and the north side of the Administration/Police Department roof (facing Caltrain tracks) and placed some additional panels on the south side of the building.



<u>Option 2 Design</u>

Like Option 1, Option 2 removes panels from the library and the north side of the Administration/Police Department roof and placed some additional panels on the south side of the building. Option 2 also adds additional east facing panels on the Administration/Police Department roof.



The layouts were also modified to account for code clearances around the perimeter for fire access.

Current view of the Town Center Administration and Police Building:

The following table provides a brief summary comparison of the economics associated with the PV layout options – without consideration of the micro-grid:

Assumptions:
Estimated annual consumption = 348,300 kWh
Estimated annual electric cost = $92,000
Estimated average cost of electricity (per kWh) = $0.264

	2020 Update	Option 1	Option 2
System Size (kW-DC)	208.8	149.3	194.9
PV Production (year 1)	295,000	232,000	302,000
PV Efficiency (kWh/kW/Year)	1,412	1,551	1,551
Value of Solar Power Produced ($/kWh)	$0.174	$0.179	$0.179
Value of Solar Power Produced (annual)	$51,300	$41,500	$54,100
Estimated PPA Power Price	$0.27	$0.23	$0.22
Annual PPA Energy Cost	$79,700	$$53,400	$66,400
Estimated Year 1 Total Energy Cost (as	$127,100	$112,200	$113,000

compared to PG&E @ $92k)			
Additional Cost of Solar (year 1)	$35,100	$20,200	$21,000

Note: Estimates are conservative, and the RFP may yield better results. The rate of increase associated with the procurement of power from PG&E is estimated at 3%/year which is on the low side considering current and recent issues facing PG&E. PPA rate escalator set at 0%.

With the low PG&E rate escalator assumed, the forecast indicates that the total energy costs associated with a PV only PPA would be more than direct purchase through the grid. A higher rate of increase would have a positive impact on the economic calculations for the PPA and would, over time reduce the energy costs below that of the grid provider.

Sage recommends that the Town consider revising the layout of the PV system to align with Option 2 as it maximizes energy efficiency and production.

<u>Battery Energy Storage System and Micro-Grid</u>

The addition of a battery energy storage system (BESS) and micro-grid system would provide additional benefits associated with resiliency, demand charge reduction and time of use energy/rate shifting, which increase the value of the solar energy produced by storing power produced during low cost periods and using stored energy when rates are higher. Though the extra cost of installing the battery storage and micro-grid system would not reduce overall costs below the forecasted cost of grid energy, they do decrease the cost of energy purchased from PG&E, which is subject to greater fluctuation than rates associated with the PPA. There is also an additional added value associated with the resiliency provided by the micro-grid.

Conceptually, the value of resiliency is the cost one would pay for a backup power system. In the case of conventional construction, this would be the cost to install a generator and fuel tank as well as the ongoing costs of operating and maintaining the generator, and cost of usage. In the case of a micro-grid storage system, it would be the direct cost of installing and maintaining the battery and control systems, or in the case of a PPA, the incremental cost of power purchased through the PPA (paid over time vs. up front).

Electrical loads have varying levels of importance, and therefore, the process of provisioning energy resilience relies on allocating loads into different tiers so that energy can be provided to critical loads first, priority loads second, and all other loads thereafter. The Clean Coalition has developed a methodology for allocating loads into the following three tiers:

- Tier 1 are mission-critical and life-sustaining loads that are necessary to keep operational at all times, including during grid outages. Tier 1 loads usually represent less than half of the total load.
- Tier 2 are priority loads that should be maintained as long as doing so does not threaten the ability to maintain Tier 1 loads. Tier 2 loads are usually comparable in magnitude to the Tier 1 load.

- Tier 3 are discretionary loads that make up the remaining load, usually about 75% of the total load, and can be maintained when doing so does not threaten the ability to maintain Tier 1 & Tier 2 loads.

In the case of the Town Center/Library project, the following loads have been deemed to be Tier 1 & Tier 2:

- Tier 1: Police Station for four days
- Tier 2: Library partial load of 20% for one day

The design for Town Center/Library project already has a type of control and islanding system design included which is referred to as Fully Automated Microgrid (FAM). The FAM is used equally by either the generator of the microgrid. The FAM approach is highly desirable and is more popular in new construction. FAM requires special breakers and panels that can be automatically turned off which connects to Tier 1, 2, and 3 loads. The Tier 1 and 2 loads remain energized during an outage for a minimum of 4 and 1 days respectively. Tier 3 loads can be manually switched on to energize when energy availability is sufficient to support the selected Tier 3 loads. Typically, all Tier 3 load circuits are automatically switched off during an outage.

The following table provides the estimated costs associated with the installation of the BESS and micro-grid system for the various options and can be compared to the cost associated with the generator and fuel tank included, and underway, in the base project.

	2020 Update	Option 1	Option 2
Value of Solar Power Produced ($/kWh)	$0.174	$0.179	$0.179
Value of Solar Power Produced (annual)	$51,400	$41,400	$54,100
PPA Power Price, PV Only($/kWh)	$0.27	$0.23	$0.22
PPA Price add, BESS($/kWh)	$0.17	$0.21	$0.16
Total PPA Price with BESS ($/kWh)	$0.44	$0.43	$0.38
Annual PPA Energy Cost (PV & BESS)	$130,000	$102,000	$115,000
Annual Net Energy Cost (as compared to PG&E @ $92k)	$147,000	$123,000	$131,000
Additional Year 1 Energy Cost Comparison	$55,000	$31,000	$39,000

Though the Year 1 energy costs for Option 1 are lower than that of Option 2, the reduced solar production would not be able to sustain the same level of resiliency as Option 2. Therefore, Sage is recommending Option 2.

It is important to note that in addition to the costs associated with the PPA, there will be costs for changes to the current construction contract that will be needed to accommodate changes to the size/scope of PV, the PV layout option selected, inclusion of micro-grid vs keeping the generator. It should also be noted that Option 2 adds PV to <u>all roof areas</u> of the City Hall/Police Building. To accommodate, necessary project changes may be either credits, such as savings from not installing the generator/fuel system, not installing PV stations on the Library roof, potential reduction in amount of clay vs composite roofing; or additional costs – changes to the Administration/PD roof to account for additional stations, or conversely replacing the composite roofing materials with clay tiles if PV is not installed at this time. Staff has initiated conversations with Amoroso, the project contractor, to start estimating the potential costs/credits associated with potential changes. The following provides a rough order of magnitude of costs, based on the preliminary information received to date:

- Elimination of PV from project:
  - Cost of switching from composite roofing to clay tiles, if PV not installed - $95,000
  - Credit for elimination of PV roofing supports - ($40,000)
  - Net - $55,000 additional cost
- If PV Option 2 & BESS is included in project in lieu of diesel generator and fuel tank
  - Credit for generator ($135,000 value item)– conservatively assumed at $0, as it has been fabricated and purchased, credit for not installing may be nominal – can continue to review if can be returned
  - Credit for fuel tank ($234,000 value item) – conservatively assume loss of deposits and payments made to date ($50,000) results in a net savings - ($184,000)
  - Net estimated contract savings – ($184,000)

Separately, staff has reached out to Peninsula Clean Energy (PCE) regarding their efforts around power purchase agreements and bulk PV procurement. PCE has released a joint Request for Information in partnership with East Bay Community Energy (EBCE) for support in gaining information and evaluation of options to procure Solar + Storage across a portfolio of public sector facilities located in Alameda and San Mateo Counties. As part of that process, the Joint CCAs aim to better determine the procurement pathways that will lead to efficient Solar + Storage system deployment. This process is lagging behind our project. Ultimately, PCE may be looking at entering into lease agreements with public agencies for the placement of solar and storage systems.

Staff is seeking direction from the City Council with regards to the options for PV layout and the inclusion of the battery energy storage system and micro-grid.

POLICY FOCUS

The City Council's policy discussion should revolve around the inclusion and layout of the PV system at the Town Center and the desire to include the battery energy storage/micro-grid systems in the request for proposals associated with the Power Purchase Agreement for the Town Center.

FISCAL IMPACT

None at this time.

PUBLIC NOTICE

Public notification was achieved by posting the agenda, with this agenda item being listed, at least 72 hours prior to the meeting in print and electronically. Information about the project is also disseminated via the Town's electronic News Flash and Atherton Online. There are approximately 1,200 subscribers to the Town's electronic News Flash publications. Subscribers include residents as well as stakeholders – to include, but be not limited to, media outlets, school districts, Menlo Park Fire District, service provides (water, power, and sewer), and regional elected officials.

COMMISSION/COMMITTEE FEEDBACK/REFERRAL

This item ____ has or _x__ has not been before a Town Committee or Commission.
____ Audit/Finance Committee (meets every other month)
____ Bicycle/Pedestrian Committee (meets as needed)
____ Civic Center Advisory Committee (meets as needed)
____ Environmental Programs Committee (meets every other month)
____ Park and Recreation Committee (meets each month)
____ Planning Commission (meets each month)
____ Rail Committee (meets every other month)
____ Transportation Committee (meets every other month)
____ Tree Committee (meets each month)

ATTACHMENTS

1. Solar PV, Battery Energy Storage, Microgrid Feasibility Study – Atherton Town Center, by Sage Energy/Clean Coalition
2. Summary of Project Update

Solar PV, Battery Energy Storage, Microgrid Feasibility Study

Atherton Town Center

May 12, 2020

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1 EXECUTIVE SUMMARY

1.1 Overview

The Town of Atherton retained Sage Energy Consulting, Inc. (Sage) to evaluate the potential installation and lifetime performance of solar photovoltaic (PV), battery energy storage systems (BESS) and a microgid at the new Atherton Town Center. Project goals are to reduce electrical energy usage and cost for the campus and to provide a reliable power supply in the event of emergencies including electrical grid reliability issues such as PG&E's Public Safety Power Shutdowns (PSPS) events.

This Feasibility Study has been conducted to assess detailed feasibility of implementing Solar and BESS Microgrids at the Atherton Town Center site. The primary purpose of is to provide the Town Council with the detailed costs and values associated with the economic, environmental, and resilience of benefits of a Solar and BESS Microgrid.

All scenarios were financially modeled assuming Power Purchase Agreement (PPA) financing where an independent third-party developer engineers, procures, constructs, commissions, operates and maintains the systems, selling the energy produced to the Town according to a Service Contract. PPA financing nearly eliminates project capital costs to the Town and provides a strong incentive for the system owner to maintain and operate the systems at peak capacity.

1.2 Comparison of Solar PV Options

After consultation with Town staff, four solar PV system design options were considered with two microgrid resource scenarios: a battery energy storage system (BESS) or a diesel genset. The new PV design options are as follows:

Table 1-1 shows the choices that were considered for this analysis. It compares the systems by PV size, their annual production and the resulting efficiency/yield of production.

Table 1-1: PV Design Options

Solar PV Design Options					
Design Option		Original 2017	2020 Update	Option 1	Option 2
System Size	kW-DC	401.5	208.8	149.3	194.9
Production, Year 1	kWh	401,000	295,000	232,000	302,000
Yield (Efficiency), Year 1	kWh/kW/Year	998	1,412	1,551	1,551

The original design from 2017 covered many rooftops with modules that are either orientated North (away from best solar resource) or shaded from the numerous tall trees surrounding the site. The problems show up in the extremely low efficiency (yield) of the design, 998 kWh/kW/Year, which would not result in a viable PPA.

In the 2020 Update design Sage eliminated inefficient PV siting locations from the 2017 design. This approach cuts the PV by about half, but only drops the production by about a quarter because the efficiency improves to 1,412 kWh/kWh/Year.

The 2017 original design was also estimated to cost around $6.81/Wdc. The 2020 original design is estimated to cost around $4.50/Wdc. The 2020 Update design has significant improvements, but it is not reasonably fundable with a PPA for economic savings, mostly due to the low efficiency of the design.

1.3 Financial Analysis

Sage preformed lifetime financial modeling for each of the three design options based on the above system sizes, energy production, BESS sizing resiliency requirements, and the PG&E tariffs that will be used. The estimated PPA prices are based on market pricing for similar contemporary PV systems in the area and indicative pricing from solar vendors.

Option 2 is used for the PV+BESS analysis as it provides the best financial returns. The larger PV system in Option 2 allows for a smaller battery to support the critical loads during an outage.

The energy storage system size of 174 kW/696 kWh is designed to support both energy management and backup functions. Energy management provides a variety of cost savings functions including but not limited to demand charge reduction and time of use (TOU) energy shifting.

Tables **1-2 to 1.5** shows the Financial Analysis for the Option 2 PV alone and Option 2 PV+BESS scenarios. Details for the analyses of the other options are in **Appendices C and D**.

Table 1-2: Project and load information for Option 2 PV (194.9 kW) + BESS project

Project Information		
Solar PV System Size	kW-DC	194.91
Solar PV Year 1 Production	kWh	302,000
Solar PV Yield	kWh/kW/Year	1,549
Energy Storage System Size	kW/kWh	174kW/696kWh
Modeled System Lifetime	Years	25
Electricity Usage Information		
Annual Electricity Consumption	kWh	348,000
Annual Electricity Cost	$, Current Tariffs	$92,000
Blended Average Cost of Electricity	$/kWh	$0.2640

Table 1-3: Financial Assumptions for Option 2 PV (194.9 kW) + BESS project

Financial Assumptions		
Project Soft Costs	$	$147,000
PPA Contract Term	Years	25
PPA Price, PV	$/kWh	$0.2200
PPA Price Adder, BESS	$/kWh	$0.1611
PPA Price, Total	$/kWh	$0.3811
PPA Price Escalator	%	0%
Avoided Generator CapEx	$	$421,000
Avoided Generator OpEx, year 1	$, Year 1	$8,800
Annual Utility Inflation Rate	%	3.00%
NPV Discount Rate	%	2.50%

Table 1-4: Financial Results for Option 2 PV (194.9 kW) + BESS project

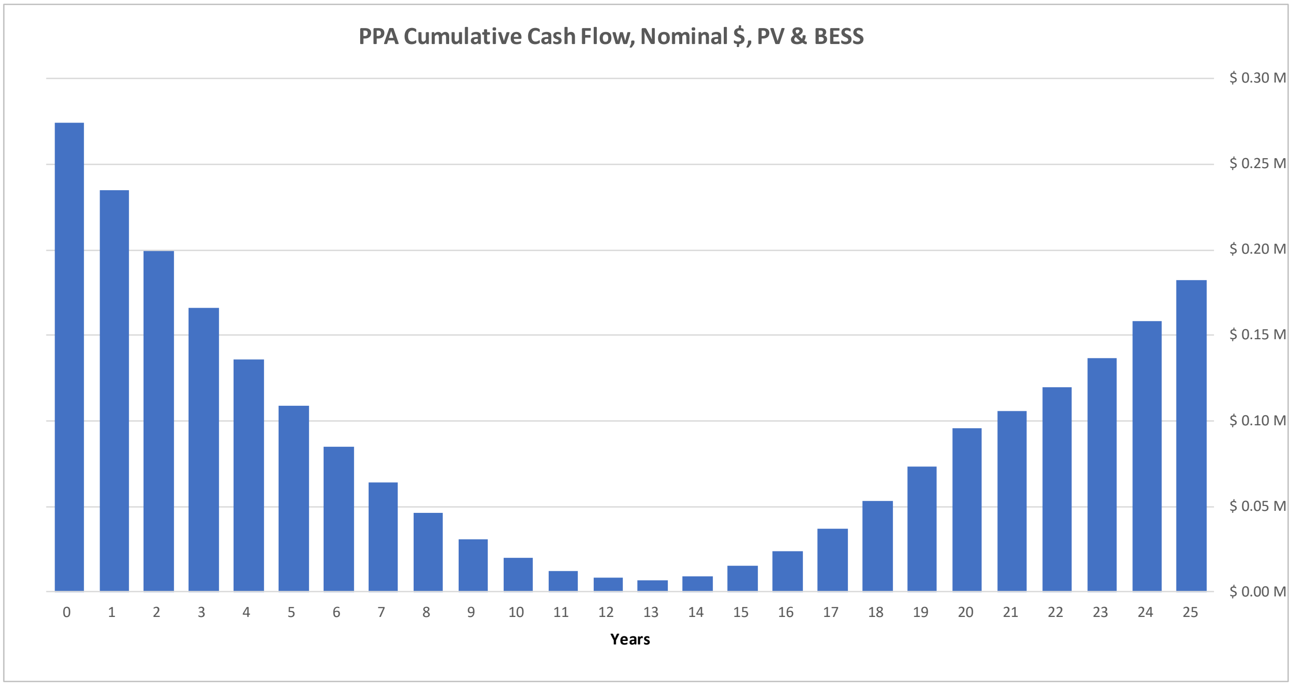
Financial Results		
Year 1		
Annual Electricity Cost	$, Current Tariffs	$92,000
Annual Value of Solar	$	$52,000
Value of Energy Storage	$	$16,000
Annual Value of Avoided Generator, OpEx	$	$8,800
Annual PPA Energy Cost (PV&BESS)	$	$115,000
Annual Net Energy Cost	$	$131,000
25-year P50 Results, Solar PV		
Simple Payback, Solar	Years	22.3
Nominal Returns	$	$49,000
NPV Returns, 2.5% Discount Rate	$	-$23,000
25-year P50 Results, Solar+Storage		
Simple Payback, Solar	Years	<1
Nominal Returns	$	$185,000
NPV Returns, 2.5% Discount Rate	$	$145,000

Table 1-5: Environmental impact for Option 2 PV (194.9 kW) + BESS project

Environmental Impacts		
CO2e Offset per Year (Average)	CO2e	104
CO2e Offset 25-year Total	CO2e	3,000
Equivalent Cars	Cars per Year	20

The initial PPA rate is greater than the initial electric bill savings and avoided generator OpEx costs causing the initial savings to initially erode downward. However, after year 13 the savings begin to grow as the utility rates and electric savings increase compared to the fixed PPA price. The PPA with zero escalator lowers the risk, protecting the Town from the anticipated increase in utility rates over the life of the project.

Figure 1-6: Cumulative cash flow for expected case, Option 2 PV + BESS



See **Appendix B** for a sensitivity analysis plot of the key variables driving the lifecycle analysis calculations used in the PPA for the PV+BESS scenario. The top three most sensitive items are the utility annual escalator, the soft costs, and the base price for the BESS for which we have market indicative pricing. Monte Carlo methods are used to provide a range of expected outcomes.

1.4 Genset Backup Analysis – Value of Resilience (VOR)

The Value of Resilience is the value to the Town for providing electrical grid resilience for critical functions during utility outages. The VOR is computed by calculating the CapEx and OpEx costs for the backup generator system.

There is a significant savings from not purchasing and installing the backup generator and its accessories. The avoided generator CapEx costs, less generator restocking fee and the project soft costs, were added to the project financial analysis for year 0. There is an additional OpEx savings from not fueling and maintaining the backup generator which is included in the annual savings.

Table 1-7: Inputs to VOR model for NPV calculations

Financial Modeling Assumptions		
PG&E PSPS Event Duration	Days/yr	4
Fuel Inflation	%/year	2%
Opex Inflation	%/year	3%
Asset Lifetime	Years	25
NPV Discount rate	%	2.50%
Genset Assumptions		
Size	kW	500
CapEx Costs		
Genset Cost	$	$ 125,000
Genset Install Cost	$	$ 37,500
Tank Cost	$	$ 245,000
Tank install Cost	$	$ 24,500
Total CapEx	$	$ 432,000
OpEx costs		
Fuel		
Tank Size	Gallons	4,000
Fuel cost	$/Gallon	$ 3.50
Initial Fuel Cost	$	$ 14,000
Annual Fuel Consumption	Gallons	1320
Annual Fuel Cost	$	$ 4,620
Maintenance		
Annual Contract	$/year	$ 1,000
Annual Parts	$/year	$ 2,000
Monthly Run Time	Hours	2
Annual Staff Hours	Hours	24
Labor Cost/hr	$/Hour	$ 50
Labor cost	$	$ 1,200
Total Annual Maint	$	$ 4,200
Generator Restock Fee		
Restock Fee	% Unit Cost	20%
Restock Fee	$	$ 25,000

1.5 Key Findings

1. Four solar PV options were considered. Sage/CC recommend proceeding with Option 2. Options considered were:

   1.1. Original 2017 design – this design is the largest in terms of system nameplate kW but has unacceptably low performance due to significant shading and mounting of panels on the north slope of the Police Station roof. With an efficiency/yield of less than 1000 kWh/kW/year, the PPA price would need to be at least 50% higher than Sage's recommended designs, rendering this option financially infeasible.

   1.2. Original design 2020 update – Sage began with the original 2017 design and optimized it to significantly improve energy production and align it with current site plans. The most heavily shaded panels on the Library roof and panels located on buildings that are not in the final site plans were removed. While this design improves project performance and PPA price somewhat, it still significantly underperforms compared with Options 1 and 2.

1.3. Option 1 – optimizes placement of solar PV panels for system energy production while minimizing the visibility of panels. This is the smallest of the four designs but provides the second-best financial performance. The BESS may need to increase in size with the Option 1 PV design to support the critical loads during an outage and that would further increase the PV & BESS PPA price.

1.4. Option 2 – is the recommended solar PV system, optimizing both the size and performance to achieve the maximum financial returns for a PV system while taking into consideration aesthetic impact.

2. BESS system sizing is based on maximum demand of the backed-up facilities (police station, Library [one day]), providing critical load support for a minimum of four consecutive days of electrical grid outage. The solar PV+BESS system could conceivably support critical loads for a much longer duration grid outage.
3. The BESS system provides energy cost reduction through demand charge management and energy arbitrage when the electrical grid is up, as well as emergency power backup when the grid is down.
4. Option 2 is the only solar PV+BESS scenario that shows positive cumulative cash flow throughout the 25-year project life, assuming a 25-year PPA term with 0% annual escalator. The provision of no escalator reduces risk in later years of the contract.
5. There are significant savings at the outset of the project due to the avoided costs of not installing the diesel emergency generator and fuel tank. The solar PV+BES financial analysis assumes that the diesel genset is returned to the distributor with a 20% restocking fee.
6. PPA pricing for this project was derived from similar recent PPA projects as well as indicative pricing provided by potential proposers.
7. The economics of all scenarios assume that this project qualifies for the 26% Investment Tax Credit (ITC), which requires that IRS safe harbor requirements are met for 2020. The ITC steps down to 22% in 2021 which would increase PPA pricing approximately 10%. It should be possible to qualify the project for the 26% ITC.

1.6 Recommendations & Next Steps

The following recommendations are made with the intention of achieving the most favorable potential outcomes for the Town with respect to economics, resilience, and timing:

1. Finalize the solar PV system design and update project design documents, permits, and contracts.
2. Sage/CC recommends returning the diesel genset and associated equipment and using BESS in combination with solar PV on the site to provide critical load backup.
3. Use a competitive procurement RFQ/P process to select the best value proposal for the solar PV plus BESS project utilizing GC 4217.10-18.
4. Maintain the RFP schedule to secure the 26% Investment Tax Credit and ensure construction is synchronized with the overall project build schedule.
5. Continue to engage the Sage & Clean Coalition team for expert support through the design, construction, commissioning, and monitoring & verification (M&V) stages to ensure adherence to contract requirements and achievement of financial goals

2 METHODOLGY

2.1 Data Collection

Sage utilized energy usage calculations provided by WRNS and independently verified by Sage for all facilities in the New Town Center. Energy usage profiles were then developed from similar sized facility types in the project area (Police, Library, Town Hall, City Hall). These individual profiles were then combined to produce the anticipated energy usage profile of the project and to identify and model critical loads for the resiliency analysis.

2.2 Conceptual Designs, Sizing, and Production/Performance Modeling

Conceptual system designs started with solar PV analysis using Helioscope design/production modeling software to evaluate the original design, optimize the original design, and create design options with improved performance and cost.

Once solar PV systems were modeled, BESS systems were evaluated to provide critical load backup required by the Town. BESS system sizing for critical load coverage was performed using HOMER GRID software to establish the minimum size BESS system that would address the City's minimum 4-day electrical grid outage requirement.

With the BESS systems sized for critical loads, Sage modeled the combined solar PV+BESS systems using Energy Toolbase to calculate the energy cost savings from these systems on various applicable PG&E tariffs.

Model assumptions are shown in Table **1-3**.

2.3 Financial Modeling

Sage uses both industry standard and proprietary in-house financial modeling for lifetime financial and environmental performance. Sage's modeling assumptions are conservative and based on market knowledge from other similar projects, current industry trends and utility historical pricing for specific customer classes over the past thirty or more years.

2.3.1 Tariff Modeling

Sage performed modeling using the Energy Toolbase solar analytics program, Sage's proprietary modeling and PG&E's current applicable utility tariff. Tariff modeling establishes the value of energy produced in year 1 for both the PV and BESS systems.

Table 2-1: Tariff Assumptions

Tariff Modeling Assumptions	
Modeled Tariff(s)	- PG&E B-10

2.3.2 Lifecycle Financial Modeling

Financial analysis of the project was performed utilizing the results of the tariff modeling to produce 25-year financial performance estimation. Sage's PPA modeling is based on over sixty input variables. Sage performs sensitivity analysis to identify the input variables that have the largest impact on financial performance, and multi-variable Monte Carlo analysis to estimate future financial performance as a probability distribution.

The table below summarizes the key model inputs and assumptions used in the financial analysis model.

Table 2-2: Important Financial Modeling Assumptions

Financial Information	
Annual Utility Inflation Rate	3.0%
Net Present Value (NPV) Discount Rate	2.5%
Project Soft Costs	$147,000
PPA Rate, Solar+BESS	$0.3811
Genset Avoided CapEx Costs	$432,000
Genset Avoided OpEx Costs, Year 1	$4,200

2.3.3 Sensitivity and Risk Analysis

Sage captures the impacts of key project variables to economic outcomes by performing both sensitivity analysis and Monte Carlo analysis. The sensitivity analysis identifies which variables have the most significant impact on the financial performance of the project. Monte Carlo analysis establishes a P50 and P90 percent probability envelope for financial performance over the lifetime of the project.

The table below summarizes the key project variables used for the Optimistic, Expected, and Conservative assumptions included in the sensitivity analysis. Based on the findings, the following were five variables and assumptions that had the most financial impact on the project.

Table 2-3: Sensitivity Analysis Assumptions

Parameter	Optimistic	Expected	Conservative
Utility Annual Escalator	4.0%	3.0%	2.0%
System Production Degradation, per year	0.38%	0.75%	1.50%
Testing, Inspection, Legal and Administration Costs	1.1%	1.5%	2.2%

3 MICROGRID CONFIGURATIONS & VALUING RESILIENCE

3.1 Load Tiers

Loads have varying levels of importance, and therefore, the process of provisioning energy resilience relies on allocating loads into different tiers so that energy can be provided to critical loads first, priority loads second, and all other loads thereafter. The Clean Coalition has developed a methodology for allocating loads into the following three tiers:

- Tier 1 are mission-critical and life-sustaining loads that are necessary to keep operational at all times, including during grid outages. Tier 1 loads usually represent less than half of the total load.
- Tier 2 are priority loads that should be maintained as long as doing so does not threaten the ability to maintain Tier 1 loads. Tier 2 loads are usually comparable in magnitude to the Tier 1 load.
- Tier 3 are discretionary loads that make up the remaining load, usually about 75% of the total load, and can be maintained when doing so does not threaten the ability to maintain Tier 1 & Tier 2 loads.

In the case of the Town Center site, the following loads have been deemed to be Tier 1 & Tier 2:

- Tier 1: Police Station for four days
- Tier 2: Library partial load of 20% for one day

For further illustrative details, see Appendix F – *Resilience levels by load tier for a Solar Microgrid*.

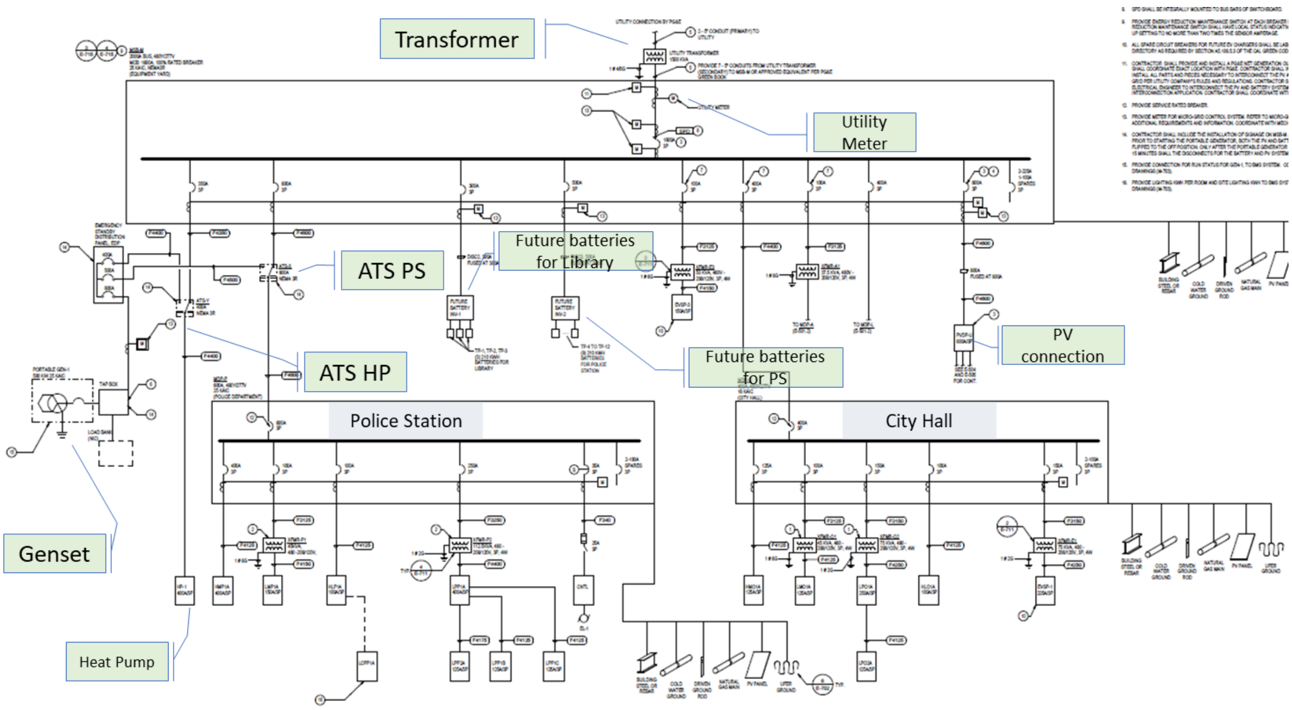
3.2 Microgrid Configuration

The design for Town Center already has a type of control and islanding system design embedded which is referred to as Critical Load Panel (CLP). The CLP approach groups Tier 1 & Tier 2 loads together and requires dedicated wiring that connects those critical & priority loads into a "critical load panel." There is no change with respect to the way the Tier 3 loads are served, and the CLP approach relies on limited manual switching to turn Tier 2 loads off & on at the critical load panel when energy availability is scarce. Similarly, the CLP approach relies on manual switching to energize Tier 3 loads when energy availability is only sufficient to support a portion of the Tier 3 loads – else all Tier 3 load circuits are either automatically switched off & on at the Main Service Board (MSB) as a full set.

The design under construction already has many of the control elements, such as critical load panels for shedding Tier 3 loads. While reasonable possibilities exist that sophisticated DBOOs will be able to beat this budgetary microgrid cost-adders, load management solutions are still relatively immature and represent the biggest cost uncertainty in securing the level of resilience that is being sought.

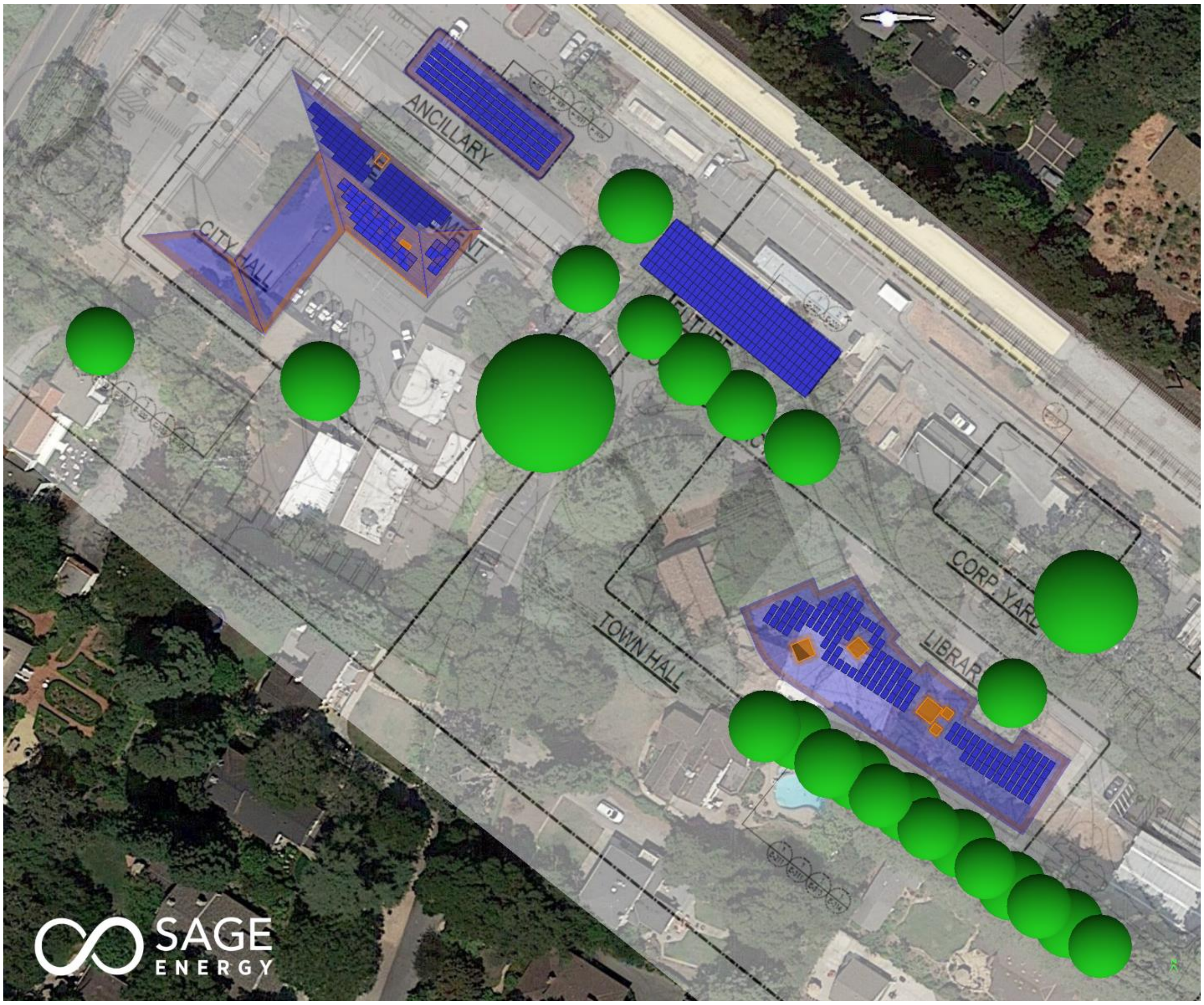
Figure 2-1 shows the original proposed microgrid design for the Town Center. It features a generator and two ATS switches that move the Police and the Heat Pump (Tier 1 loads) onto the generator for backup operation. There are circuit breakers planned for the design that will shed Tier3 loads. The Library file servers are a Tier 2 load and would be kept operating for one day using batteries that are normally planned to be working with the PV system. The solar+storage in this design works in the normal grid-tied mode until a grid outage occurs; then stored energy in the BESS is used to power the library file servers for one day.

Figure 2-1: Original proposed microgrid design for Town Center

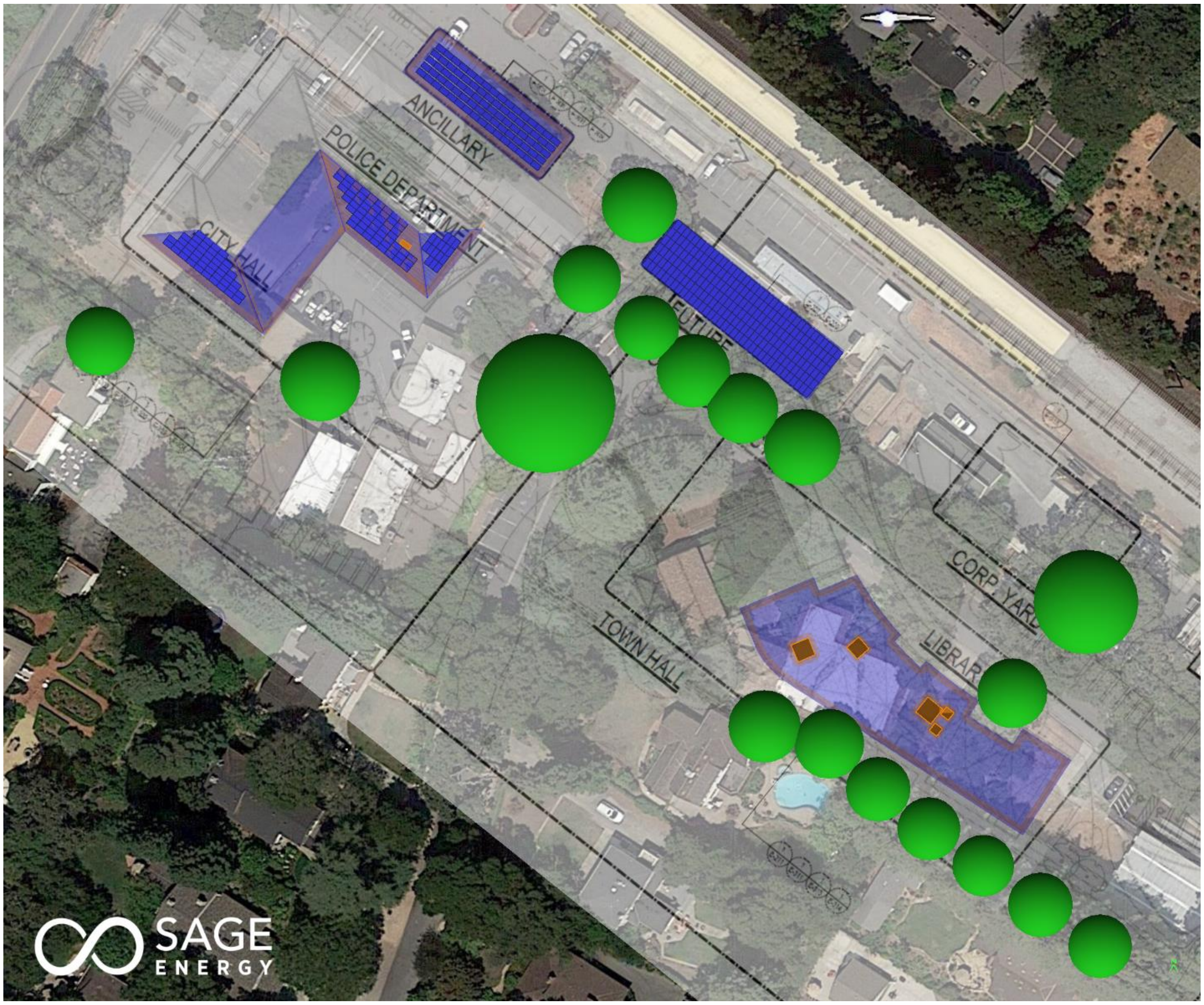


APPENDIX A – PV DESIGN MODULE LAYOUTS

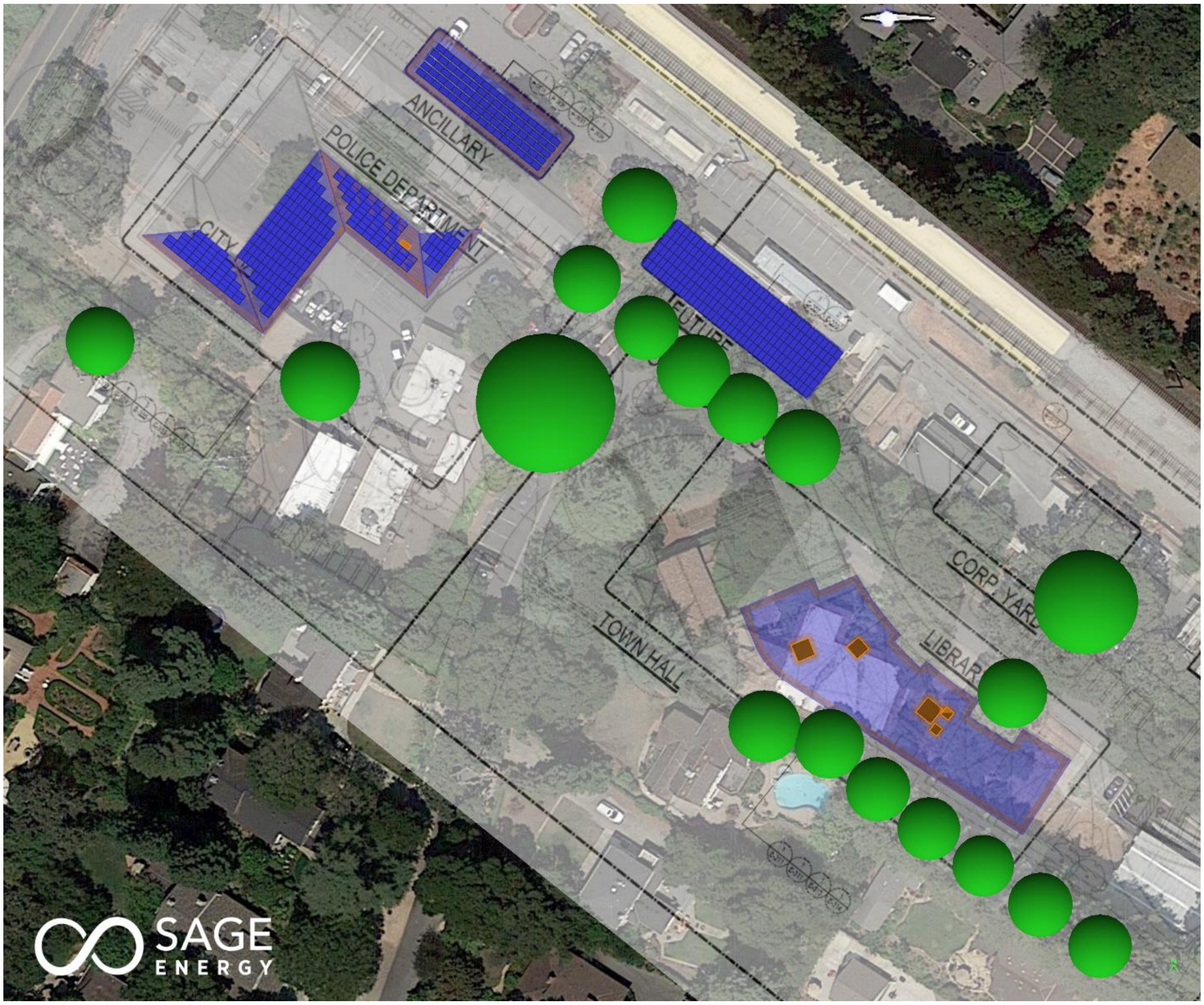
2020 Update Design



Option 1 Design



Option 2 Design



APPENDIX B – FINANCIAL ANALYSIS FOR OPTION 2 PV & BESS

Table B-1: Cash Flow Analysis of Option 2 Solar PPA, PV Only

Cash Flow Analysis of Solar PPA, PV Only

Atherton New Town Center Solar PV, BESS, Microgrid Project

PV							
Year	Estimated Utility Usage (kWh)	Annual Estimated Utility Cost w/o PV	Utility Energy Cost w/PV	PV Operating Costs	PPA Payments	Net Annual Savings	Cumulative Project Cash Flow
0	-	$ -	$ -	$ -	$ -	$ (89,000)	$ (89,000)
1	348,000	$ 92,000	$ 40,000	$ 67,000	$ 67,000	$ (14,000)	$ (103,000)
2	348,000	$ 95,000	$ 41,000	$ 66,000	$ 66,000	$ (13,000)	$ (116,000)
3	348,000	$ 98,000	$ 43,000	$ 66,000	$ 66,000	$ (11,000)	$ (127,000)
4	348,000	$ 100,000	$ 44,000	$ 65,000	$ 65,000	$ (9,000)	$ (136,000)
5	348,000	$ 103,000	$ 46,000	$ 65,000	$ 65,000	$ (7,000)	$ (143,000)
6	348,000	$ 107,000	$ 49,000	$ 64,000	$ 64,000	$ (6,000)	$ (149,000)
7	348,000	$ 110,000	$ 50,000	$ 64,000	$ 64,000	$ (4,000)	$ (153,000)
8	348,000	$ 113,000	$ 52,000	$ 63,000	$ 63,000	$ (2,000)	$ (155,000)
9	348,000	$ 116,000	$ 54,000	$ 63,000	$ 63,000	$ -	$ (155,000)
10	348,000	$ 120,000	$ 56,000	$ 62,000	$ 62,000	$ 2,000	$ (153,000)
11	348,000	$ 124,000	$ 59,000	$ 62,000	$ 62,000	$ 3,000	$ (150,000)
12	348,000	$ 127,000	$ 60,000	$ 61,000	$ 61,000	$ 5,000	$ (145,000)
13	348,000	$ 131,000	$ 63,000	$ 61,000	$ 61,000	$ 7,000	$ (138,000)
14	348,000	$ 135,000	$ 65,000	$ 60,000	$ 60,000	$ 9,000	$ (129,000)
15	348,000	$ 139,000	$ 68,000	$ 60,000	$ 60,000	$ 11,000	$ (118,000)
16	348,000	$ 143,000	$ 70,000	$ 60,000	$ 59,000	$ 13,000	$ (105,000)
17	348,000	$ 148,000	$ 73,000	$ 59,000	$ 59,000	$ 15,000	$ (90,000)
18	348,000	$ 152,000	$ 76,000	$ 59,000	$ 59,000	$ 17,000	$ (73,000)
19	348,000	$ 157,000	$ 79,000	$ 58,000	$ 58,000	$ 20,000	$ (53,000)
20	348,000	$ 161,000	$ 81,000	$ 58,000	$ 58,000	$ 22,000	$ (31,000)
21	348,000	$ 166,000	$ 97,000	$ 57,000	$ 57,000	$ 12,000	$ (19,000)
22	348,000	$ 171,000	$ 100,000	$ 57,000	$ 57,000	$ 14,000	$ (5,000)
23	348,000	$ 176,000	$ 104,000	$ 57,000	$ 56,000	$ 16,000	$ 11,000
24	348,000	$ 181,000	$ 107,000	$ 56,000	$ 56,000	$ 18,000	$ 29,000
25	348,000	$ 187,000	$ 111,000	$ 56,000	$ 56,000	$ 20,000	$ 49,000

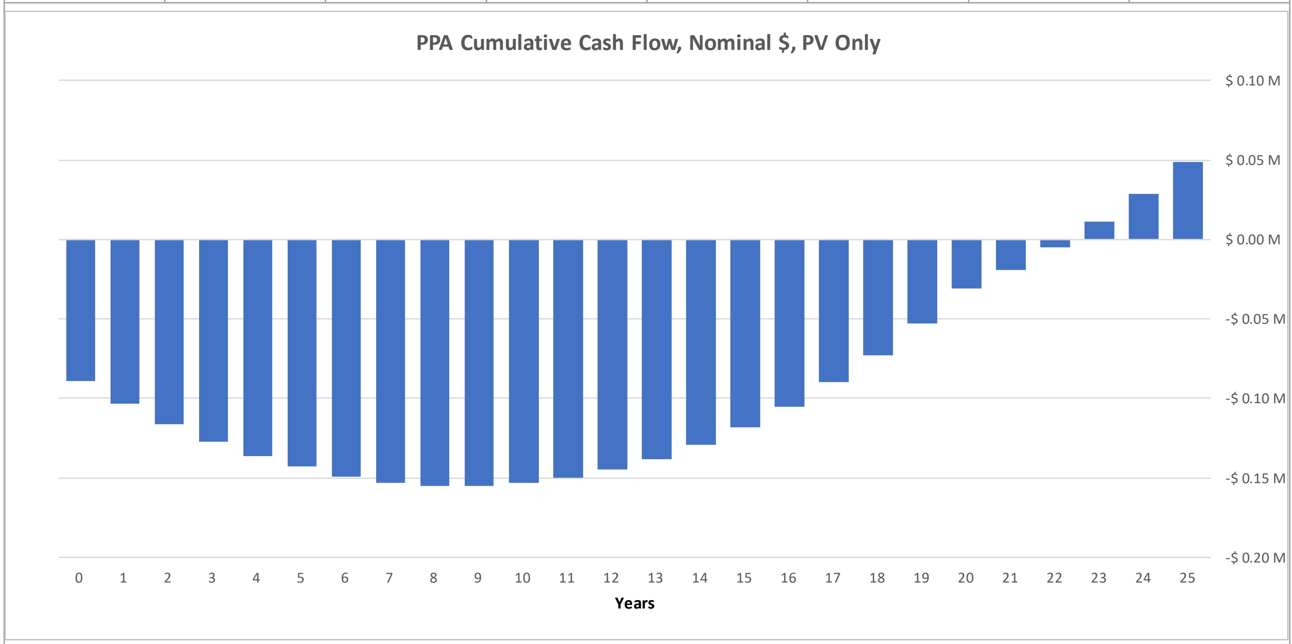
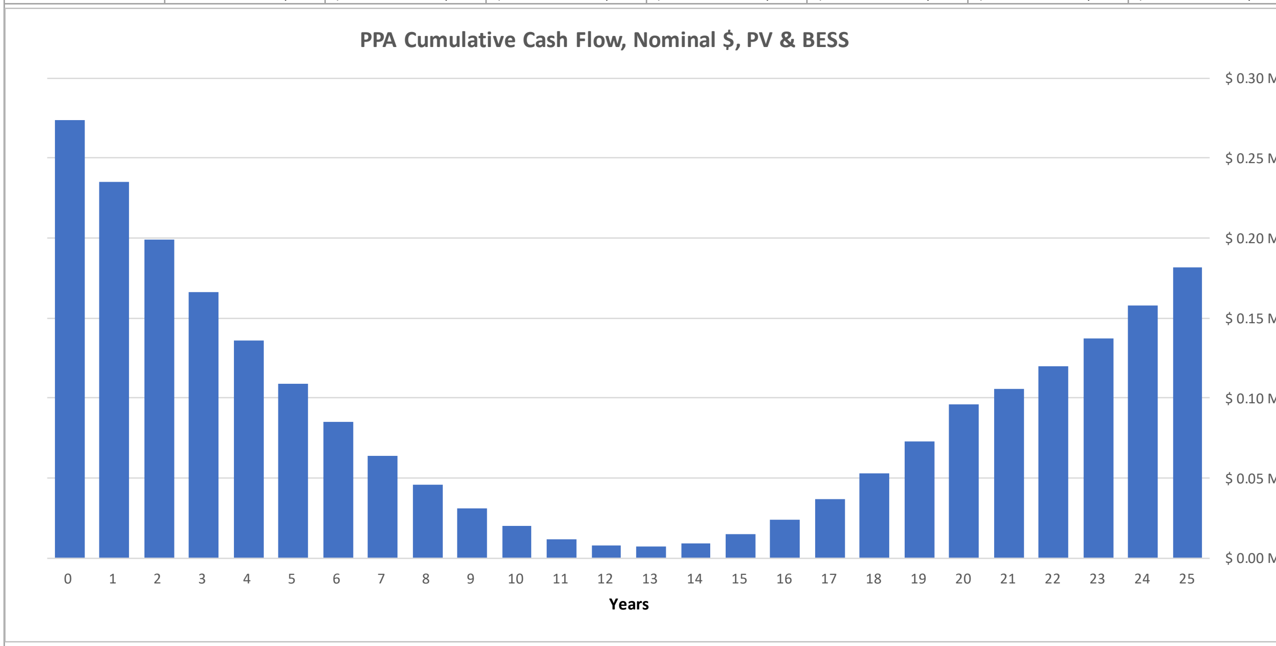


Table B-2: Cash Flow Analysis of Option 2 Solar PPA, <u>PV & BESS</u>

Cash Flow Analysis of Solar PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

PV & BESS							
Year	Estimated Utility Usage (kWh)	Annual Estimated Utility Cost w/o PV	Utility Energy Cost w/PV & BESS	PV & BESS Operating Costs	PPA Payments	Net Annual Savings	Cumulative Project Cash Flow
0	-	$ -	$ -	$ 421,000	$ -	$ 274,000	$ 274,000
1	348,000	$ 92,000	$ 24,000	$ 124,000	$ 115,000	$ (39,000)	$ 235,000
2	348,000	$ 95,000	$ 25,000	$ 124,000	$ 114,000	$ (36,000)	$ 199,000
3	348,000	$ 98,000	$ 26,000	$ 123,000	$ 114,000	$ (33,000)	$ 166,000
4	348,000	$ 100,000	$ 27,000	$ 122,000	$ 113,000	$ (30,000)	$ 136,000
5	348,000	$ 103,000	$ 28,000	$ 122,000	$ 112,000	$ (27,000)	$ 109,000
6	348,000	$ 107,000	$ 29,000	$ 121,000	$ 111,000	$ (24,000)	$ 85,000
7	348,000	$ 110,000	$ 31,000	$ 120,000	$ 110,000	$ (21,000)	$ 64,000
8	348,000	$ 113,000	$ 32,000	$ 120,000	$ 109,000	$ (18,000)	$ 46,000
9	348,000	$ 116,000	$ 33,000	$ 119,000	$ 109,000	$ (15,000)	$ 31,000
10	348,000	$ 120,000	$ 34,000	$ 119,000	$ 108,000	$ (11,000)	$ 20,000
11	348,000	$ 124,000	$ 36,000	$ 118,000	$ 107,000	$ (8,000)	$ 12,000
12	348,000	$ 127,000	$ 37,000	$ 118,000	$ 106,000	$ (4,000)	$ 8,000
13	348,000	$ 131,000	$ 39,000	$ 117,000	$ 105,000	$ (1,000)	$ 7,000
14	348,000	$ 135,000	$ 40,000	$ 117,000	$ 105,000	$ 2,000	$ 9,000
15	348,000	$ 139,000	$ 42,000	$ 116,000	$ 104,000	$ 6,000	$ 15,000
16	348,000	$ 143,000	$ 44,000	$ 116,000	$ 103,000	$ 9,000	$ 24,000
17	348,000	$ 148,000	$ 46,000	$ 115,000	$ 102,000	$ 13,000	$ 37,000
18	348,000	$ 152,000	$ 48,000	$ 115,000	$ 101,000	$ 16,000	$ 53,000
19	348,000	$ 157,000	$ 50,000	$ 115,000	$ 101,000	$ 20,000	$ 73,000
20	348,000	$ 161,000	$ 52,000	$ 114,000	$ 100,000	$ 23,000	$ 96,000
21	348,000	$ 166,000	$ 71,000	$ 114,000	$ 99,000	$ 10,000	$ 106,000
22	348,000	$ 171,000	$ 73,000	$ 113,000	$ 98,000	$ 14,000	$ 120,000
23	348,000	$ 176,000	$ 76,000	$ 113,000	$ 98,000	$ 17,000	$ 137,000
24	348,000	$ 181,000	$ 79,000	$ 113,000	$ 97,000	$ 21,000	$ 158,000
25	348,000	$ 187,000	$ 82,000	$ 112,000	$ 96,000	$ 24,000	$ 182,000



The top three elements of the sensitivity analysis in Table A-3 are discussed in section 1.4.

Table B-3: Sensitivity Analysis of Option 2 PV & BESS in PPA analysis

25-year Sensitivity Analysis PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

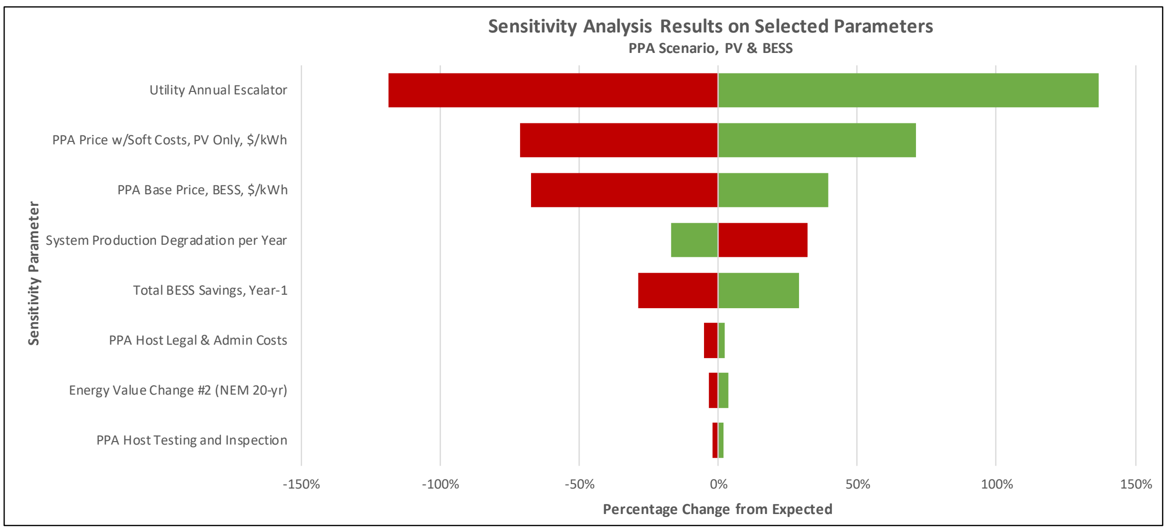
Parameters

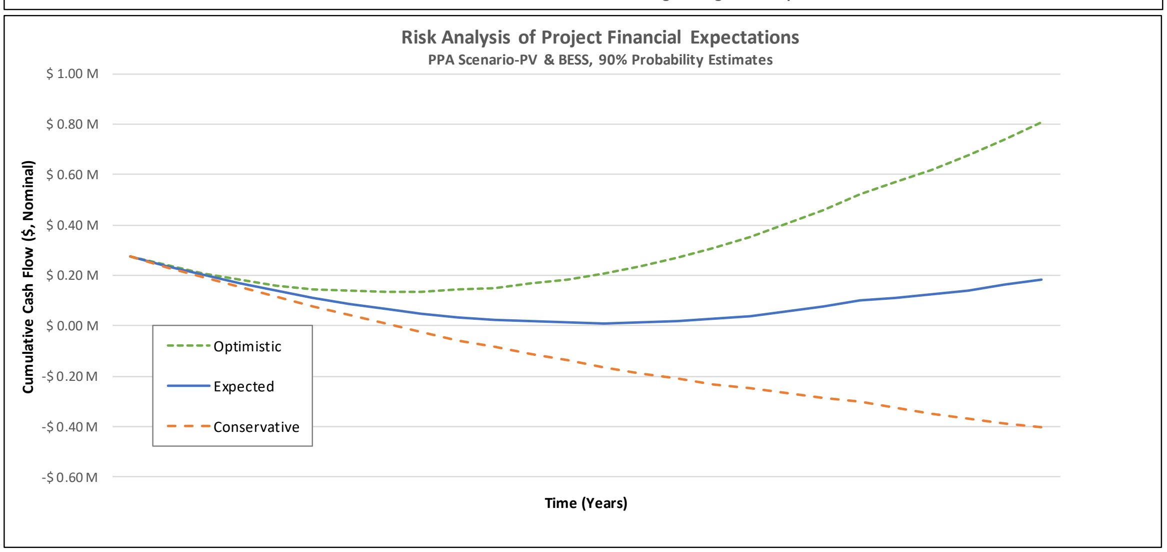
The table below presents the NPV savings and variation under Conservative, Expected and Optimistic assumptions.

		25-Year NPV			Parameter Variation	
PPA Sensitivity Parameter	Expected Value	Conservative (P90)	Expected (P50)	Optimistic (P10)	Conservative	Optimistic
Utility Annual Escalator	3.00%	-$27,000	$145,000	$343,000	-118.4%	136.9%
PPA Price w/Soft Costs, PV Only, $/kWh	$0.2200	$42,000	$145,000	$248,000	-71.2%	71.2%
PPA Base Price, BESS, $/kWh	$0.1611	$47,000	$145,000	$202,000	-67.3%	39.5%
System Production Degradation per Year	0.75%	$191,000	$145,000	$120,000	31.9%	-17.1%
Total BESS Savings, Year-1	$15,537	$103,000	$145,000	$186,000	-28.9%	28.9%
PPA Host Legal & Admin Costs	0.50%	$137,000	$145,000	$148,000	-4.9%	2.5%
Energy Value Change #2 (NEM 20-yr)	-15.00%	$140,000	$145,000	$150,000	-3.5%	3.5%
PPA Host Testing and Inspection	1.00%	$142,000	$145,000	$147,000	-2.0%	2.0%
	Weighted Sensitivity:	-$251,000	$145,000	$565,000		

Risk Analysis Results

The figures below present the variation in NPV for each sensitivity parameter and yearly cash flow variation under Conservative and Optimistic





APPENDIX C: FINANCIAL ANALYSIS FOR OPTION 1 PV & BESS

Table C-1: Cash Flow Analysis of Option 1 Solar PPA, PV & BESS

Cash Flow Analysis of Solar PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

PV & BESS							
Year	Estimated Utility Usage (kWh)	Annual Estimated Utility Cost w/o PV	Utility Energy Cost w/PV & BESS	PV & BESS Operating Costs	PPA Payments	Net Annual Savings	Cumulative Project Cash Flow
0	-	$ -	$ -	$ 421,000	$ -	$ 277,000	$ 277,000
1	348,000	$ 92,000	$ 36,000	$ 111,000	$ 102,000	$ (38,000)	$ 239,000
2	348,000	$ 95,000	$ 38,000	$ 110,000	$ 101,000	$ (35,000)	$ 204,000
3	348,000	$ 98,000	$ 39,000	$ 110,000	$ 100,000	$ (32,000)	$ 172,000
4	348,000	$ 100,000	$ 40,000	$ 109,000	$ 100,000	$ (30,000)	$ 142,000
5	348,000	$ 103,000	$ 41,000	$ 109,000	$ 99,000	$ (27,000)	$ 115,000
6	348,000	$ 107,000	$ 43,000	$ 108,000	$ 98,000	$ (24,000)	$ 91,000
7	348,000	$ 110,000	$ 45,000	$ 108,000	$ 97,000	$ (22,000)	$ 69,000
8	348,000	$ 113,000	$ 46,000	$ 107,000	$ 97,000	$ (19,000)	$ 50,000
9	348,000	$ 116,000	$ 47,000	$ 107,000	$ 96,000	$ (17,000)	$ 33,000
10	348,000	$ 120,000	$ 49,000	$ 106,000	$ 95,000	$ (13,000)	$ 20,000
11	348,000	$ 124,000	$ 51,000	$ 106,000	$ 95,000	$ (11,000)	$ 9,000
12	348,000	$ 127,000	$ 53,000	$ 106,000	$ 94,000	$ (8,000)	$ 1,000
13	348,000	$ 131,000	$ 55,000	$ 105,000	$ 93,000	$ (5,000)	$ (4,000)
14	348,000	$ 135,000	$ 57,000	$ 105,000	$ 92,000	$ (2,000)	$ (6,000)
15	348,000	$ 139,000	$ 59,000	$ 104,000	$ 92,000	$ 1,000	$ (5,000)
16	348,000	$ 143,000	$ 61,000	$ 104,000	$ 91,000	$ 4,000	$ (1,000)
17	348,000	$ 148,000	$ 64,000	$ 104,000	$ 90,000	$ 7,000	$ 6,000
18	348,000	$ 152,000	$ 66,000	$ 103,000	$ 90,000	$ 10,000	$ 16,000
19	348,000	$ 157,000	$ 69,000	$ 103,000	$ 89,000	$ 13,000	$ 29,000
20	348,000	$ 161,000	$ 71,000	$ 103,000	$ 88,000	$ 16,000	$ 45,000
21	348,000	$ 166,000	$ 87,000	$ 102,000	$ 88,000	$ 5,000	$ 50,000
22	348,000	$ 171,000	$ 90,000	$ 102,000	$ 87,000	$ 8,000	$ 58,000
23	348,000	$ 176,000	$ 93,000	$ 102,000	$ 86,000	$ 11,000	$ 69,000
24	348,000	$ 181,000	$ 96,000	$ 101,000	$ 86,000	$ 14,000	$ 83,000
25	348,000	$ 187,000	$ 100,000	$ 101,000	$ 85,000	$ 17,000	$ 100,000

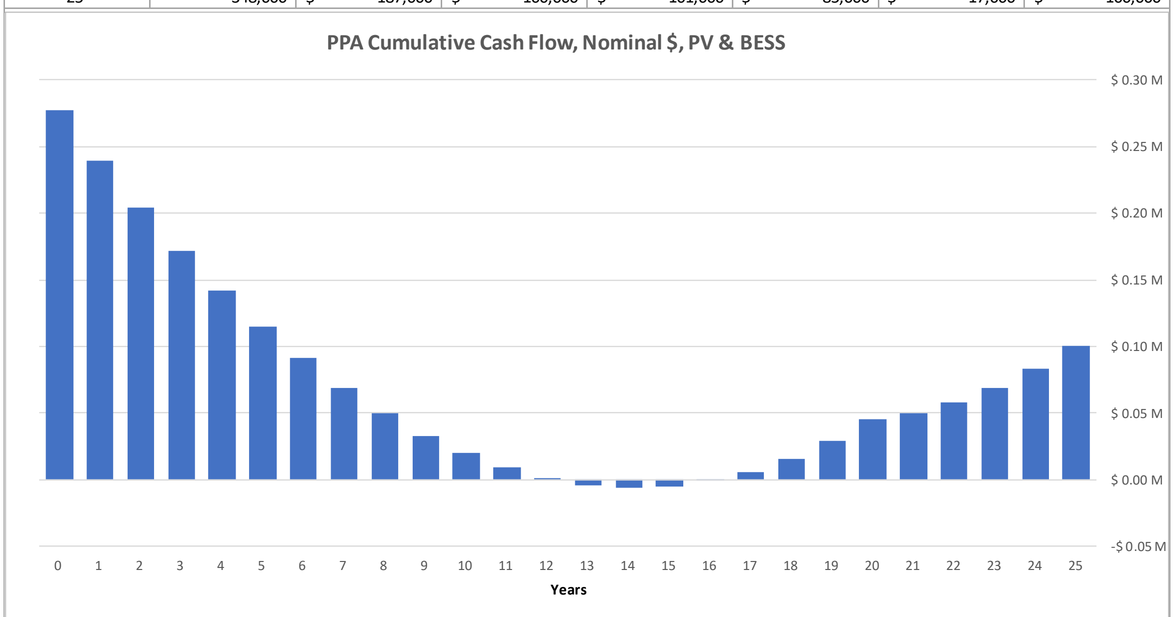


Table C-2: Sensitivity Analysis of Option 1 PV & BESS in PPA Analysis

25-year Sensitivity Analysis PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

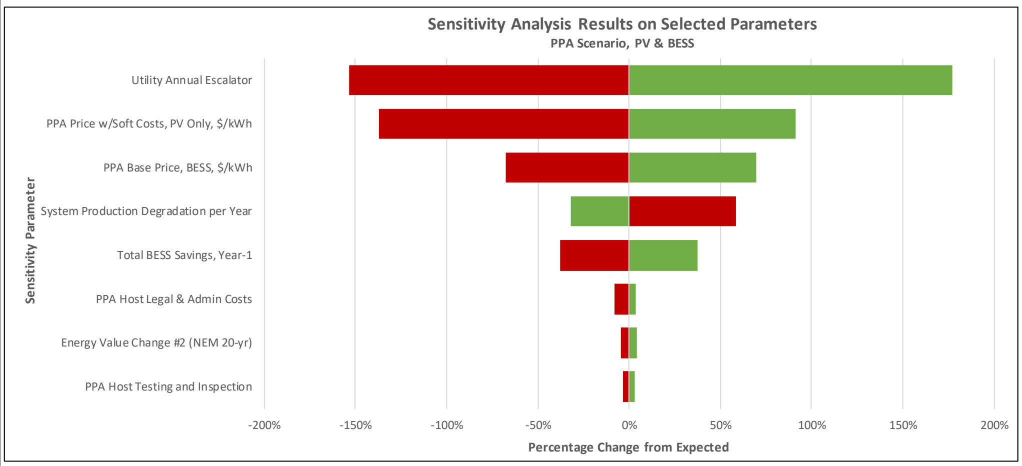
Parameters

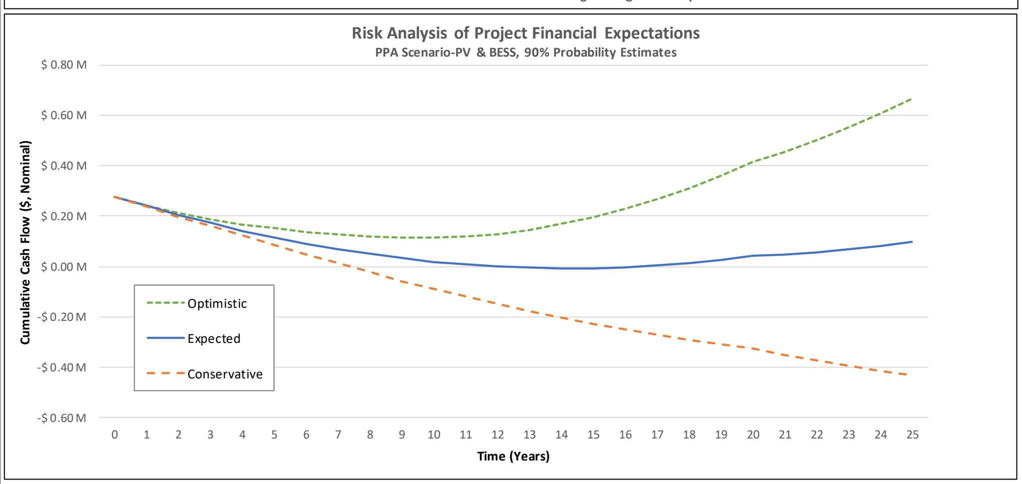
The table below presents the NPV savings and variation under Conservative, Expected and Optimistic assumptions.

PPA Sensitivity Parameter	Expected Value	25-Year NPV Conservative (P90)	25-Year NPV Expected (P50)	25-Year NPV Optimistic (P10)	Parameter Variation Conservative	Parameter Variation Optimistic
Utility Annual Escalator	3.00%	-$52,000	$90,000	$253,000	-157.7%	182.4%
PPA Base Price, BESS, $/kWh	$0.2103	$12,000	$90,000	$170,000	-86.4%	89.4%
PPA Price w/Soft Costs, PV Only, $/kWh	$0.2300	$11,000	$90,000	$169,000	-87.9%	87.9%
System Production Degradation per Year	0.75%	$140,000	$90,000	$63,000	56.1%	-30.2%
Total BESS Savings, Year-1	$14,379	$51,000	$90,000	$128,000	-43.1%	43.1%
PPA Host Legal & Admin Costs	0.50%	$83,000	$90,000	$93,000	-6.9%	3.5%
Energy Value Change #2 (NEM 20-yr)	-15.00%	$86,000	$90,000	$94,000	-4.6%	4.6%
PPA Host Testing and Inspection	1.00%	$87,000	$90,000	$92,000	-2.8%	2.8%
	Weighted Sensitivity:	-$269,000	$90,000	$466,000		

Risk Analysis Results

The figures below present the variation in NPV for each sensitivity parameter and yearly cash flow variation under Conservative and Optimistic





APPENDIX D: FINANCIAL ANALYSIS FOR 2020 UPDATE DESIGN PV & BESS

Table D-1 : Cash Flow Analysis of 2020 Update Solar PPA, PV & BESS

Cash Flow Analysis of Solar PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

PV & BESS							
Year	Estimated Utility Usage (kWh)	Annual Estimated Utility Cost w/o PV	Utility Energy Cost w/PV & BESS	PV & BESS Operating Costs	PPA Payments	Net Annual Savings	Cumulative Project Cash Flow
0	-	$ -	$ -	$ 421,000	$ -	$ 270,000	$ 270,000
1	348,000	$ 92,000	$ 25,000	$ 137,000	$ 128,000	$ (53,000)	$ 217,000
2	348,000	$ 95,000	$ 27,000	$ 136,000	$ 127,000	$ (50,000)	$ 167,000
3	348,000	$ 98,000	$ 28,000	$ 136,000	$ 126,000	$ (47,000)	$ 120,000
4	348,000	$ 100,000	$ 28,000	$ 135,000	$ 125,000	$ (44,000)	$ 76,000
5	348,000	$ 103,000	$ 29,000	$ 134,000	$ 125,000	$ (41,000)	$ 35,000
6	348,000	$ 107,000	$ 31,000	$ 134,000	$ 124,000	$ (37,000)	$ (2,000)
7	348,000	$ 110,000	$ 32,000	$ 133,000	$ 123,000	$ (34,000)	$ (36,000)
8	348,000	$ 113,000	$ 33,000	$ 132,000	$ 122,000	$ (31,000)	$ (67,000)
9	348,000	$ 116,000	$ 34,000	$ 132,000	$ 121,000	$ (28,000)	$ (95,000)
10	348,000	$ 120,000	$ 35,000	$ 131,000	$ 120,000	$ (24,000)	$ (119,000)
11	348,000	$ 124,000	$ 37,000	$ 130,000	$ 119,000	$ (21,000)	$ (140,000)
12	348,000	$ 127,000	$ 38,000	$ 130,000	$ 118,000	$ (18,000)	$ (158,000)
13	348,000	$ 131,000	$ 40,000	$ 129,000	$ 117,000	$ (15,000)	$ (173,000)
14	348,000	$ 135,000	$ 42,000	$ 129,000	$ 116,000	$ (11,000)	$ (184,000)
15	348,000	$ 139,000	$ 44,000	$ 128,000	$ 115,000	$ (8,000)	$ (192,000)
16	348,000	$ 143,000	$ 45,000	$ 128,000	$ 115,000	$ (4,000)	$ (196,000)
17	348,000	$ 148,000	$ 48,000	$ 127,000	$ 114,000	$ (1,000)	$ (197,000)
18	348,000	$ 152,000	$ 50,000	$ 126,000	$ 113,000	$ 3,000	$ (194,000)
19	348,000	$ 157,000	$ 52,000	$ 126,000	$ 112,000	$ 6,000	$ (188,000)
20	348,000	$ 161,000	$ 53,000	$ 125,000	$ 111,000	$ 10,000	$ (178,000)
21	348,000	$ 166,000	$ 72,000	$ 125,000	$ 110,000	$ (2,000)	$ (180,000)
22	348,000	$ 171,000	$ 75,000	$ 125,000	$ 110,000	$ 1,000	$ (179,000)
23	348,000	$ 176,000	$ 78,000	$ 124,000	$ 109,000	$ 5,000	$ (174,000)
24	348,000	$ 181,000	$ 80,000	$ 124,000	$ 108,000	$ 8,000	$ (166,000)
25	348,000	$ 187,000	$ 84,000	$ 123,000	$ 107,000	$ 12,000	$ (154,000)

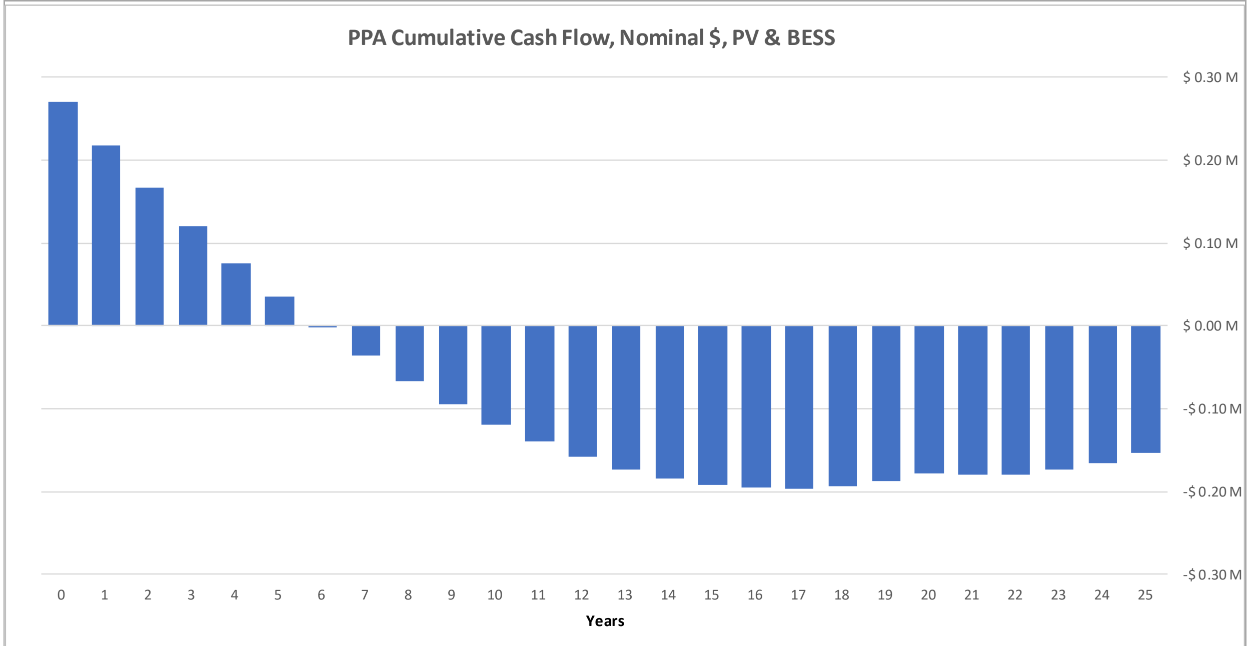


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Table D-2: Sensitivity Analysis of 2020 Update PV & BESS in PPA Analysis

25-year Sensitivity Analysis PPA, PV & BESS

Atherton New Town Center Solar PV, BESS, Microgrid Project

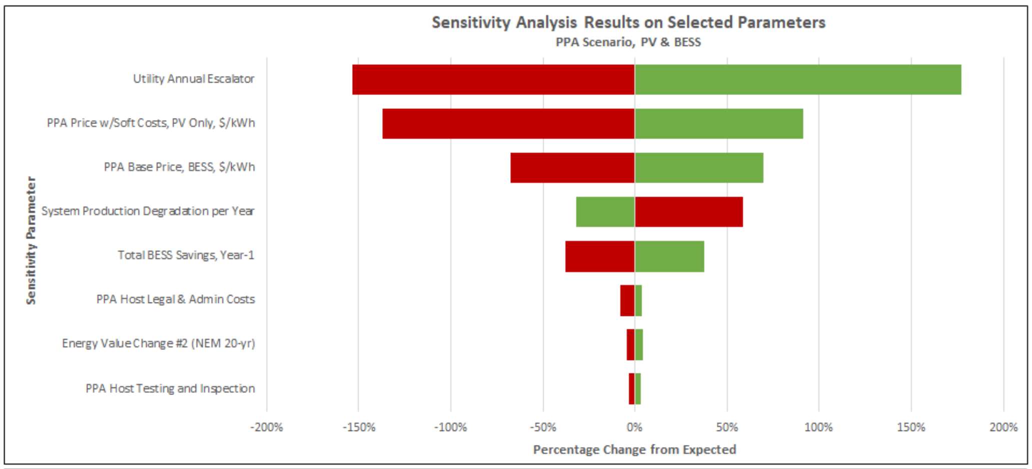
Parameters

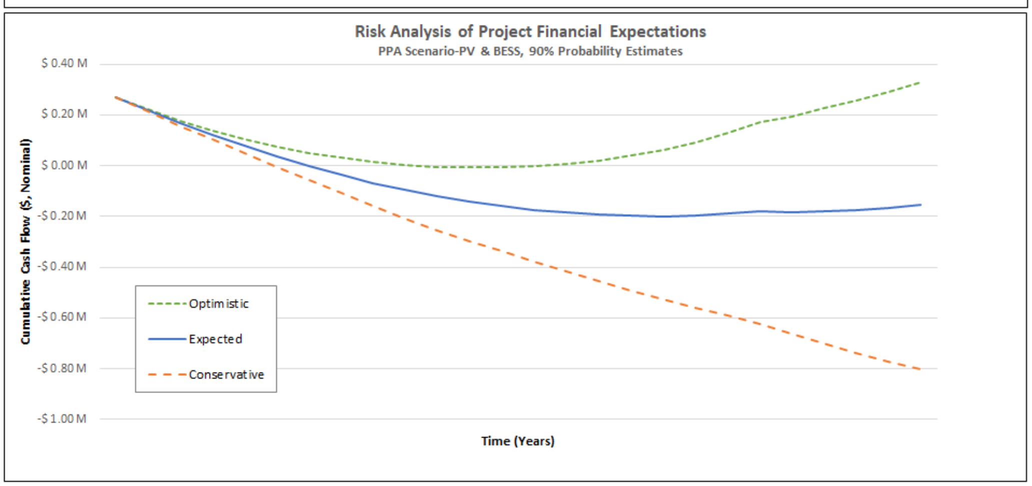
The table below presents the NPV savings and variation under Conservative, Expected and Optimistic assumptions.

PPA Sensitivity Parameter	Expected Value	25-Year NPV Conservative (P90)	25-Year NPV Expected (P50)	25-Year NPV Optimistic (P10)	Parameter Variation Conservative	Parameter Variation Optimistic
Utility Annual Escalator	3.00%	-$278,000	-$110,000	$85,000	-153.4%	177.5%
PPA Price w/Soft Costs, PV Only, $/kWh	$0.2700	-$260,000	-$110,000	-$9,000	-137.2%	91.5%
PPA Base Price, BESS, $/kWh	$0.1653	-$184,000	-$110,000	-$33,000	-67.3%	69.9%
System Production Degradation per Year	0.75%	-$45,000	-$110,000	-$144,000	58.8%	-31.7%
Total BESS Savings, Year-1	$15,363	-$151,000	-$110,000	-$68,000	-37.7%	37.7%
PPA Host Legal & Admin Costs	0.50%	-$118,000	-$110,000	-$105,000	-7.8%	3.9%
Energy Value Change #2 (NEM 20-yr)	-15.00%	-$115,000	-$110,000	-$105,000	-4.5%	4.5%
PPA Host Testing and Inspection	1.00%	-$113,000	-$110,000	-$106,000	-3.1%	3.1%
	Weighted Sensitivity:	-$546,000	-$110,000	$224,000		

Risk Analysis Results

The figures below present the variation in NPV for each sensitivity parameter and yearly cash flow variation under Conservative and Optimistic





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APPENDIX E – RESILIENCE LEVELS BY LOAD TIER FOR A SOLAR MICROGRID

Figure F-1 is illustrative of the level of resilience anticipated to be possible from typical microgrid sites. For the Town Center project, the chosen support tiered load support is:

- Tier 1: 100% of the time
- Tier 2: 25% of the time in this case (first day of a four-day outage).
- Tier 3: As allowed by solar resource, as long as Tier 1 and 2 loads are supported

Figure F-1: Resilience levels by load tier for a Solar Microgrid evaluated at multiple, prototypical sites with a net zero level of solar and storage energy capacity equal to 2 hours of solar production (1 MW of solar and 2 MWh of storage for example).

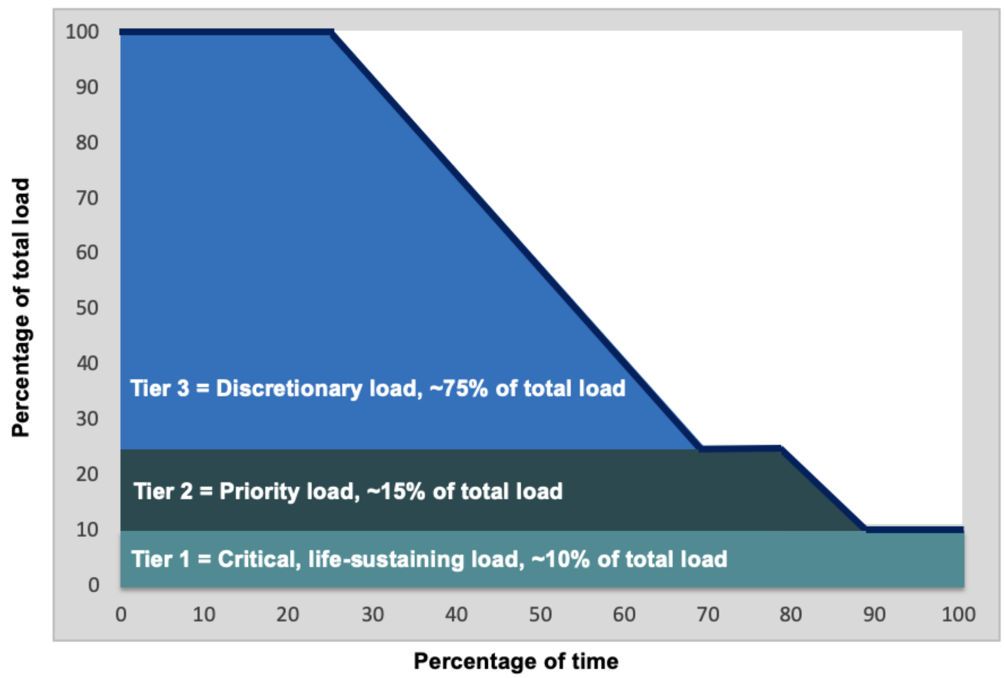
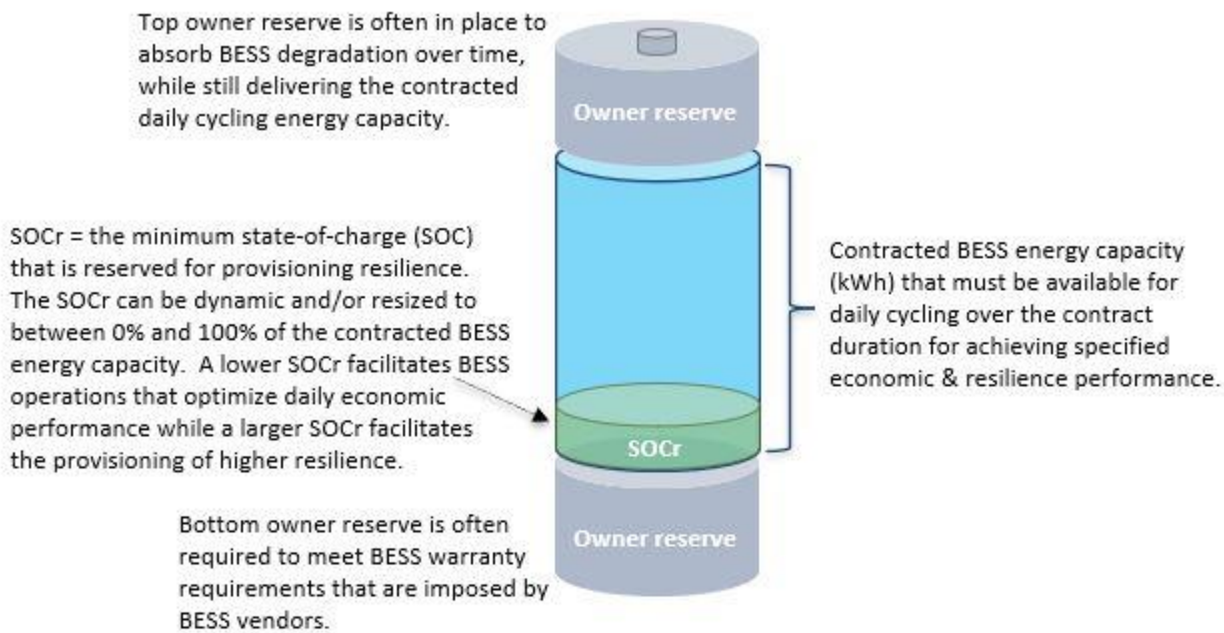


Figure F-1 is illustrative of the level of resilience anticipated to be possible from typical microgrid sites. For the Town Center project, the chosen support tiered load support is Police Station for four days and the Library for just the first day of the outage.

APPENDIX F – BATTERY CAPACITY ALLOCATIONS

As illustrated in Figure G-1, the contracted designer-builder-owner-operator (DBOO) will be responsible for provisioning the specified battery capacities for daily cycling over the 20-year PPA periods. Each specified capacity is required for achieving the expected economic and resilience performance. Owner reserves might be included in the BESS deployments in order to comply with the daily cycling requirements over time, amidst BESS degradation realities and warranty requirements. The state-of-charge (SOC) that is reserved for the specified resilience performance, referred to as the SOCr (pronounced like “soccer” the sport), can be dynamic in constant response to energy availability, solar forecast, and critical load forecast. Importantly, the Town can mandate specific SOCr sizing, between 0% and 100% of the contracted BESS energy capacities. If preferences increase for everyday economic optimization, then the SBUSD can mandate smaller SOCr levels. Conversely, in the face of coming storms and/or Public Safety Power Shutoff (PSPS) warnings, the Town can mandate higher SOCr levels to prepare for the increased likelihood of grid outages and associated energy resilience needs.

Figure G-1: BESS energy capacity allocations



Note that the SOCr for the Town Center project will b a very large fraction of a very large battery needed to support four-day operation during a worst-case, minimum solar period. When the forecast holds much sunlight, SOCr will be much smaller, so that most of the battery capacity can be used for other savings.

Project UPDATE 5/20/2020

Project Update

The PPA pricing in Sage's Feasibility Study dated May 12, 2020, was a conservative estimate based on similar projects and current market conditions. Important considerations were:

- Small size of the project – this typically results in fewer bids from smaller developers that have relatively high cost of financing, resulting in high PPA pricing.
- Complexity of the project – the combination of roofs with Spanish tile, a small carport, and a large battery based microgrid all contribute to complexity and cost.
- COVID-19 uncertainty – there is considerable uncertainly with labor costs, supply chains, incentives, and developer viability. Sage captured this uncertainty as risk in our project analysis with added to anticipated PPA pricing.

Since releasing the Feasibility Study and based on feedback from City staff, Sage has remodeled the project to remove the microgrid. This allowed us to downsize the battery energy storage system (BESS) to improve its financial performance. In this configuration the PV system and BESS would not provide any backup capabilities during a power outage. The microgrid was removed because it was determined that the City required the diesel backup generator for the project, eliminating the need for a solar PV+BESS microgrid.

In addition, Sage has continued to reach out to the solar PV vendor community for indicative pricing for the Town Center project. We recently received indicative PPA pricing from a very well-established firm that has expressed interest in the project. This pricing is considerably lower than Sage's original conservative estimate and, together with the much smaller BESS and no microgrid control system, may result in annual energy savings in year 1 and thereafter.

We will not know actual project PPA pricing until hard bids are received, if the City decides to move forward with an RFP for the project. .

The following tables show updated project information based on the Option 2 design and credible indicative project pricing received after the Feasibility Study was completed.

Table 1 – Project Overview

Project Overview		
Number of Sites	Sites	1
Solar PV System Size	kW-DC	194.91
Solar PV Year 1 Production	kWh	302,000
Solar PV Yield	kWh/kW/Year	1,549
Energy Storage System Size	kW/kWh	58kW/232kWh
Modeled System Lifetime	Years	25

Table 2 - Project Financial Assumptions

Financial Assumptions		
Project Soft Costs	$	$137,000
PPA Contract Term	Years	25
PPA Price, PV	$/kWh	$0.1650
PPA Price Adder, BESS	$/kWh	$0.0350
PPA Price, PV+BESS Total	$/kWh	$0.2000
PPA Price Escalator	%	0%
Annual Utility Inflation Rate	%	3.00%
NPV Discount Rate	%	2.50%

Project Financial Performance

The following tables and graphs show project financial performance for PPA financing of the solar PV plus BESS project based on the financial assumptions shown above. The significantly lower PPA base price and BESS adder result in the system reducing energy costs in year 1 and every year thereafter.

Table 3 - Project Financial Performance, Solar PV Only, Solar PV+BESS

Financial Results			
Year 1		Solar PV	Solar PV + BESS
Value of Energy Produced	$/kWh	$0.1732	$0.2028
PPA Cost of Energy Produced	$/kWh	$0.1650	$0.2000
Energy Cost Savings/(Loss)	$/kWh	$0.0082	$0.0028
Value of Energy	$	$2,400	$740
25-year P50 Results, Solar PV		Solar PV	Solar PV + BESS
Simple Payback, Solar	Years	10.4	11.6
Nominal Returns	$	$415,000	$477,000
NPV Returns, 2.5% Discount Rate	$	$246,000	$273,000

Project Cash Flow Table and Graph

The following table and graph show 25-year PPA cash flows in nominal dollars based on the above project assumptions. Table 4 is cash flow for the solar PV+BESS project. Figure 1 compares the annual cost of energy for three cases: do nothing (purchase all electricity from PG&E); solar PV only, and; solar PV+BESS project.

Table 4 - 25-Year Project Cash Flows, Solar PV+BESS

PV & BESS							
Year	Estimated Utility Usage (kWh)	Annual Estimated Utility Cost w/o PV	Utility Energy Cost w/PV & BESS	PV & BESS Operating Costs	PPA Payments	Net Annual Savings	Cumulative Project Cash Flow
0	-	$ -	$ -	$ -	$ -	$ (137,000)	$ (137,000)
1	348,000	$ 92,000	$ 31,000	$ 61,000	$ 60,000	$ 1,000	$ (136,000)
2	348,000	$ 95,000	$ 32,000	$ 60,000	$ 60,000	$ 3,000	$ (133,000)
3	348,000	$ 98,000	$ 33,000	$ 60,000	$ 60,000	$ 5,000	$ (128,000)
4	348,000	$ 100,000	$ 34,000	$ 59,000	$ 59,000	$ 7,000	$ (121,000)
5	348,000	$ 103,000	$ 35,000	$ 59,000	$ 59,000	$ 9,000	$ (112,000)
6	348,000	$ 107,000	$ 38,000	$ 58,000	$ 58,000	$ 11,000	$ (101,000)
7	348,000	$ 110,000	$ 39,000	$ 58,000	$ 58,000	$ 13,000	$ (88,000)
8	348,000	$ 113,000	$ 40,000	$ 57,000	$ 57,000	$ 15,000	$ (73,000)
9	348,000	$ 116,000	$ 42,000	$ 57,000	$ 57,000	$ 17,000	$ (56,000)
10	348,000	$ 120,000	$ 43,000	$ 57,000	$ 57,000	$ 20,000	$ (36,000)
11	348,000	$ 124,000	$ 46,000	$ 56,000	$ 56,000	$ 22,000	$ (14,000)
12	348,000	$ 127,000	$ 47,000	$ 56,000	$ 56,000	$ 24,000	$ 10,000
13	348,000	$ 131,000	$ 49,000	$ 55,000	$ 55,000	$ 27,000	$ 37,000
14	348,000	$ 135,000	$ 51,000	$ 55,000	$ 55,000	$ 29,000	$ 66,000
15	348,000	$ 139,000	$ 53,000	$ 55,000	$ 54,000	$ 32,000	$ 98,000
16	348,000	$ 143,000	$ 55,000	$ 54,000	$ 54,000	$ 34,000	$ 132,000
17	348,000	$ 148,000	$ 58,000	$ 54,000	$ 54,000	$ 36,000	$ 168,000
18	348,000	$ 152,000	$ 60,000	$ 53,000	$ 53,000	$ 39,000	$ 207,000
19	348,000	$ 157,000	$ 62,000	$ 53,000	$ 53,000	$ 42,000	$ 249,000
20	348,000	$ 161,000	$ 64,000	$ 53,000	$ 52,000	$ 44,000	$ 293,000
21	348,000	$ 166,000	$ 82,000	$ 52,000	$ 52,000	$ 32,000	$ 325,000
22	348,000	$ 171,000	$ 85,000	$ 52,000	$ 52,000	$ 34,000	$ 359,000
23	348,000	$ 176,000	$ 88,000	$ 51,000	$ 51,000	$ 37,000	$ 396,000
24	348,000	$ 181,000	$ 91,000	$ 51,000	$ 51,000	$ 39,000	$ 435,000
25	348,000	$ 187,000	$ 95,000	$ 51,000	$ 50,000	$ 42,000	$ 477,000

Figure 1 - Annual Energy Cost Comparison, Solar PV, BESS