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Silicon Valley Power

City of Santa Clara

Silicon Valley Power

Powering the Center of What's Possible

SILICON VALLEY POWER / CITY OF SANTA CLARA
AB 2514 ENERGY STORAGE PROCUREMENT PLAN
NOVEMBER 2020

EXECUTIVE SUMMARY

This study is a re-evaluation of energy storage targets and goals for SVP, and provides a summary of the comprehensive research and analysis of energy storage technologies, economic modeling, industry and technology research, and collaboration with other joint power agencies, municipal utilities and Community-Choice Aggregators (CCAs) that SVP has carried out to support its findings. SVP has also participated in energy storage educational conferences, and conducted research and outreach with multiple energy storage vendors through request for proposal solicitations and bilateral meetings, to research and review emerging technologies across the electrochemical (battery), thermal, mechanical, and hydrogen storage technologies.

At this time SVP finds that lithium-ion batteries, both lithium nickel manganese cobalt oxide (NMC) and lithium-iron phosphate (LFP) batteries chemistries, to be the most common and frequent storage medium across the stationary storage landscape, due to the scaling from electric vehicles and growing utility-scale storage installations[1], however, SVP finds that the total installed costs for battery storage remain high with an average levelized cost of energy (LCOE) between $500-600/kWh and a payback period of 15 years for systems less than 10 MW in capacity, and is not cost-effective at current market prices. SVP currently has more cost-effective means of achieving most of the performance characteristics provided by energy storage systems. Thus SVP will not set energy storage goals and targets at this time, however the pilot programs described in this plan will assist SVP in determining the most cost-effective means of developing energy storage and determining energy storage procurement targets for the future.

In July 2020, CAISO's former president and CEO Steve Berberich indicated that energy storage technology will play a critical role in integrating renewables in the future and as much as 15,000 MW of energy storage of different duration levels and various technologies will be needed for California to reach its aspirational goal of cutting carbon emission output by 100 percent by 2045. There is reasonable expectation that energy storage technologies will both improve in capacity and reduce in cost over the next 24 years. As a share of load, SVP's portion of the CAISO's predicted need would be approximately 190 MW of energy storage technology.

SVP will test the technological and economic feasibility of energy storage through four research and development pilot projects, and will evaluate a utility-scale battery storage system to support its transmission system and future load growth. SVP seeks to explore energy storage

[1] Currently pumped hydro storage is the predominant storage technology in the United States in terms of rated installed capacity (MW), however it has become less common due to very limited geographical possibilities, large impact on the landscape, environmental issues for siting, long regulatory timeline to obtain FERC license and other government permits, and the high associated capital costs.

projects and programs, that will provide value to the ratepayer, increase the reliability of its grid, increase renewable energy consumption, and reduce greenhouse gas (GHG) emissions and criteria pollutants to improve local air quality in the City of Santa Clara.

The four pilot projects are expected to provide SVP with a total of approximately 8 MW of energy storage. Combined with an existing total of 1.48 MW in customer-owned battery storage installations.

As prices for battery storage continue to decline, and are combined with federal, and state incentives or subsidies, this will create opportunities for new business models for battery and energy storage investments for the utility that will benefit SVP's customers. Through its research, SVP believes that a diverse set of energy storage technologies must be commercially-available, scalable, and cost-effective in order to maximize the potential of energy storage for various end-use applications, and to de-carbonize the grid. In particular, long-duration storage (8 hours or longer in duration) that has a renewable primary source of fuel, that can be scaled in order to become cost-effective, must be developed in order to de-carbonize the grid, provide flexibility to ramp (during the morning and evening peaks), and operate as a base load power plant in order to compensate for future nuclear and natural gas power plant retirements.

The CAISO Stage 3 Alerts (its highest emergency level alert) and rolling outages that occurred during the August 2020 heatwave showed that the California grid would need support from energy storage for at least a six-hours in duration if storage was the only means used to resolve problems leading to the outages.

AB 2514, as amended, requires the governing boards of POUs to re-evaluate prior determinations of storage targets every three years. Moving forward, SVP will continue to report progress on energy storage procurement, strategy and deployment in its Integrated Resources Plan to the CA Energy Commission (CEC) published every five years.

BACKGROUND

In 2013, AB2514 codified Public Utilities Code Section 2836(B) that requires the governing board of each local publicly owned electric utility (POU) to determine appropriate targets for the utility to procure viable and cost-effective energy storage systems to be achieved by December 31, 2016, and December 31, 2020, on or before October 1, 2014 as part of their supply plan. There are no requirements for POUs to set future targets for energy storage. The statute also requires each governing board to re-evaluate the determinations made pursuant to this subdivision not less than once every three years, where the first three-year period ended in 2017, and the second evaluation period will end December 31, 2020.

In 2017, SVP determined that energy storage was not cost-effective, therefore, did not pursue energy storage targets. At the time, SVP analyzed three potential R&D pilot projects at the transmission, distribution point-of-interconnections, and behind-the-customer meter. Updates on these projects are included in this plan.

SVP ENERGY STORAGE STRATEGY

SVP has four on-going pilot projects that will be commercially operational from 2021 through 2023. Through various economic analyses evaluating the wholesale and distribution benefits of battery storage, SVP finds that lithium-ion battery storage can achieve a payback period of about 15 years at current unit pricing. The mix of battery costs declining (based on market forecasts), as well as new wholesale market revenue streams, and avoided transmission and distribution costs, will result in a reduced payback period in the future.

The pilot projects will test the feasibility of battery storage in response to wholesale market price signals, reduce thermal overloading on SVP's distribution grid, reduce transmission costs, reduce resource adequacy compliance obligations, and provide clean back-up power for power quality events and grid outages for up to four hours in duration. Next, SVP will test the ability of the battery storage inverters to provide frequency response, voltage support, as well as quickly ramp or curtail energy (demand response) in order to operate based on real-time grid conditions.

Additionally, because of increased interest from SVP's customers to invest and partner with SVP on energy storage installations and projects, SVP continues to evaluate storage solutions with its customers, as well as through utility-owned models. SVP expects to see more potential in energy storage due to the dynamic operations of the technology to provide energy, capacity, and ancillary services, to respond to day-ahead market signals, and the potential for participating in the wholesale frequency regulation and real-time (intra-hour) markets.

In order to recover the total installed cost of the energy storage systems, including hardware, software, and installation and constructions costs, there must be multiple revenue streams that the battery storage system can respond to and can provide through the project life cycle, not only participation in the wholesale market, but also on the distribution and transmission side.

SVP PROJECT DEPLOYMENT

Below is a summary of SVP's pilot projects by customer sector that are currently in the planning and development process. The year below indicates when the system is expected to be commercially operating.

Sector	2021	2022	2023	Total (MW)
Commercial	4.0		1.0	5.0
Industrial			1.0	1.0
Municipal		0.6		0.6
Residential		1.0		1.0
Total	4.0	1.6	2.0	7.6

PROJECT USE CASES FOR EACH R&D PROJECT

Impact	Uses Cases and Stacking Benefits	Data center battery storage project	Commercial Customer Partnership	Renewable Energy Microgrid	Residential DER Resilience and Equity Program
Wholesale Market	Energy Price Arbitrage	x	x	x	x
	Resource Adequacy	x	x	x	x
	Reduced Transmission Access Charge (Demand)	x	x	x	x
	Frequency Regulation				
	Demand response	x	x	x	x
Transmission/ Distribution	Peak Shave	x	x	x	x
	T&D deferral				x
	Power Quality	x		x	x
	Frequency Response	x		x	x
	Load following				
	Ancillary Services (Spin/ Non-Spin)				
	Voltage Support	x		x	x
	Black Start			x	
	Localized Distribution Congestion Relief	x	x	x	x
	Contingency/ N-1				
Customer Benefits & Environmental Benefits	Back-up Power/ Resilience	x		x	x
	Emissions/ Criteria pollutants reductions	x	x	x	x
	Increased Renewables Consumption	x	x	x	x

WHOLESALE MARKET BENEFITS

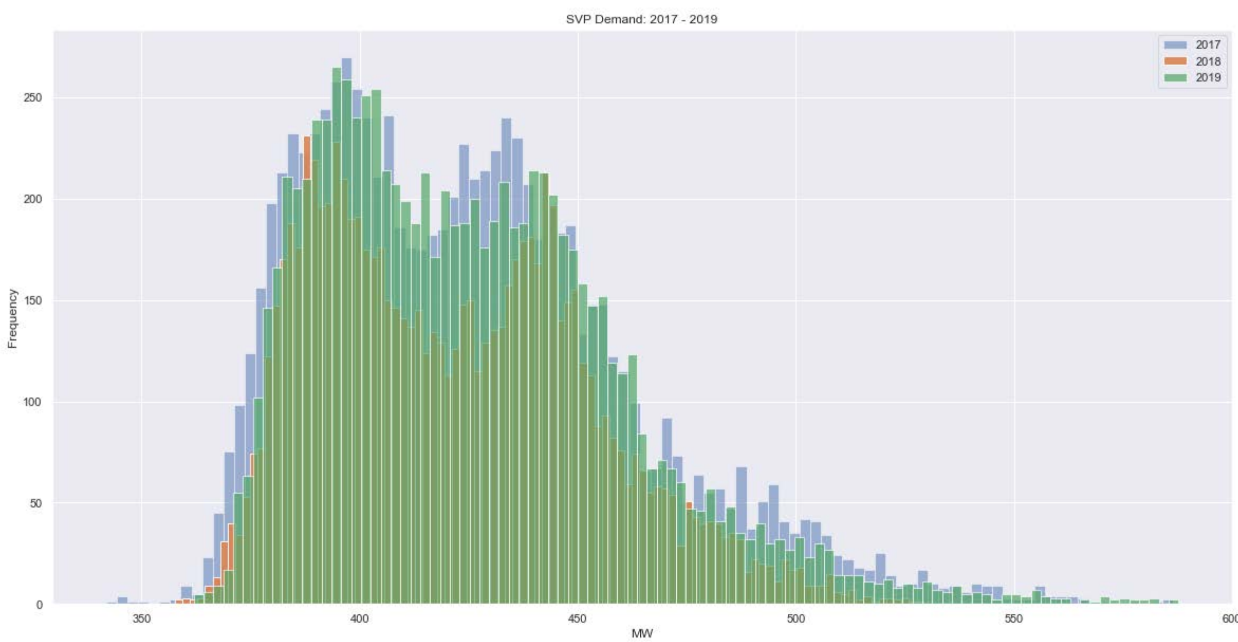
1. Energy price arbitrage: the storage system is charged during low (or negative) priced hours and discharged during higher priced hours (and hours with high marginal emissions factors)

to avoid dispatching generators with high fuel and variable operating and maintenance costs.

2. Peak shave/demand response:
    a. To alleviate system peaks, SVP will analyze certain days of the year during the summer months through early Fall (September) to reduce system super peaks. See histogram (Figure 1) below.
    b. Battery storage system will discharge to reduce SVP's coincident-peak, aligned with the CAISO gross peak of the day to reduce Resource Adequacy compliance obligations as well as reduce run-times of combined-cycle natural gas units correlated to higher emissions intensities on the California Independent System Operator (CAISO) grid.

The graph below depicts a histogram of SVP's demand from 2017 through 2019, which indicates a right-skewed distribution. Battery storage systems can be deployed to alleviate SVP system peak events, with a focus on alleviating SVP's super peaks which occur between June and September and are correlated to high temperatures, and in combination to increased energy consumption due to the return of the academic year in September.

Figure 1 Histogram of SVP's Load (2017-2019)



3. Generation capacity / resource adequacy: energy storage systems can respond to system and local resource adequacy needs by discharging during peak demand hours and scarcity events.
4. Reduce transmission access charges.
    a. The demand charge is based on a coincident-peak demand determinant. The CAISO has proposed a two-part hybrid approach to capture both peak demand and volumetric use to determine the high voltage and low voltage transmission access

charges (impacting power that flows into SVP's service territory through the 115 kV and 230 kV transmission lines).

5. Ancillary services: voltage support; frequency response; frequency regulation; spinning reserves; flexible resource adequacy.
    a. SVP believes the need for these services may grow as market penetration of renewable generation grows (and more customer behind-the-meter PV and distributed energy resource installations grow).
6. Real-time market: SVP will analyze market bidding and operational decisions to participate in the real-time energy markets, as a stacking benefit to the economic viability of energy storage.
7. Ramping/Load following: Through SVP's pilot projects, SVP will analyze the potential for storage as an alternative resource to provide ramping due to the inverter capability of operating up to full and at partial output levels and can respond very quickly when output modulation is needed for load following.

DISTRIBUTION

SVP sees an opportunity in distribution infrastructure deferral: identify key constrained locations on the grid, reducing demand during times of capacity constraints and deferring the need for transmission and distribution capacity upgrades.

1. The potential for peak shaving on the distribution demand by strategically locating the storage installation on City facilities. This can benefit distribution assets from overloading and to remain in a healthy state reducing the maintenance needs.
2. The potential of running customer engagement demand response programs by promoting energy storage within residential customers with existing solar PV will help reduce peak demand in the residential transformers during the peak period and would prevent transformers and secondaries from overloading and reduce outages. It will also offset loads by electric vehicle (EV) charges which will be a source of new load in the coming years. Much of this will also be determined by the increased adoption of electric vehicles, increased adoption of air conditioning locally and the electrification of buildings, which has the potential to create spikes in electrical demand patterns.
3. Voltage support: the energy storage solutions combined with the high penetration of solar PV can provide voltage support and reactive power compensation in the distribution area.
4. Optimize the distribution grid by putting control intelligence at the DER fleet level, the circuit level, and behind the customer meter.
    a. Economic and thermal data on circuits to efficiently dispatch and communicate with SVP's Supervisory control and data acquisition (SCADA) system the operations of the distributed energy resources (DER) assets in real-time.
5. Analyze potential distribution planning deferral opportunities.
6. Black start.

SVP R&D PILOT PROJECTS

DATA CENTER BATTERY STORAGE PROJECT

In 2018, SVP was awarded a grant for $300,000 from the Bay Area Air Quality Management District (BAAQMD) to implement a behind-the-meter lithium-ion battery storage pilot project. SVP has partnered with a battery equipment manufacturer and a data center to pilot a demonstration project.

The project will demonstrate the use-case for lithium-ion batteries as longer-duration uninterruptible power supply for data centers that are instantaneous and reliable, delaying or avoiding the use of diesel generators as backup power. Additionally, the pilot will demonstrate the economic viability and flexibility of a 2 MW/4 MWh battery energy storage system (BESS) that can be simultaneously dispatched at 2 MW capacity to support critical loads during a power quality event or outage.

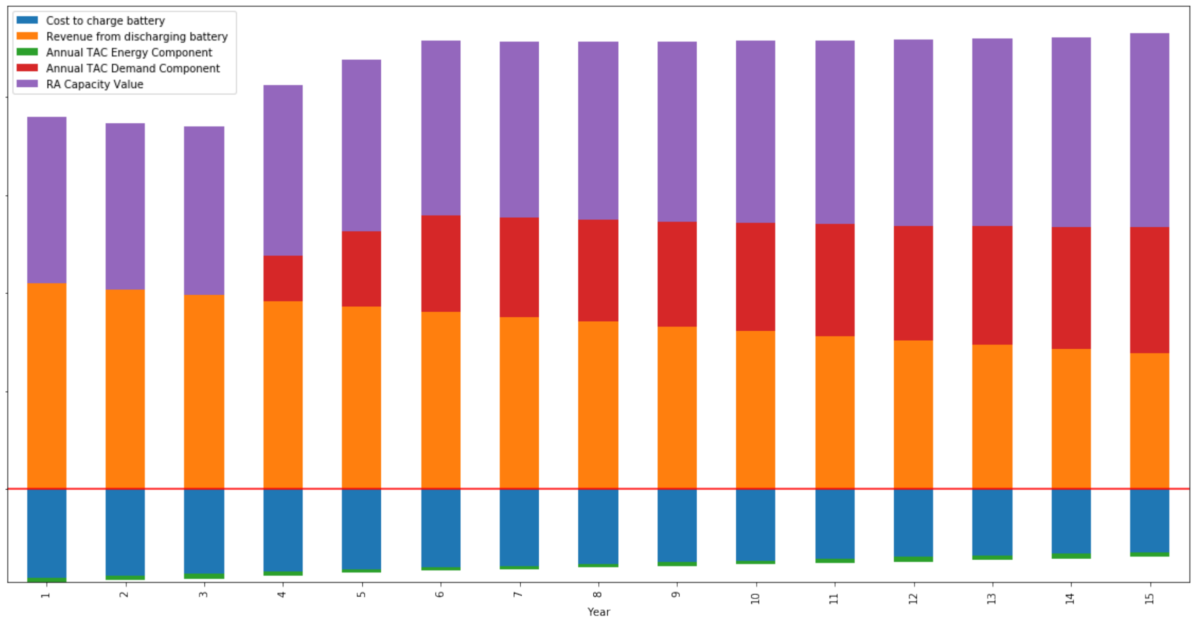
The program will foster innovative programs in the City of Santa Clara targeted to reduce GHG emissions and particulate matter, with a focus in vulnerable communities. Additionally, the battery will be charged/discharged to increase renewable utilization on the grid, while also being discharged, to reduce the need for natural gas generation dispatch during the evening peak.

The project will be commercially online in December 2021/January 2022.

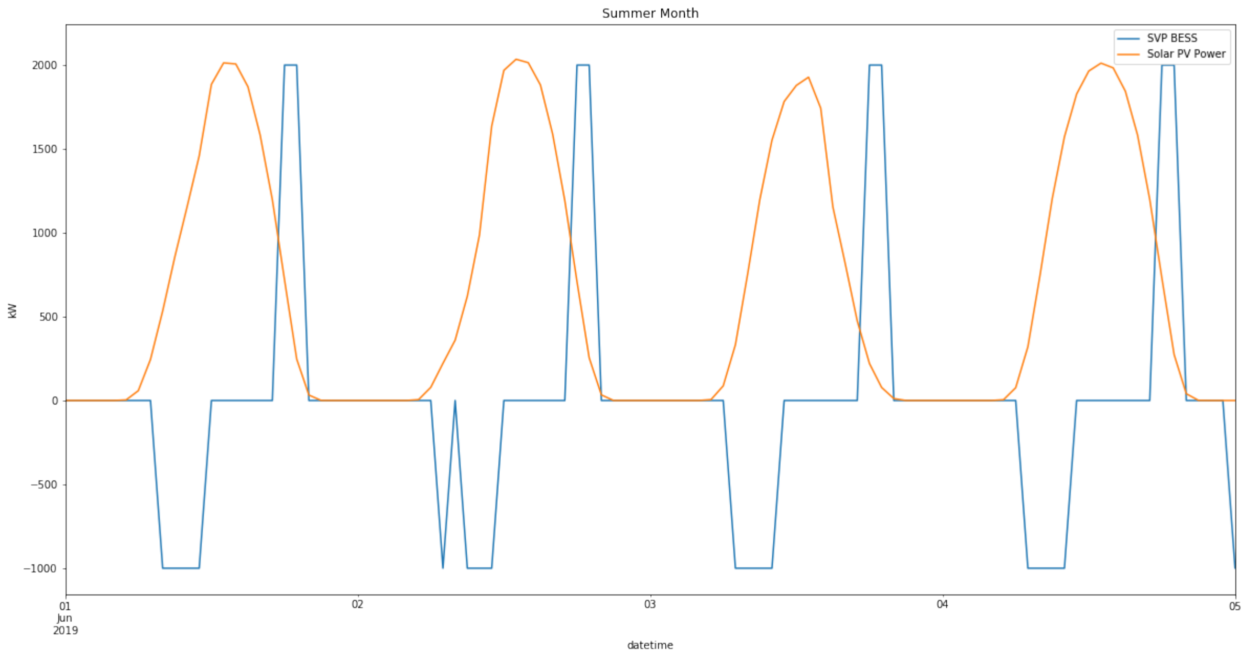
CUSTOMER-SITED BATTERY STORAGE AND SOLAR POWER PURCHASE AGREEMENT

SVP partnered with one of its commercial customers on a 2 MW/4MWh behind-the-meter battery energy storage system, charged for the most part from on-site PV solar generation. The battery will be cycled daily to increase renewable energy consumption from the on-site solar PV system, while also being discharged, to reduce run-times for natural gas generation dispatch during the evening peak. Commercial operation of the solar PV and battery storage system is planned for October 2021.

The bar chart below shows the various revenue streams analyzed by SVP. The values below the horizontal red line indicate negative values (or costs), and the values above the red line indicate positive values (or cost savings or revenues) to the utility. The total installation costs of the battery storage project (inclusive of hardware costs for the battery system and balance of plant, and installation and construction) are calculated as an initial capital cost outlay therefore must be taken into account to determine overall net present value of the project over 15 years. Overall, SVP achieved a 15-year payback period for the battery storage system, and passed on the utility-cost savings to the respective customer through a monthly payment structure.



The plot below shows the impact of the charging patterns (below the 0 axis) from the solar PV system, and the impact of the battery system discharging (above the 0 axis), which is correlated to high emissions intensity factors on the grid.



RESIDENTIAL DER RESILIENCE AND EQUITY PROGRAM

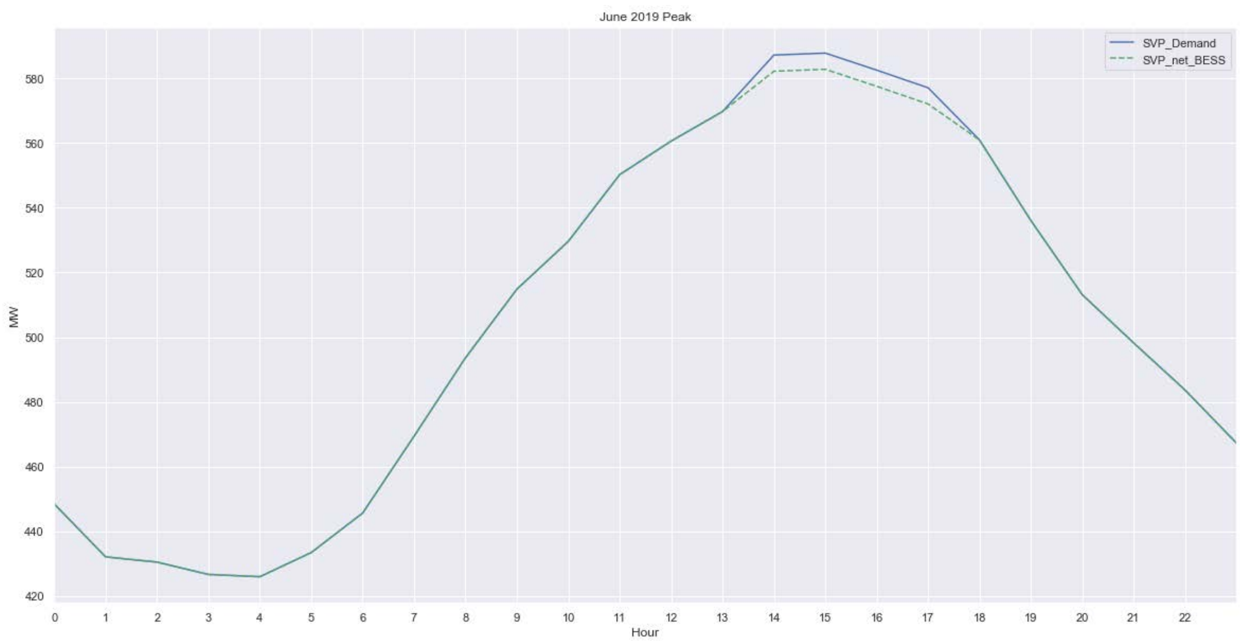
In 2019, SVP joined three community-choice aggregators (CCAs), East Bay Community Energy, Silicon Valley Clean Energy, and Peninsula Clean Energy in the release of a joint request for proposal for Resource Adequacy and load modification capacity to reduce SVP's system and

CAISO coincident peak. SVP requested a total of 0.7 MW for the residential sector, and 2 MW for the commercial and industrial sectors.

SVP's Residential Distributed Energy Resources (DER) Resilience and Equity program will operationalize a fleet of residential PV-paired battery systems as a peak shaving instrument and also to increase renewables and reduce GHG emissions in the most vulnerable communities through a virtual power plant concept. The Program will prioritize customer segments, including: low-income, medical baseline, and the disadvantaged community. Additionally the program intends to mitigate localized grid congestion and provide back-up power during grid outages or PG&E's Public Safety Power Shutoff (PSPS) events. The program will evaluate installations at both single family homes and multi-unit dwellings.

SVP is currently in the research and design phase of the Program with the intent to increase the use of clean, affordable energy to SVP's customers. With increased attention to the forced blackouts by PG&E's PSPS events that affected hundreds of thousands of customers in the Bay Area but not in Santa Clara to date, the systems will provide islanding capability for customer back-up power and will support the aggregation of the residential solar PV and battery storage systems.

The graph below shows the impact of the peak shaving with virtually aggregated battery storage systems when dispatched for four hours as a virtual power plant, and the impact on SVP's load.



MICROGRIDS

SVP is developing two Renewable Energy Microgrids to support two City of Santa Clara Fire Stations for up to four hours of run-time providing back-up power during grid outages. SVP will study the feasibility of meeting and exceeding 6-8 hours long-duration run-times for the energy storage systems. SVP is partnering with the Fire Department to prioritize Fire Station #1, and Fire Station #2 with the potential to co-locate the microgrid at FS#2 with co-located public sites to enable a community microgrid concept. The project will demonstrate the installation of solar and storage integrated with smart microgrid components. The microgrids will support the research, design, deployment, and operations of a microgrid through the implementation of advanced energy management controller/software, load control, for standby power, energy and capacity and test feasibility to serve grid ancillary services.

SVP is piloting microgrid concepts to create more redundancy in its grid, enable the detection of outages and faults on the grid, to prevent outages, and power quality events. The microgrid automatically responds to a grid outage by islanding. The microgrid remains in island mode supporting the Fire Stations and auxiliary load until a resynchronization command is issued. This allows the microgrid to autonomously support the islanded loads during grid outages and then automatically resynchronize and resume grid connection upon restoration of normal grid voltage and frequency. Additionally, built in software will perform an analysis of the microgrid components to detect equipment and process inefficiencies.

The project is planned to be commercially online in 2022.

ELECTRIC VEHICLES

Green Lots – Tasman Drive Parking Structure

SVP completed its pilot energy storage project at the Tasman Drive Parking Structure with the original intent to reduce customer-side peak demand charges due to high energy consumption from EV level 2 and Direct Current (DC) fast charging. Green Charge Networks, a Santa Clara based energy storage company, approached SVP to install a 30 kW "GreenStation" battery energy storage system along with an EV DC fast charger station at this location. The cost of the energy storage system, the DC fast charger and the installation was covered by a CEC grant program, resulting in no costs to the City of Santa Clara or SVP.

The pilot ended in 2018, and through the monitoring of the EV Charging Station patterns, the pilot resulted in an increased usage of the EV charging stations from 2015 through 2018. It was concluded that given the large station count (49 in total), power demand is still peaking at a small fraction of the system capacity (under 17 percent for the 30-day period from February 19, 2018 to March 21, 2018). The GreenStation is installed behind-the-meter and dampens the demand spikes that occur when the DC fast charging station is used, therefore reducing the operating costs for the City's Streets Department due to the management of spikes to avoid an increase in demand charges.

TRANSMISSION

The August 2020 heat wave recorded temperatures of 102 degrees Fahrenheit and concurrently led to multiple lightning strikes. The record temperatures and insufficient operating reserves determined by the CAISO led the balancing authority (CAISO) to issue Stage 3 Alerts (its highest emergency level) and subsequently leading to the CAISO initiating rotating outages throughout the State to maintain grid stability. During this period, SVP's system peaked for the year at 586 MW. The factors leading to the rotating grid outage increase the desire for in-town generation that is flexible, in-town black start capable, and capability to provide critical system support not dependent on transmission during heat waves.

In SVP's 2017 Energy Storage Procurement Plan submitted to the CEC, SVP proposed exploring a 2.5 MW Black Start Battery Hybrid Project at a Generation Facility in Santa Clara. SVP proposed using a Battery Energy Storage System (BESS) to provide black start capabilities. The BESS would be capable of supplying enough electrical power to start the gas turbine on a complete loss of electrical power. SVP submitted a proposal to the CAISO to be part of the network of generators that brings the electric grid back on-line after a widespread system failure commonly described as black start. The Project was not selected by the CAISO, and the Project was suspended. SVP will continue to analyze the project feasibility of black start systems including updates on unit pricing ($/kWh) for battery storage due to forecasted price declines, and will analyze the potential for a black start capability at its Donald von Raesfeld (DVR) combined cycle natural gas power plant with a rated peak capacity of 147 MW, in the event of a grid-wide outage, in order to restore the backbone 230 kV transmission system supporting the Greater Bay Area.

GENERATION

Due to SVP's projected retail demand growth driven primarily from the industrial sector and secondarily from the commercial sector, and to replace existing renewable energy contracts that are set to expire in the future, SVP is scoping renewable energy projects coupled with energy storage as well as stationary storage systems to co-locate with its existing solar and wind generating assets. SVP continues to explore options for the procurement of energy storage and is undergoing economic analysis to understand how to cost-effectively invest in energy storage and how the Federal Investment Tax Credit eligibility can help to mitigate the costs.

SVP analyzed an in-front-of the meter project with Northern California Power Agency (NCPA) to support a 100 MW/400 MWh lithium-ion battery storage system. The analysis looked at daily cycling of the battery system for energy price arbitrage benefits. The battery system would be paid down in monthly capacity payments ($/kW), combined with variable operation and maintenance charges valued in ($/MWh) structure. The project analysis for this project ended due to high costs and evolved into a competitive Request for Proposals for Renewable Energy Resources, Carbon Free Energy Resources, and Energy Storage Solutions issued by NCPA in March 2020.

As member of NCPA, a joint powers agency, SVP will analyze the benefit of renewable energy paired with storage and standalone storage offerings in order to meet its renewables and carbon free goals, and to meet compliance in line with the California Renewables Portfolio Standard Program, including amendments enacted by the passage of SB 100.

NCPA targeted proposals for renewable resources and carbon free resources with commercial operation or delivery starting in 2021 and beyond. The competitive solicitations propose: 1) project ownership by NCPA (in which the resource could be jointly-owned by SVP as a member City, along with NCPA's member Cities) 2) a power purchase agreement with an ownership option or, 3) a power purchase agreement without an ownership option.

BENEFITS

SVP believes there are multiple societal benefits from energy storage for its customers and rate base, as follows.

CUSTOMER BENEFITS

1. Back-up Power/Resiliency: prioritizing pilots that will target SVP's vulnerable communities: medical baseline and low-income communities, and will research program offerings open to all SVP customers to enroll in.
2. Critical sites: City of Santa Clara Fire Department, Police Department, and is partnering with the Emergency Services to provide solar PV and energy storage back-up power to City's designated Red Cross Shelters.
3. Reliability – restoring service, preventing outages in an emergency, and preventing power quality events, rolling outages, PSPS events.
4. Local air quality
5. Increased local renewables

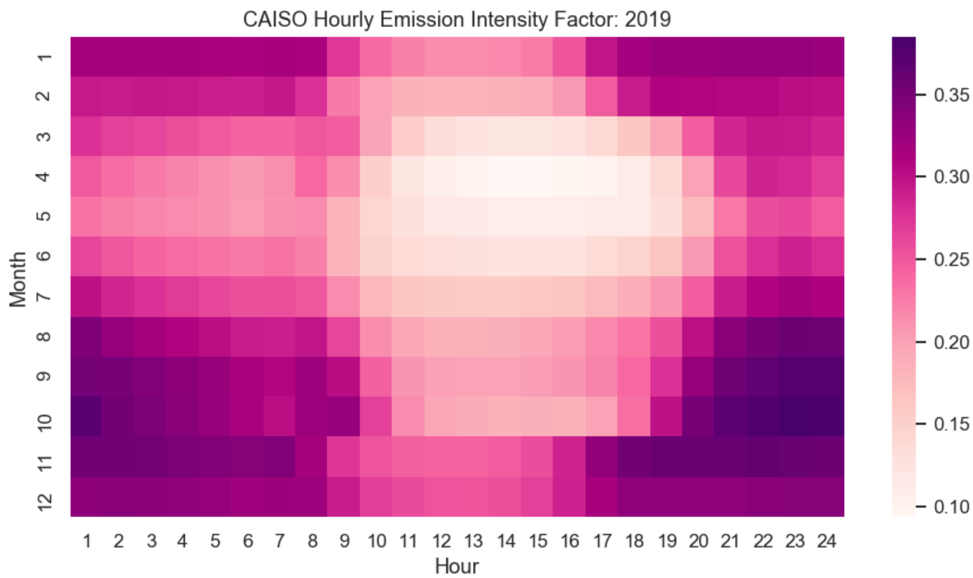
ENVIRONMENTAL BENEFITS

Through optimized cycling patterns, SVP intends to have the battery charged during hours with minimal to low marginal emissions, or have the battery systems coupled to on-site solar PV with zero marginal emissions output, and to discharge the battery system during hours of high marginal emissions rates.

The energy storage systems for the Data Center and Microgrid pilots are tied to existing back-up diesel generators. By allowing the building loads to island, this will offset or delay diesel generation run-times, reducing output of GHG emissions and criteria pollutants from diesel generators. Both programs intend to be proof-of-concept projects that can scale to other mission critical sites with emergency back-up generators and data center hybrid energy storage and diesel generator configurations.

The R&D projects also support the City of Santa Clara's Climate Action Plan and SVP's Integrated Resources Plan.

The heatmap below depicts emissions factors (MT $CO2_{eq}$/MWh) on the CAISO grid by month and by hour. The most emissions intense hours of the day are from 6 pm to 4 am, and changes based the season of the year.



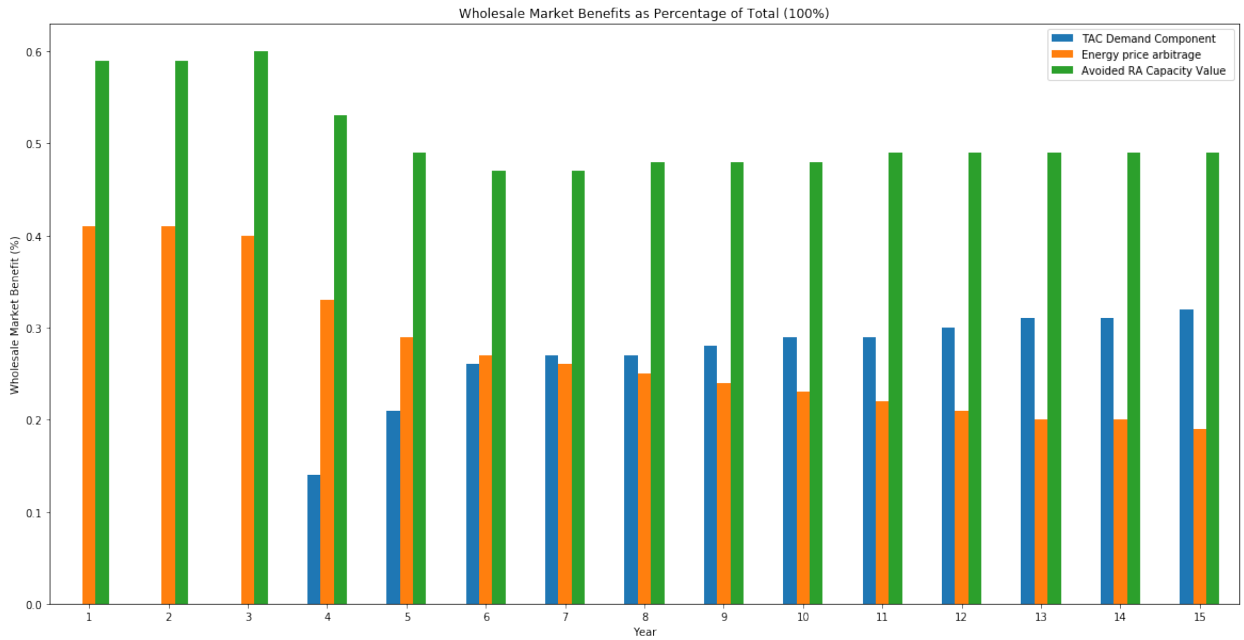
ECONOMIC BENEFITS

SVP designed a techno-economic model to model the performance of a utility-scale lithium-ion battery, which incorporated a discounted cash flow analysis to evaluate the financial feasibility of a battery energy storage system over the operating life of the system. The model discounts project costs, savings and revenues generated to present value to assess the payback period of the project required to recover the total installed cost of the battery energy storage system. SVP is continuing to identify viable business models for future deployments, stacking benefits for various wholesale, distribution, and transmission side benefits.

Payback period

A break-even point analysis is determined to understand how subsidies, and future battery storage costs required can improve project viability. The analysis provides case studies on battery capacity over time, efficiency losses through system components, the useful life of the system, total system costs over time, and various cost savings achieved through the participation in the wholesale market and other multi-use application for the battery energy storage system.

The bar chart below, represents the cost-savings for each wholesale market benefit by percentage for SVP's Customer-Sited Battery Storage Pilot Project.



TECHNOLOGY SCOPING & COST-EFFECTIVENESS

In June 2020, SVP partnered with NCPA and 12 of its member municipal utilities along with SEPA to analyze current program offerings from utilities across the United States, and incentives for its customers. The study also surveyed competitive market pricing for battery storage.

From the study, 18 battery storage programs were analyzed across 11 states in the United States. It was concluded that most programs dispatch the battery systems to reduce utility peak demand, participate in the wholesale market, and allow for customers to enroll in the programs. Most of the programs were developed for research purposes or a pilot program in order to understand end-use application and system performance.

Based on the survey from SEPA, current battery storage pricing ranged from $200/kWh to $800/kWh, averaging to $500/kWh. Based on SVP’s research much of the variability in price is a function of total capacity (MW) of the system, applied rebates or subsidies, variance in the soft costs (for the construction and installation of the system), and if applicable, the additional costs for substation, land, and development costs.

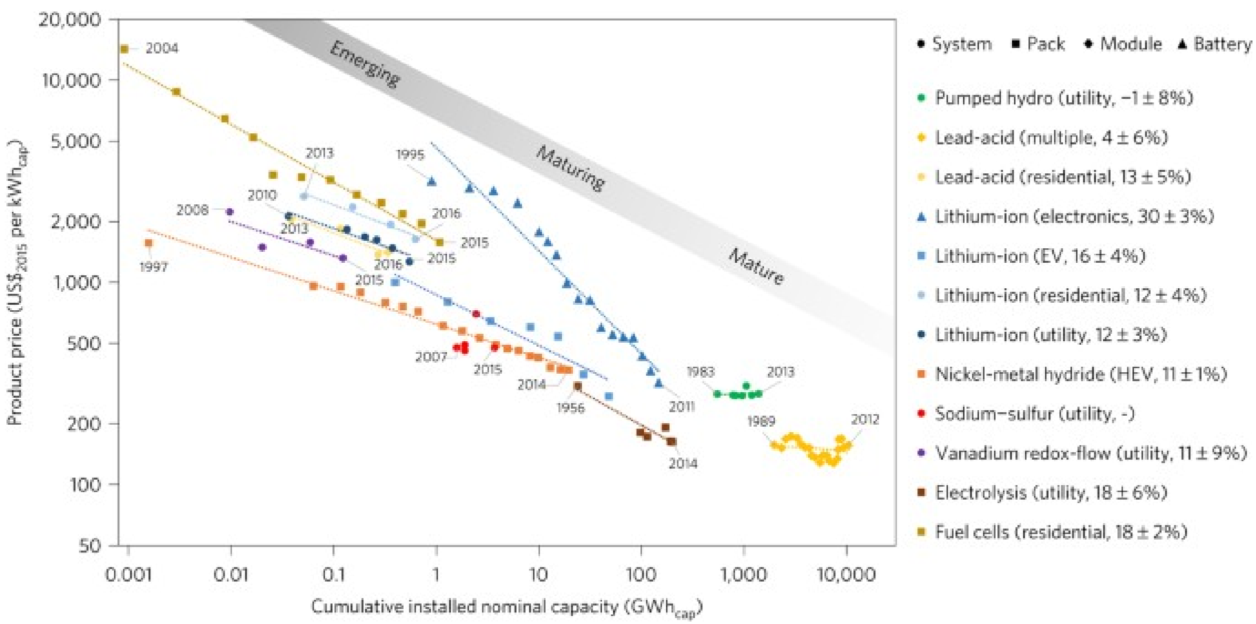
Studies from various research and academic institutions, including the Department of Energy’s National Renewable Energy Lab, University of California-Berkeley, and Lazard’s Levelized Cost of Storage Analysis, amongst others, suggest that lithium-ion technologies dominate the energy storage market across applications due to the cost trade-offs, increased energy density and longer duration compared to lead acid batteries, and the modular availability and deliverability of battery storage system.

Currently pumped hydro storage is the predominant storage technology in the United States in terms of rated installed capacity (MW), however it has become less common due to very limited geographical possibilities, large impact on the landscape, environmental issues for siting, long regulatory timeline to obtain Federal Energy Regulatory Commission (FERC) license and other government permits, and the high associated capital costs.

From the graph (Figure 2) below it is evident that most energy storage technologies are in the research and proof-of-concept stages, and require subsidies to justify the investment, in order to make the project cost-effective. However over time, due to the regulatory trajectory, California's aspirational goals to be 100 percent carbon free by 2045, the increased adoption in electric vehicles, and renewable energy goals, the need for storage will be continue to increase, as prices decline.

The CAISO anticipates 900 MW of energy storage capacity will be interconnected with the CAISO in 2020.

Figure 2 Nature Energy (2017)[2]



MOVING FORWARD

In the next five years, SVP plans to focus its research on the deployment of energy storage projects and to develop localized system integration studies to determine locational nodes in SVP's service territory to alleviate congestion and to manage energy and capacity needs as well as maintaining balance of its grid. Other variables will also impact scalability and the use-case for storage, including, SVP's load growth, increased behind-the-meter customer distributed energy resources, electric vehicles, and building electrification. The deployment of storage will help SVP meet on-going State and City-wide renewable energy and sustainability goals and targets.

SVP will research the potential to participate in the CAISO wholesale market, including participating in the non-generator resource (NGR), regulation energy market (REM), and proxy

[2] Schmidt, O., Hawkes, A., Gambhir, A. et al. The future cost of electrical energy storage based on experience rates. Nat Energy 2, 17110 (2017). https://doi.org/10.1038/nenergy.2017.110

demand response (PDR) participation models, which include not only bidding energy resources, but also ancillary services (frequency regulation, spin, non-spin).

In order to manage, operate, and monitor performance, SVP intends to research an architecture that integrates each of its pilot programs into a distributed energy resources management (DERMs) platform, tied to additional microgrid sites. The purpose is to enhance coordination amongst DERs, dispatch, and communication across DER assets connected to the grid to optimize reliability, safety and efficiency when operating the distribution grid.

SVP believes that commercially available long-duration technologies tied to clean fuel sources that can be stored on-site will be required to transform adoption at the utility-scale level. SVP and its customers must have confidence that there is no interruption to the electric or gas supply if on-site fuel cannot be achieved, otherwise storage fuel must be dense enough to store on-site. Further, SVP anticipates that more demonstration projects from utilities and utility-customer partnerships will be required to test end-use applications, monitor stacked benefits, and to help scale the technology. Grant funding along with the decrease in energy storage costs will be needed to assist in bringing down the total installed costs of the systems. Additional federal, state, and local incentives and grants, can encourage investment to scale the technology and test various end-use applications.

Lastly, SVP will continue to benchmark new storage technologies, assess scalability and cost-effectiveness, and pilot new programs/projects that foster a diverse set of clean, hybrid and long-duration energy storage technologies. Because the City of Santa Clara is approximately 19 square miles, new storage technologies sited within the City boundaries must be energy dense to accommodate space constraints.

SUMMARY

The long-term impacts of SVP's energy storage strategy will help to realize California's zero net GHG-emission energy goals, soften the effects of large scale electric vehicle adoption, increase grid resiliency while concurrently increasing SVP's renewables goals, meet the future load growth for SVP, and ensure reliability for its customers. SVP will also work to analyze various program offerings for each customer segment, while also focusing on installations in disadvantaged communities, and areas with a high concentration of emissions.