City of Vernon Gas & Electric Energy Storage Staff Report

Recommendation

Vernon Gas & Electric (VG&E) staff recommends that the City Council adopt a resolution that a target to procure energy storage systems is not appropriate at this time. This recommendation comes from the absence of cost-effective options, a determination required under California law. This recommendation, however, does not inhibit VG&E from evaluating and pursuing cost-effective energy storage solutions that strengthen utility operations in the future.

Executive Summary

Assembly Bill (AB) 2514 (Public Utilities Code 2835 et seq.), the energy storage law in California, requires the governing board of each publicly-owned utility (POU) to "determine appropriate targets, if any, for the utility to procure viable and cost-effective energy storage systems..." The California Energy Commission (CEC) was given the responsibility to review the procurement targets and policies that are developed and adopted by POUs to ensure that the targets and policies include the procurement of cost-effective and viable energy storage systems. The CEC then reports to the Legislature regarding the progress made by each local POU serving end-use customers in meeting the requirements of AB 2514.

The law establishes definitive deadlines for POU compliance within the statute as follows:

1) A POU has the responsibility to evaluate the cost-effectiveness and viability of energy storage systems in their respective electric systems. Additionally, a POU may also consider various policies to encourage the cost-effective deployment of energy storage systems. The initial evaluation is to take place before October 1, 2014.
2) A POU also possesses the authority to deem any, all or no energy system(s) that are evaluated as being "cost-effective and viable". Taking into account the significant differences between respective POU electric system requirements, the cost-effectiveness and viability of energy storage technology options may vary greatly for each POU.

Once the evaluation is complete, no later than October 1, 2014, the Governing body of each POU is required to adopt a target, if appropriate, for the amount of energy storage that the POU will procure by December 31, 2016. Also at this time, the governing body is required to adopt an additional target for the amount of appropriate energy storage the POU will procure by December 31, 2020. Policies to encourage the cost-effective deployment of energy storage systems may also be considered by the Governing body. Each Governing body must reevaluate its procurement targets and any energy storage policies at least once every three years.

VG&E staff evaluated the costs and associated benefits of various energy storage projects submitted in response to a Southern California Public Power Authority (SCPPA) request for proposals (RFP) to consider local applications from both a utility and a customer perspective. Over the next fifteen years, the costs of utility-owned and operated energy storage technologies exceed the value of the benefits, and hence, do not provide cost-effective, viable opportunities for VG&E or VG&E customers. More specifically, staff endorses the approach that currently there is no reasonable justification to procure energy storage systems within the City of Vernon for applications of Ancillary Services, outage mitigation, renewable integration, deferral of transmission and distribution upgrades, load leveling, grid operational support or grid stabilization.

To meet the City's obligation under AB 2514 while adhering to VG&E's Integrated Resource Plan (IRP), staff proposes that energy storage procurement targets are not adopted by virtue that energy storage is not cost-effective, and therefore not appropriate for the City and City customers. VG&E will, nevertheless, encourage customers to consider this emerging technology where it is cost-effective. Furthermore, staff is committed as required by AB 2514 to reevaluate this finding within three years and return to City Council to reassess this recommendation.

Staff fully expects that energy storage will substantially impact the overarching electric power system. Staff will continue to perform due diligence in the analysis of energy storage systems as they continue to move from the research and development realm to the production realm and as the potential benefits of these systems begin to clearly outweigh the costs.

Energy Storage Background

The purpose of energy storage systems is to absorb energy, store it for a period of time with minimal loss, and then release it when appropriate. When deployed in the electric power system, energy storage provides flexibility that facilitates the real-time balance between electric supply and demand. Maintaining this balance becomes more challenging as the contribution of electricity supplied by intermittent renewable resources expands.

Typically the balance between supply and demand is achieved by keeping some generating capacity in reserve to ensure sufficient supply at all times and by adjusting the output of fast-responding resources such as hydropower. Energy storage systems, however, have the potential to perform this role more efficiently.

Rechargeable batteries are the most familiar form of energy storage technology. Large battery energy storage systems can be connected to the transmission grid to absorb excess wind or solar power when demand for electricity is low and, in turn, release the power when demand is high.

Energy Storage Technologies

There are numerous energy storage technologies with varying performance ranges suitable for key electrical applications. The preceding is a brief description of the most notable technologies in this developing industry.

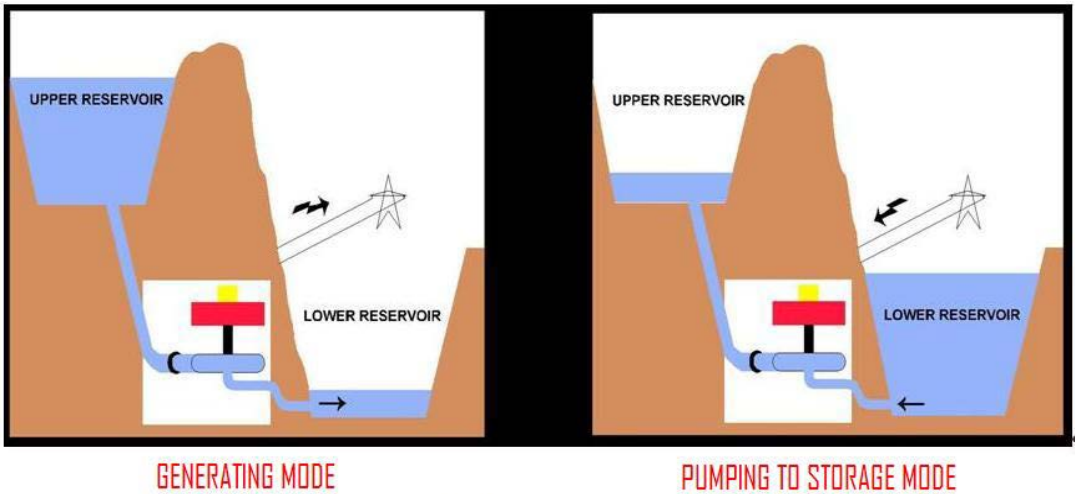
Pumped Hydro

Pumped hydroelectric energy storage is a mature, commercial utility-scale technology that is currently in operation at many locations throughout the country. Pumped hydro draws off-peak electricity to pump water from a lower reservoir to a reservoir located at a higher elevation. When demand for electricity is high, water is released from the upper reservoir, run through a hydroelectric turbine and deposited once again in the lower reservoir in order to generate electricity. This application has the highest capacity of the energy storage technologies that were studied. The output is only limited by the volume of the upper reservoir.

Projects can be sized up to 4000 MW and operate at approximately 76%–85% efficiency. Pumped hydro plants can have a service life of 50 years, yielding rapid response times that warrant participation in voltage and frequency regulation, spinning and non-spinning reserve markets, arbitrage and system capacity support.

While the siting, permitting, and associated environmental impact processes can take many years, there is growing interest in re-examining opportunities in pumped hydro.

Figure 1 Pumped Storage Hydro

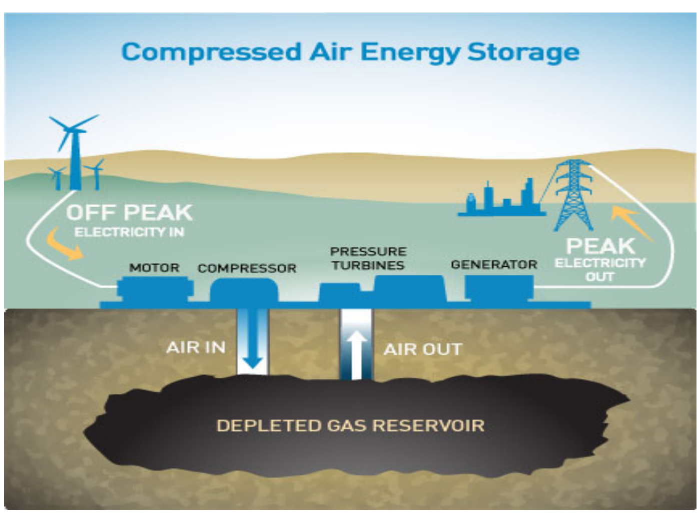


(Source: ClimateTechWiki)

Compressed Air Energy Storage (CAES)

CAES uses off-peak electricity to compress air and store it in an underground reservoir or in above ground pipes. When demand for electricity is high, the compressed air is heated, expanded, and directed through a conventional turbine-generator to produce electricity. Underground CAES storage systems are most cost-effective with storage capacities up to 400 MW and discharge times of between 8 and 26 hours. Siting CAES plants requires locating and verifying the air storage integrity of an appropriate geologic formation within a service territory of a given utility. CAES plants employing aboveground air storage would typically be smaller capacity plants on the order of 3 to 15 MW with discharge times of between 2 and 4 hours. Aboveground CAES plants are easier to site but more expensive to build.

Figure 2 Compressed Air Energy Storage



(Source: PGE)

Lead-Acid Batteries

Lead-acid is the most commercially mature rechargeable battery technology in the world. Valve regulated lead-acid (VRLA) batteries are used in a variety of applications, including automotive, marine, telecommunications, and UPS systems. Transmission and distribution applications are rare for these batteries due to their relatively heavy weight, large bulk, cycle-life limitations and maintenance requirements. Serviceable life can vary greatly depending on the application, discharge rate, and the number of deep discharge cycles. Battery price can be influenced by the cost of lead, which is a commodity. Finally, very limited data is available regarding the operation and maintenance costs of lead-acid based storage systems for grid support.

Figure 3 Lead-Acid Battery Storage

(Source: Energy Source Publishing)

Flow Battery

Vanadium redox batteries are the most mature type of flow battery systems available. In flow batteries, energy is stored as charged ions in two separate tanks of electrolytes, one of which stores electrolyte for positive electrode reaction while the other stores electrolyte for negative electrode reaction. Vanadium redox systems are unique in that they can be repeatedly discharged and recharged. Like other flow batteries, many variations of power capacity and energy storage are possible depending on the size of the electrolyte tanks.

Vanadium redox systems can be designed to provide energy for 2 to 8 hours depending on the application. The lifespan of flow-type batteries is not significantly impacted by cycling. Suppliers of vanadium redox systems estimate the lifespan of cell stacks to be 15 or more years.

Figure 4 Flow Batteries

(Source: Construction21.eu)

Lithium-Ion (Li-ion)

Rechargeable Li-ion batteries are commonly found in consumer electronic products, which make up most of the worldwide production volume of 10 to 12 GWh per year. A mature technology for consumer electronic applications, Li-ion is positioned as the leading platform for plug-in hybrid electric vehicle (PHEV) and electric vehicles (EV).

Given their attractive cycle life and compact nature, in addition to high efficiency ranging from 85%–90%, Li-ion batteries are being considered for utility grid-support applications such as distributed energy storage, transportable systems for grid-support, commercial end-user energy management, home back-up energy management systems, frequency regulation, and wind and photovoltaic smoothing.

Figure 5 Lithium Ion Battery

(Source: Clean Technica)

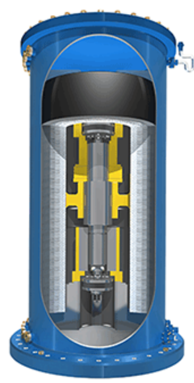
Flywheels

Flywheels are shorter energy duration systems that are not generally attractive for large-scale grid support applications that require many kilowatt-hours or megawatt-hours of energy storage. They operate by storing kinetic energy in a spinning rotor made of advanced high-strength materials, charged and discharged through a generator.

Flywheels charge by drawing off-peak electricity from the grid to increase rotational speed, and discharge when demand is high by generating electricity as the wheel rotation slows. Flywheels enjoy a very fast response time of 4 milliseconds or less, can be sized between 100 kW and 1650 kW and may be used for short durations of up to 1 hour. Flywheels possess very high efficiencies of about 93% with a lifetime estimated at 20 years.

Because flywheel systems are quick to respond and very efficient, they are being positioned to provide frequency regulation services.

Figure 6 Flywheels



(Source: Beacon Power)

Energy Storage Assessment Tool

Navigant consulting was contracted by participating SCPPA utilities to create a framework and decision making tool for identifying, quantifying, and monetizing the benefits of energy storage projects. In the framework, potential benefits are substantiated differently depending on the system characteristics unique to each electric utility. Benefits are realized by analyzing energy storage in the three fundamental categories of load leveling, grid operational support and grid stabilization. Within these categories, each application of energy storage can lead to different economic, reliability, and environmental benefits.

Inputs specific to the VG&E system were initially populated in The Navigant Energy Storage Assessment Tool. These inputs included information such as project location, project owner, regulatory environment and technology type. Cost and performance data including installed cost, operation and maintenance costs, round trip efficiency and cycle life were then loaded into the tool. Finally, based upon the applications selected, additional inputs were populated in order to calculate benefits, such as the capacity of energy storage, market pricing and rate structures. After inputting and running applicable cases through the assessment tool, the product of the tool is realized in the form of net present costs and benefits of the project. These results were then analyzed by staff.

The tool itself has gone through extensive review and usage. Sandia National Labs and the US Department of Energy (DOE) have both conducted formal peer reviews of the framework. The DOE has adopted this framework for use by the 16 recipients of the Smart Grid Demonstration program to quantify the costs and benefits of energy storage demonstration projects.

Energy Storage Applications and Associated Assumptions

In conjunction with the SCPPA Energy Storage Working Group and Navigant Consulting, VG&E staff identified 3 basic areas to apply energy storage technologies in relationship to the electrical system.

1) Load Leveling
2) Grid Operational Support
3) Grid Stabilization

Based on this broad range, electricity storage can potentially provide services at the generation, transmission, distribution and customer (behind the meter) levels.

Load Leveling

Load Leveling in general terms refers to the practice of generating power off peak when prices and demand are low and using or dispatching this power on peak when prices and demand are high. Four basic areas of Load Leveling are as follows:

1) Renewable Energy Shifting – The process of capturing electricity generated from renewable sources during periods of over-generation or low demand then, in turn, dispatching the stored electricity to the grid in times of high demand.
2) Wholesale Arbitrage – This method takes advantage of a price difference between markets by capitalizing and profiting from the imbalance between them.
3) Retail Market Sales – The practice of capturing electricity off peak in order to sell to the retail market at on peak pricing for profit.

4) Asset Management – Energy Storage technologies can be used to store and dispatch certain amounts of electricity so that generating units may be run at the most efficient output level. This practice can save wear and tear on the generating units by allowing them to run in an optimal state.

Vernon Gas & Electric Assumptions and Approach to Load Leveling

VG&E does not own any renewable resources and outright ownership of renewable projects is not projected within the VG&E integrated resource plan (IRP) at this time. As a consequence, renewable energy shifting is not applicable to the City at this time and hence, was not considered a viable case to run through the Navigant Energy Storage Assessment Tool in order to determine the cost effectiveness of energy storage.

Wholesale arbitrage is a practice that VG&E currently employs, therefore, arbitrage presented a valid, tangible case to run through the Assessment Tool in order to determine the cost effectiveness of energy storage. As stated in the Navigant Energy Storage Framework, economic benefits in the form of market revenue can be realized by the installation of an energy storage system for the purpose of wholesale arbitrage.

Retail Market Sales are handled by the California Independent System Operator (CAISO), the balancing authority for VG&E and therefore, do not present a case worthy of evaluation.

VG&E does not own and operate significant generating units to the scale that could benefit from strategic asset management.

Grid Operational Support

Grid Operational Support can be defined as ancillary services utilized to effectively match supply to demand. These services are typically performed by an Independent System Operator to maintain the reliability of the electric grid. Five different areas were examined with respect to grid operation support applications:

1) Load Following – an ancillary service concerned with maintaining grid balance by adjusting power as demand for electricity fluctuates throughout the day.
2) Operating Reserves – an ancillary service charged with maintaining extra capacity that can be called upon when some portion of the normal electric supply resources suddenly become unavailable.
3) Frequency Regulation – an ancillary service tasked with managing energy flows to reconcile momentary differences between supply and demand.
4) Renewable Energy Capacity Firming – an application using energy storage to produce more consistent power output when renewable resources temporarily drop.
5) Black Start – an ancillary service responsible for providing power to a conventional generator in order to restart after a partial or full shutdown.

Vernon Gas & Electric Assumptions and Approach to Grid Operational Support:

As a metered subsystem of the CAISO, the balancing authority is responsible to provide the services that enable the matching of supply to demand. As merely a market participant, VG&E relies upon and pays the CAISO for these contracted services.

Grid Stabilization

Grid Stabilization involves improving reliability. Grid Stabilization can be divided into four components as follows:

1) Renewable Energy Ramping – Using energy storage to mitigate volatility from low wind conditions and high wind cutout. Cut out speed, typically between 45 and 80MPH, causes a turbine to shut down, ceasing power generation.
2) Renewable Energy Smoothing – Solar and wind resources are intermittent on a second to second basis. Energy storage can assist in smoothing the output volatility of these resources, thus, improving power quality.
3) Backup Power – Energy Storage may be used to ensure highly reliable electric service. In the event of a system disruption, energy storage can be used to ride through the outage.
4) Power Quality – Energy Storage technologies have the potential to function as capacitors and transformer tap changers by providing voltage support for localized reactive power issues.

Vernon Gas & Electric Assumptions and Approach to Grid Stabilization:

As previously stated, VG&E does not own any renewable resources and outright ownership of renewable projects is not projected within the VG&E integrated resource plan (IRP) at this time. In addition, as a market participant, the CAISO provides these services as the control area balancing authority.

Backup power was discussed in the process of conducting this feasibility study, however, backup power was not considered as a possible application to run through the Assessment Tool. Calling upon an energy storage device to keep services up during a distribution outage carries with it a host of issues. The energy storage device could not be brought online seamlessly to mitigate customers being impacted by the outage due to safety and technical reasons. The energy storage device, if brought online in this scenario could contribute to a fault causing more profound damage. VG&E customers that might benefit from this type of system are either on an interruptible contract or have redundant power feeds to their facilities. Last, VG&E ranks in the top 10 percent industry-wide in terms of average outage duration and average outage frequency according to a 3rd party reliability benchmarking study utilizing the IEEE 2.5 beta methodology (the accepted industry standard).

In terms of power quality, VG&E nominal voltage is very strong, enjoying a power factor of approximately 98%. VG&E has a very stable industrial load and has short distribution feeder circuits with considerable capacity. As stated in the Navigant Energy Storage Framework, improved power quality is a potential benefit of integrating an energy storage technology into the existing electric system. However, without any substantial power quality issues, there was no need to evaluate energy storage for this purpose.

Additional Assumptions and Approach to Running Cases in the Energy Storage Assessment Tool

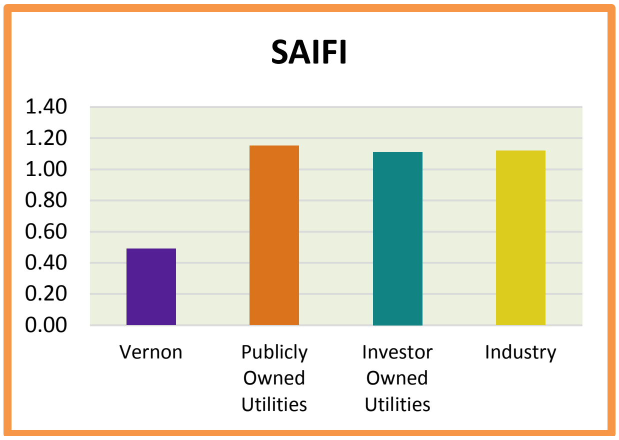
Deferral of Distribution System Upgrades

Seeing that VG&E does not own or operate significant generation or transmission resources, the focus of this feasibility study centered on the VG&E distribution system. Energy Storage systems can defer the need for distribution system upgrades. Typically, as systems evolve and grow, upgrades are made to serve loading requirements and meet the needs of customers. Installing Energy Storage systems on impacted feeders that are near full-load capacity can defer or eliminate the need for large capital investments to upgrade the system in that specific region. Assuming that the storage system reduces loading on existing equipment, the energy storage system could improve or increase the life of the existing distribution equipment, including transformers and cables.

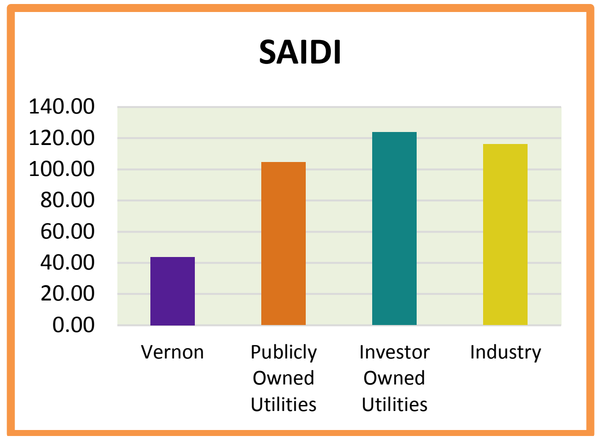
VG&E management stated that, R.W. Beck Inc. was retained to perform a comprehensive assessment on the VG&E electric distribution system. In their most recent study, R.W. Beck recommended that system upgrades be implemented when the City peak load reached 400 MW. As the national economy has struggled since the mid 2000's, the VG&E load has remained flat and peak load is currently 193 MW. The VG&E resource planning group, in performing a ten year forecast does not see any appreciable load growth, and therefore, deferral of distribution system upgrades was not an application staff considered when running cases in the Energy Storage Assessment Tool.

Reliability

VG&E runs an extremely reliable electric distribution system as evidenced by a 2012 benchmarking study conducted by PA Consulting. The nation-wide survey concluded that VG&E ranks in the top ten percent for reliability industry-wide. On average, VG&E customers spent 37 minutes during the year without power (SAIDI – System Average Interruption Duration Index). In addition, the number of outages the typical VG&E customer experienced during 2012 was less than 1 or .46 (SAIFI – System Average Interruption Frequency Index). In other words, more than half of VG&E customers experienced no interruptions in 2012.

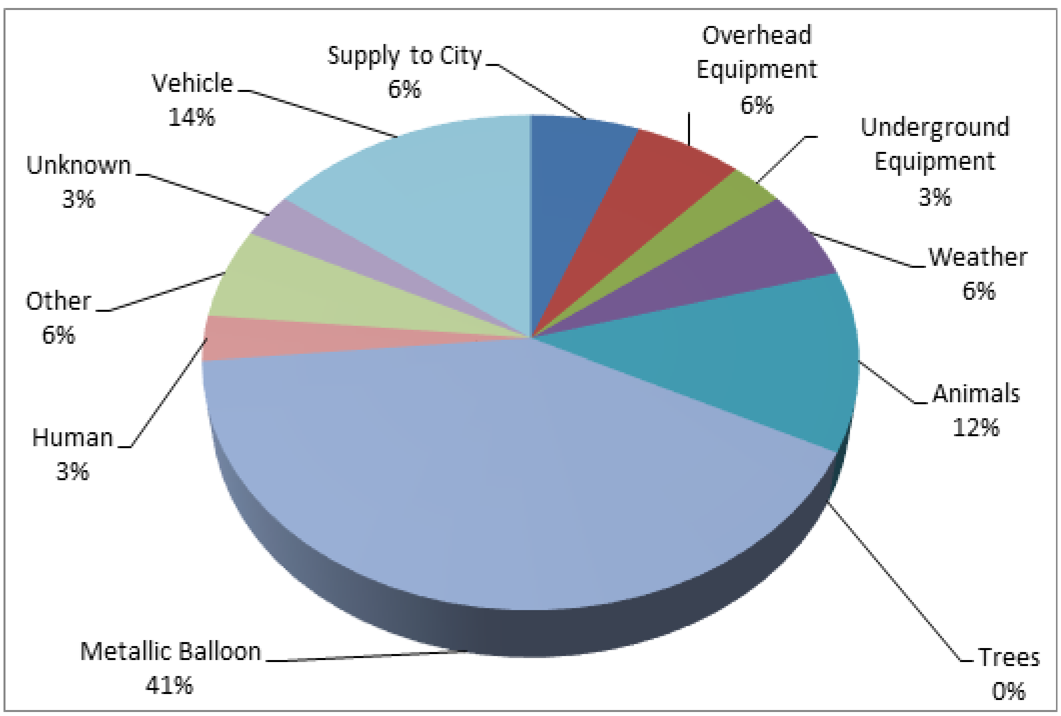


System Average Interruption Frequency Index



System Average Interruption Duration Index

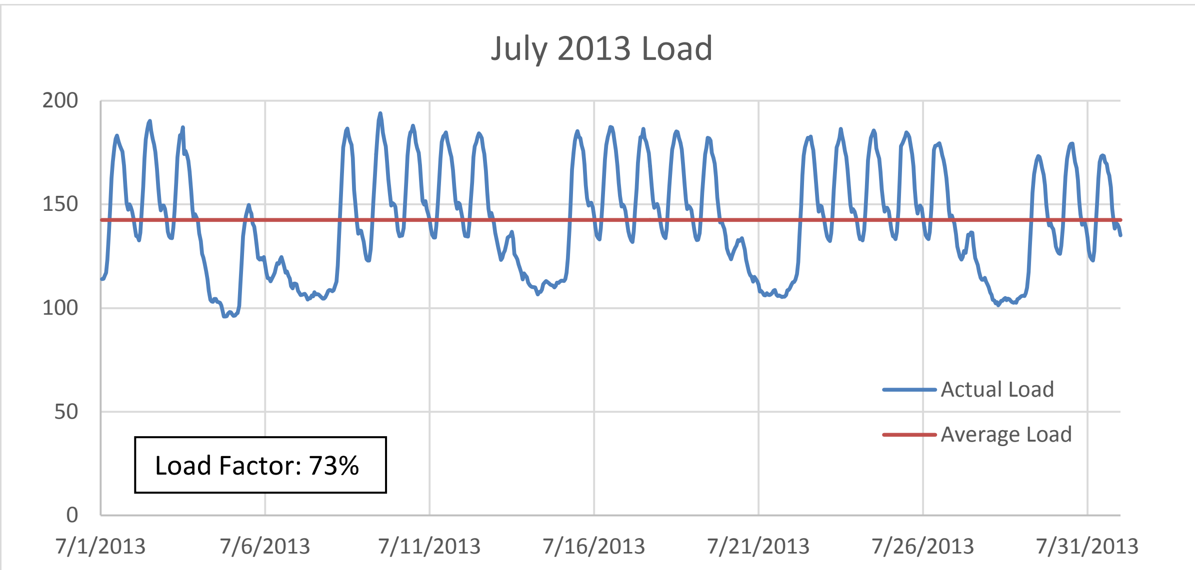
Since 2007, VG&E experiences on average, 32 electrical system outages per year. Outages in the City of Vernon are typically caused by events that are beyond control such as metallic balloons, vehicles striking utility poles, birds and weather related circumstances.

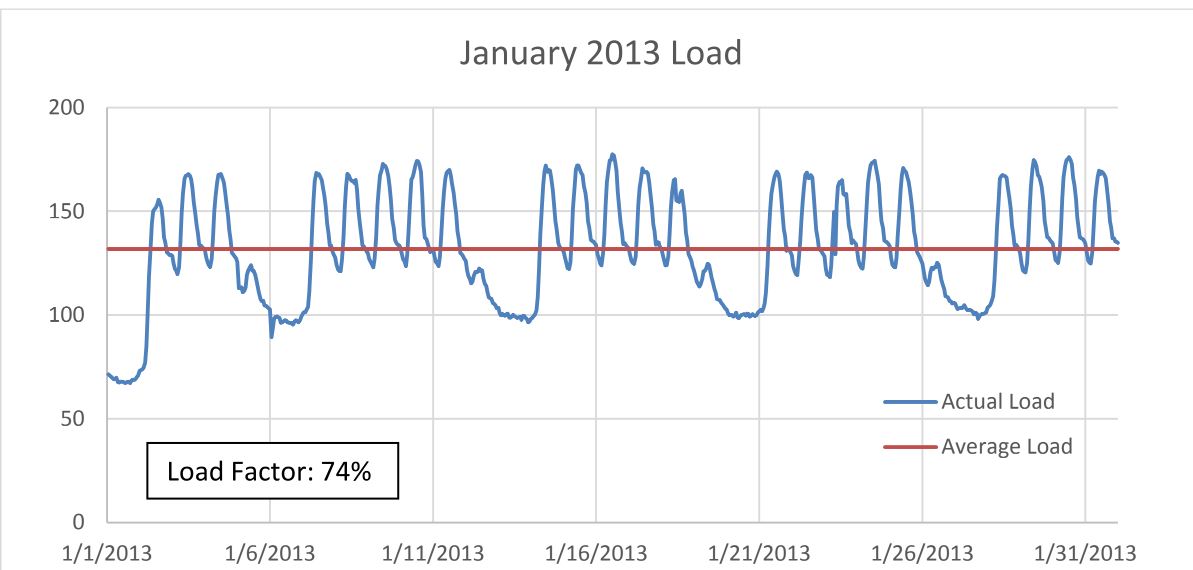


As stated in the Navigant Energy Storage Framework, reduced outages can be a potential measurable benefit of implementing an energy storage technology. However, with a robust system, a manageable amount of outages, reliability in the top ten percent nation-wide, the need for an energy storage system to bolster reliability did not present itself and consequently was not considered.

Electrical System Characteristics

The Vernon Gas & Electric system enjoys a stable load base. The City of Vernon is very unique as the city motto would suggest, as it is "exclusively industrial." The utility is focused on supporting the electrical needs of the industrial manufacturing processes that define the City's customer base. Vernon Gas & Electric offers time-of-use (TOU) rates to many of the larger industrial users. This type of rate structure encourages off peak activities for many of these larger customers. All of these factors combine to produce an extremely stable load profile and very high load factor (i.e. the peak load is not significantly higher than the average load). Due to the efficiency, capacity, and stable nature of the electrical system, along with the TOU incentives to the customers to perform high usage processes off peak, there is no significant need for energy storage peak shifting especially considering its high cost at this time.





VG&E Cost Effectiveness Methodology

SCPPA RFP for Renewable and Energy Storage Projects

The RFP process is one power procurement method that the City uses to purchase electric and gas products. VG&E works with Southern California Public Power Authority (SCPPA) to gain greater access to a broader pool of power resources, through a competitive power procurement bidding process. In accordance with California Renewable Energy Resources Program (Public Resources Code sec. 25740) and the California Renewables Portfolio Standard Program (Public Utilities Code sec. 399), including amendments enacted in 2011 by passage of California Senate Bill X1 2 (SB X1 2), and energy storage, on February 1, 2014, SCPPA launched a Request for Proposals to electric market participants for competitively-priced Renewable Energy and Energy Storage Projects. The RFP asked vendors to provide details such as: project description, name and location, contract quantity, installation costs and the delivery term for the benefit of SCPPA Member Agencies. Between February 2014 and June 2014, SCPPA received 12 proposals for energy storage projects. All 12 proposals came from vendors touting the benefits of Lithium Ion and Flow batteries for energy storage purposes.

As VG&E attempted to take a comprehensive, prudent and reasonable approach to assess the merits of energy storage as a feasible and valuable platform, the substantive, tangible results of an RFP proved the obvious foundation to start from. This cornerstone advanced the assumption that VG&E would evaluate battery technologies only at the pricing submitted in the RFP responses versus evaluating hypothetical scenarios.

VG&E Approach to Use of the Navigant Energy Storage Assessment Tool

VG&E staff evaluated all proposals submitted to the SCPPA RFP for Energy Storage Projects using the Energy Storage Assessment Tool developed by Navigant Consulting firm. The Navigant tool identifies and quantifies the benefits and associated costs of each operational Energy Storage project. The tool takes into account all benefits including those that accrue to the asset owner, ratepayer/consumer, and societal stakeholders. The tool determines potential benefits and estimates the monetized value for each energy storage project based on the project details and application specified by VG&E. The tool also optimized the size, type, and location of the Energy Storage system.

Energy Storage Applications Benefit Basis

VG&E staff utilized a basic net present value analysis in evaluating each energy storage technology. In this analysis, the present value of expected costs is subtracted from the present value of expected benefits for the lifetime of the Energy Storage project. The following sections discuss the major components of benefit and cost that were used in the model.

Market Energy & Market Revenue

The primary benefit evaluated by VG&E staff for Lithium Ion and Flow battery technologies is energy arbitrage revenues. Wholesale energy market revenue is calculated as a function of the difference between wholesale on-peak and off-peak LMP (locational marginal pricing or node pricing) prices of electricity and total energy discharged by the energy storage project for arbitrage. VG&E researched historical day-ahead hourly LMP prices at Vernon Substation PNode to arrive at annual estimates of on and off-peak pricing data used in the model to quantify the upper bound of profit ($/MWh) that may be realized for energy arbitrage.

Emission Reduction Benefits

Electricity storage can reduce electricity peak demand and thereby reduce feeder losses. This process translates into a reduction in emissions if peak generation is produced by fossil-based electricity generators. However, since electricity storage has an inherent inefficiency associated with it, electricity storage could increase overall emissions if fossil fuel generators are used for charging. Alternatively, by providing certain ancillary services, storage can enable conventional generation resources to be operated at more optimal conditions resulting in an emissions benefit. Finally, storage can yield a reduced emissions benefit by enabling greater utilization of renewable resources. The modeled system benefits estimated through comparing a portfolio without-storage and a portfolio with-storage include:

- Total quantity of monitored emissions, including nitrogen oxide (NOX), sulfur oxide (SOX), Particulate Matter (PM) Emissions, and carbon dioxide (CO_2)

- The anticipated or current market price of carbon, SOX, NOX, total cost of serving energy ($) and the PM emissions

- Total opportunity cost of reducing CO_2, NOX, SOX, and PM emissions.

Energy Storage Technology Cost Basis

SCPPA RFP responses were the VG&E source of cost data for battery storage systems used in the model. A summary of energy storage costs considered in the analysis include:

- Investment cost of storage. The Energy Storage system capital expenditure (CAPEX) is calculated as a function of the size of the units and the battery type. During the analysis period, storage units are replaced based on estimated actual life. Storage actual life is calculated as a function of the number of charge/discharge half-cycles and the amount of energy that is charged/discharged in each half-cycle, and its calendar life. A fixed charge rate is used to levelize the total cost.

- Cost of replacement. The cost of replacing storage at the end of its actual life is assumed to be a fraction of initial investment cost. The number of replacements during the project analysis period depends on the storage actual life.

- Operation and maintenance cost. Annual operation and maintenance costs are assumed to be proportional to storage power capacity.

- Cost of electricity. This cost element is defined as the cost of energy used to charge the battery. A set of electricity wholesale price time series data is used to approximate the cost of electricity.

To evaluate the cost-effectiveness of energy storage under a range of cost information that was provided by battery vendors to the SCPPA RFP, VG&E staff used average values of the battery storage device by type (Lithium-Ion and Flow Battery) to conduct the analysis.

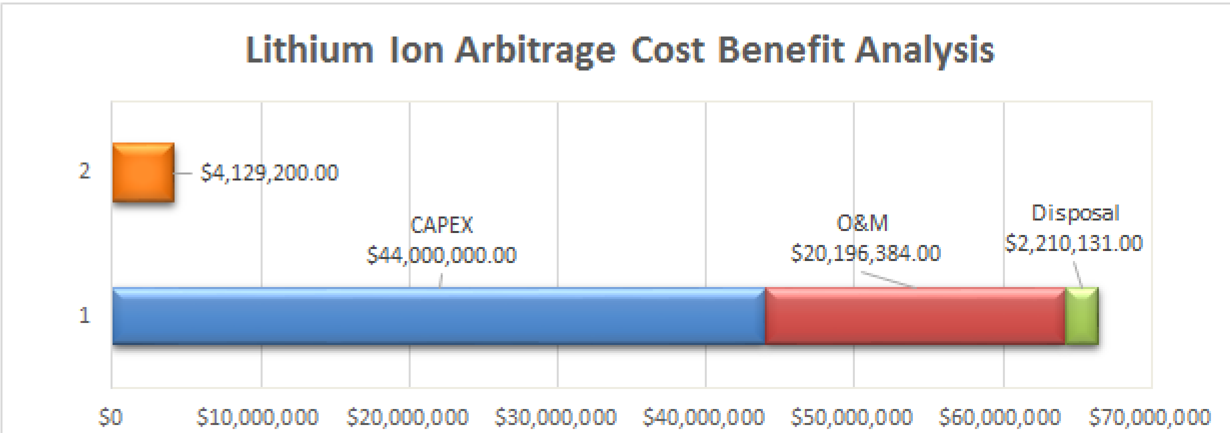
Inherent Risk

There are some true challenges when assessing the feasibility of energy storage systems that cannot necessarily be accounted for in using the Energy Storage Assessment tool. First and foremost, energy storage technologies at the grid level are not mature and do not have a long track history that can be analyzed. Attempting to calculate the cost of emerging technologies is problematic in that many of the technologies still find themselves in the research, testing and development stage rather than in an actual production or in-service environment. Being a small scale publically owned utility subject to many budgetary constraints, the approach to procuring energy storage technologies as a viable, cost effective component of the electrical system must take place after thorough vetting and after considerable in service data is available. One component VG&E places a high priority on is safety to personnel. Limited safety data is available when considering emerging technologies that are still in the development stage. Last, with newer technologies and relatively short life expectancy, accurate replacement costs are simply not available. When attempting to perform a rigorous cost-benefit analysis, valuating the replacement cost of various energy storage technologies is speculative at best.

Energy Storage Modeling Results: Lithium Ion Battery

A 10 MW, 40 MWh Lithium Ion battery storage system participating in CAISO wholesale market from 2017 to 2031 has a Net Negative Present Value of $44 million. Results indicate that the installation of a Lithium Ion battery storage system for arbitrage is not cost-effective. The 15 year annual revenues and costs for the Lithium Ion battery storage system are graphed in Figure 1. The large capital expenditure is derived from the construction and installation of the storage device. Annual loan payments are then made to pay down the remaining principal on the loan at the fixed charge rate of 11% over the 15 year life. Operating and maintenance (O&M) costs and imbalance energy costs represent the other costs incurred by the storage device. Every 15 years, the entire battery stack is replaced because of the annual reduction in energy capacity due to cycle life degradation. The total revenue generated by energy arbitrage and cost savings for reducing CO_2, NOX, SOX, and PM emissions are depicted in orange.

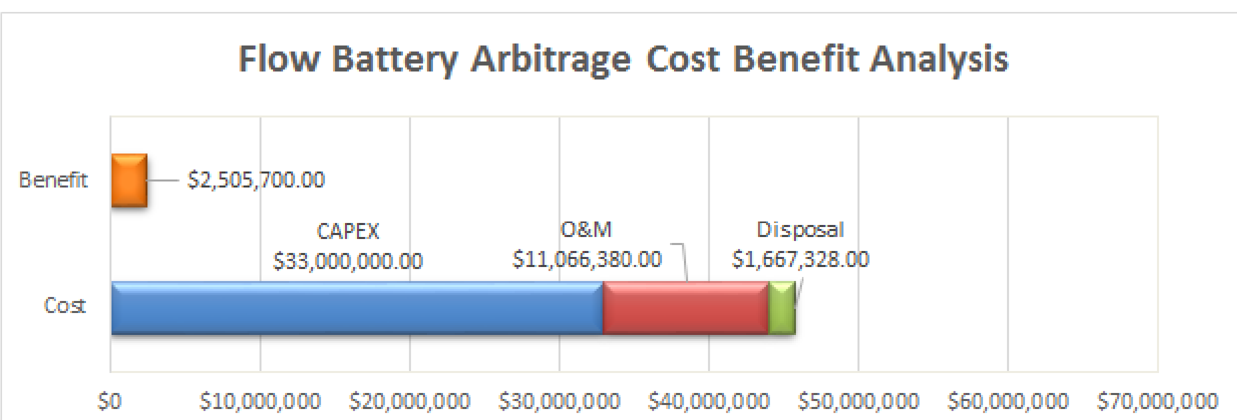
Figure 1: Chart of 15 Year Revenues for Lithium Ion Battery



Energy Storage Modeling Results: Flow Battery

A 10 MW, 40 MWh Flow battery storage system participating in CAISO wholesale markets from 2017 to 2031 has a Net Negative Present Value of $33 million. Results indicate that the installation of a Flow battery storage system for arbitrage is not cost-effective. The 15 year annual revenues and costs for the Flow battery storage system are graphed in Figure 2. The large capital expenditure in originates from the construction and installation of the storage device. Annual loan payments are then made to pay down the remaining principal on the loan at the fixed charge rate of 11% over the 15 year life. Operating and maintenance (O&M) costs and imbalance energy costs represent the other costs incurred by the storage device. Every 15 years the entire battery stack is replaced because of the annual reduction in energy capacity due to cycle life degradation. The total revenue generated by energy arbitrage and cost savings for reducing CO_2, NOX, SOX, and PM emissions is depicted in orange.

Figure 2: Chart of 15 Year Revenues for Flow Battery



Conclusion

VG&E staff performed a thorough evaluation of the cost and associated benefit of various energy storage projects submitted in response to the SCPPA RFP for local energy storage applications, both from a utility and a customer perspective. Over fifteen years of storage actual life, the costs of utility-owned and operated energy storage technologies exceed the value of the benefits, and hence, do not provide cost-effective, viable opportunities for VG&E or VG&E customers. More specifically, VG&E staff endorses the approach that currently there is no reasonable justification to procure energy storage systems within the City of Vernon for applications of ancillary services, outage mitigation, renewable integration, deferral of transmission and distribution upgrades, load leveling, grid operational support or grid stabilization.

To meet the City's obligation under AB 2514 while adhering to VG&E's Integrated Resource Plan (IRP), staff proposes that energy storage procurement targets are not adopted by virtue that energy storage is not cost-effective, and therefore inappropriate for the City and City customers. VG&E will, nevertheless, encourage customers to consider this emerging technology where it is cost-effective. Furthermore, AB 2514 requires that the City reevaluate this determination regarding the viability to procure an energy storage target within three (3) years. VG&E staff will return to the City Council to reassess the position recommended in this Staff Report within that time frame.

It is the belief of the VG&E staff that in the long term, energy storage is expected to have an impactful role in the overarching electric power system. Staff will continue to perform due diligence in the analysis of energy storage systems as they continue to mature from the research and development realm into the production realm and as the potential benefits of these systems begin to clearly outweigh the costs.