Title

Analysis of Customer Perception and Satisfaction for Behind-the-meter Battery Energy Storage Systems (BESS) for Commercial and Industrial Users in California

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Analysis of Customer Perception and Satisfaction for Behind-the-meter Battery Energy Storage Systems (BESS) for Commercial and Industrial Users in California

By

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THESIS

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Abstract

Battery energy storage systems (BESS) play a role in addressing the challenges of the current electric grid. BESS will be instrumental for meeting energy storage requirements with the increasing adoption of intermittent energy sources. California is a global leader in the adoption of intermittent renewables on their grid, and has had to devise solutions for meeting the energy storage demands of these energy sources. California has the largest proportion of solar photovoltaic (PV) on the grid of any region of the world. It thus is the first to face the challenges of meeting energy storage needs. This paper analyzes one of California's steps in meeting this challenge by increasing the adoption of BESS through its Self-Generating Incentive Program (SGIP). The paper studies SGIP beneficiaries' perceptions, satisfaction, and performance of some of the BESS currently installed for commercial and industrial (C&I) applications. This paper also defines BESS's actual and potential benefits for C&I customers. Results show that most SGIP tickets submitted for C&I installations in the last five years are yet to go live and currently installed BESS aligns with SGIP's goal of reducing electricity bills. In addition, most customers are satisfied with the installation process and the promptness of getting their BESS to serve them. SGIP has been successful for C&I customers because it has reduced the energy bill of the beneficiaries.

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1. Introduction

1.1. Research Motivation and Study Objectives

Climate change effects are increasingly evident with rising temperatures around the world, and sea level rise, which directly impact energy use (U.S. EPA, 2016). There has been a significant improvement in energy conservation in recent years. However, there is still a need to meet the current demand. Intermittent renewable energy sources, which have gained more prevalence in the last decade, need to be coupled with energy storage to provide energy when they are off. Battery energy storage systems (BESS) can address energy storage challenges from intermittent renewable energy sources. BESS are technologies that enable power system operators, utilities, and customers to store energy for later use. BESS is popular because of their high energy density and light weight. Batteries used for grid-scale storage are called front-of-the-meter (FTM) energy storage; customer-sited stationary storage systems are behind-the-meter (BTM) energy storage systems. Commercial and Industrial (C&I) customers need energy storage, and this study will focus only on BTM BESS for C&I customers.

A report by the Emerging Technologies Coordinating Council (ETCC) stated that there had been a decline in the adoption of BESS by C&I customers (Jungers et al, 2020). This decline may have resulted from limited research or information on the prospects of BESS to meet the demands of C&I customers. This study hopes to bridge the knowledge gap on the adoption of BESS for C&I customers, analyze the feedback of the early adopters of this technology and present data that will lead to an increase in its adoption across several providers of BESS.

1.2. Existing Relevant Policy

"Energy storage is a strategic focus in California's policy reform," and policies play a critical role in the continuous growth in the use of intermittent renewable energy sources in California (Shuai and Raufer, 2021). Several policies in the state of California prompted the growth in adoption of energy storage; some directly targeted increasing the acceptance of energy storage, while some indirectly impacted energy storage.

The specific bills that led to the rapid growth in energy storage adoption in California are Assembly Bill 2514 (AB 2514) of 2010 and Assembly Bill 2868 (AB 2868) of 2016.

In September 2010, the governor of California approved AB 2514, which mandated that the California Public Utilities Commission (CPUC) must set targets for all load-serving entities in the state to buy cost-effective energy storage systems by October 1, 2013. The bill also stipulated that publicly owned electric utility companies set targets by October 1, 2014, and meet them by December 31, 2016. A second target set to be met by December 31, 2021, was also expected from the electric utility companies (AB 2514, n.d.).

Furthermore, in 2016, AB 2868 adjusted some of the provisions of AB 2514. AB 2868 commissioned the CPUC to instruct the largest investor-owned electric utilities to double up on creating programs to increase the deployment of distributed energy storage systems. The bill also allocated 75% of the budget of one of its programs - the Self-Generation Incentive Program (SGIP) for energy storage projects (AB. 2868, n.d.). SGIP is an offshoot of AB 2514 and the bill incentivizes customers that reduce greenhouse gas (GHG) emissions through energy storage technologies.

One of the bills that indirectly increased the use of energy storage is Senate Bill 100 (SB 100), which mandates that by the end of 2045, all the electric demand in California should come from carbon-neutral sources (Shuai and Raufer, 2021; SB 100, n.d.). Many of these carbon neutral sources, such as photovoltaic and wind, are intermittent and require investments in energy storage in order for electricity supply to match demand.

These bills made the energy storage market in California grow tremendously in the last decade and have made California a leader in behind-the-meter (BTM) storage investments. In addition to these state policies, the Federal Energy Regulatory Commission (FERC) Order 841 created a clear legal framework for BTM storage systems to thrive. The order is described as the "single most important act" the United States has taken to achieve its clean energy future (Colthorpe, 2020; Shuai and Raufer, 2021). Additional federal acts that indirectly pushed the use of energy storage are FERC orders 719, 755, and 784 of 2008, 2011, and 2013 respectively. These federal policies have resulted in at least seven states adopting energy storage targets or energy storage procurement policies (Shuai and Roger, 2021).

1.3. Organization of This Thesis

This thesis aims to assess the satisfaction of early adopters of BTM BESS for C&I applications in California. Most of the research and analysis performed for this thesis centers on SGIP data and the feedback from surveys conducted for C&I customers with BESS installed in their facilities. The literature review of this study relied on information from peer-reviewed academic papers and several gray works of literature, including technical reports and white papers from reputable organizations and research agencies.

Literature review was performed in Chapter 2 to identify the industry trends, applications, and acceptable characteristics of BESS. The literature review aims to identify the factors driving the increase in the use of aside from incentives such as SGIP. The literature review also examined what motivated early adopters of similar technologies in and outside the United States. In Chapter 3, a quantitative analysis of the SGIP data provided by the CPUC was done; this included evaluating where the installations are and making some inferences based on the data. Chapter 4 analyzes the feedback received from surveys and interviews with C&I BESS customers and providers. A discussion section follows, which buttresses the assessment of BTM BESS. Chapter 5 provided the conclusion and recommendations for improvement to increase customers' acceptance of BESS.

1.4. Research Questions

This thesis seeks to answer the following questions regarding the Battery Energy Storage Systems in Commercial and Industrial buildings in California:

1. What is the role of SGIP in driving the adoption of BESS by C&I customers?

2. Who are the major providers of BESS in the California market?

3. What are the minimum acceptable standards for BESS, what is the availability of products to meet these standards, and what are the compliance needs for providers to meet customers or technological expectations?

4. What is the customer satisfaction and the perceived benefits of BESS?

A mixed approach was used to answer these questions using a literature review and a survey.

2. Literature Review

2.1. Energy Storage Systems

Energy storage has been in use since the 20th century, and the first central station for energy storage was a Pumped Hydroelectric Storage installed in 1929 (Chen et al., 2009).

Electrical Energy Storage is the conversion of electrical energy into a form that can be stored and reused later (Chen et al., 2009). When used as part of the electricity system, energy storage is most cost-effective when the stored electricity is produced at a cheaper rate, when in low demand, or when the resource exceeds demand, such as when sunlight is abundant on grids with high proportions of solar generation. The stored energy can then be deployed when there is high demand, high cost, and limited or non-renewable energy resources (Chen et al., 2009).

2.1.1. Benefits of Energy Storage Systems

The traditional electricity value chain consists of the energy source, generation, transmission, distribution, and customer-side energy service, as shown in Figure 1. Energy storage is considered the sixth link that solves some of the challenges and increases the benefits from the five links (Chen et al., 2009).

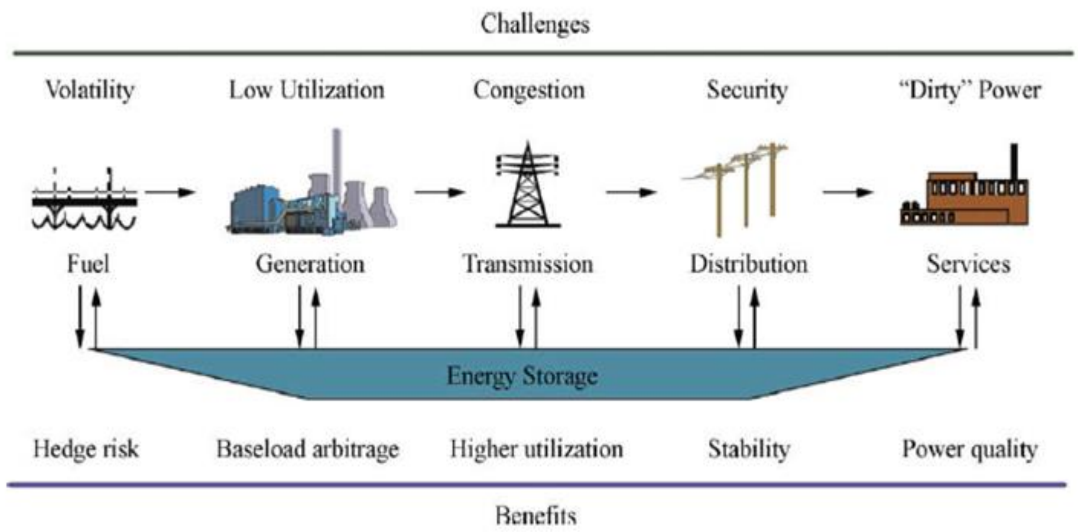

Figure 1: The Challenges of the Electricity Grid and How Energy Storage Solve Them (Chen et al., 2009)

Some benefits attributed to energy storage at the generation stage are storing bulk energy generated during off-peak periods to be used during peak periods, or black startup for energizing transmission systems. Energy storage has proven beneficial for transmission and distribution in stabilizing electrical systems to avoid grid collapse and voltage regulation. For energy services, energy storage benefits power reliability and opportunities for better energy management (Chen et al., 2009; AL Shaqsi et al., 2020).

2.1.2. Classification of Energy Storage Systems

Energy storage can be categorized based on function, or the form that is stored. Functionally, they can be categorized into storage for power quality and energy management. For power quality and reliability, the applicable systems are capacitors, supercapacitors, superconducting magnetic energy storage (SMES), flywheels, and batteries. For energy management, the systems include Pumped Storage Hydropower (PHS), Compressed Air Energy

Storage (CAES), flow batteries, fuel cells, solar fuels, and Thermal Energy Storage (TES) (Chen et al., 2009; Komarnicki et al., 2017).

Categorizing energy storage in the form it is stored is grouped into four categories: electrical energy storage (capacitors and superconductors), mechanical energy storage (flywheels, PHS and CAES), chemical energy storage systems, and thermal energy storage systems. Chemical energy storage systems are the most common and is divided into electrochemical and thermochemical systems. Electrochemical systems include conventional lithium-ion, lead acid, and flow cell batteries. An example of a thermochemical system is solar hydrogen (Chen et al., 2009; Komarnicki et al, 2017; AL Shaqsi et al., 2020).

Another method of classifying energy storage is its power rating and rated energy capacity. This classification scheme leads to three applications: power quality, bridging power, and energy management. Storage systems used for power quality can charge and discharge electricity within a short time. Storage systems for bridging power have a power rating and energy capacity higher than systems used for power quality. Storage systems used for energy management have the highest power rating and rated energy capacity based on this classification (Chen et al., 2009; Komarnicki et al., 2017).

Figure 2 below shows the different classification of BESS based on rated capacity and rated power of each technology.

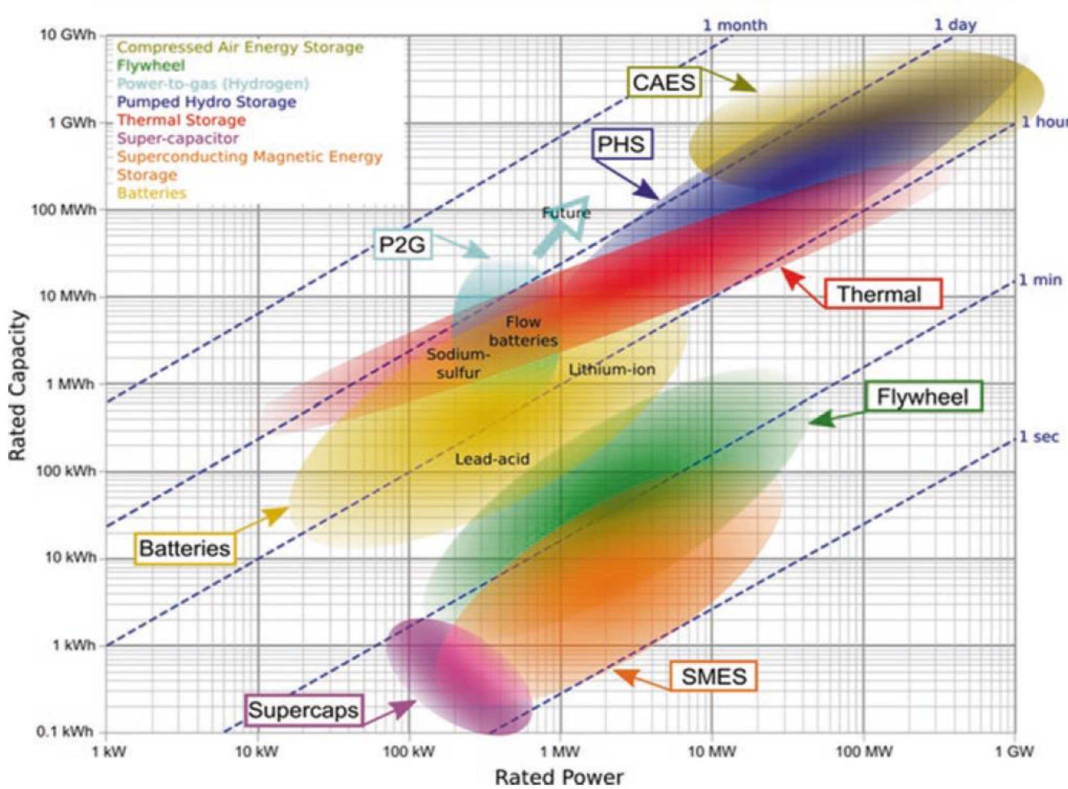

Figure 2: Classification of Energy Storage Applications (Komarnicki et al., 2017)

2.1.3. Electrochemical Systems

This study is narrowed down to electrochemical systems because it is one of the most applicable technologies for the storage systems used for C&I applications. More than 90% of the global grid battery storage business is dominated by lithium-ion batteries, today's most widely used battery storage alternative. Lithium-ion batteries are more preferred because they are lightweight and have a higher energy density than other battery types (Zablocki, 2019; Komarnicki et al., 2017).

Battery storage is particularly attractive because it can meet the expectations of different users; its application includes the installation both on the utility side of the customer meter as a grid-scale and behind-the-meter for individual facilities (Fisher and Apt, 2017). A study has shown that BTM BESS is the only storage that can add the most benefits to a variety of stakeholders and have the potential of a win-win scenario for individuals and create additional income for wholesale markets, especially for C&I customers (Shuai and Roger, 2021). BTM BESS technology penetration has also increased tremendously because of technology advancements, which has significantly reduced lithium-ion battery costs in the last decade. The significant reduction in the cost of lithium-ion batteries has led to it being called the “game changer” and “disruptive technology” that will change the perception of Germany’s power sector (Hartmann et al., 2018).

In addition to the success of lithium-ion batteries, the combination of the photovoltaic and batteries as a package is predicted as the future electricity infrastructure for supplying dispatchable power in competitive energy markets in developed and developing countries (Saini and Gidwani, 2022).

One of the leading benefits of battery technology is its fast response and modularity, which enables it to serve energy and power applications for a wide range of services from electric vehicles to grid services (Malhotra et al., 2016). As such, the potential of electrochemical batteries has continuously increased the focus on it by policymakers, academics, and the industry.

2.1.4. Components of a Typical BESS

BESS is used to describe the entire system used for storage, not just the battery, but the balance of system required for the battery to operate as an effective energy storage system. Key components include a bidirectional inverter, battery, transformer, protection devices, cooling systems, and high-level control system. A bidirectional inverter is a primary component that transforms power between the AC line voltage and the DC battery terminals and permits power to flow in both directions to charge and discharge the battery (Haines, 2018).

The components of a BESS can be divided into four elements: storage, integration, Power Conversion System (PCS), and Energy Management System (EMS) (Chalamala et al., 2016).

- The storage element stores and releases energy; some of the components in this element are cell battery management & protection and racking.
- The integration or thermal management element keeps the storage technology within the required temperature range; some of the components of this element are container/housing, wiring, and climate control (Mitchell & Hibbs, 2017; Chalamala et al., 2016).
- The PCS element converts the form of power (Alternating current or Direct current) of the incoming or outgoing energy; the components of the PCS are the bi-directional inverter, switchgear, transformer, and skid (Mitchell & Hibbs, 2017; Chalamala et al., 2016).
- The EMS elements are software and controls; they monitor and control the flow of energy. The components of the EMS are charge/discharge, load management, and ramp rate control (Mitchell & Hibbs, 2017; Chalamala et al., 2016),

Figure 3 below shows the schematic diagram of a typical BESS.

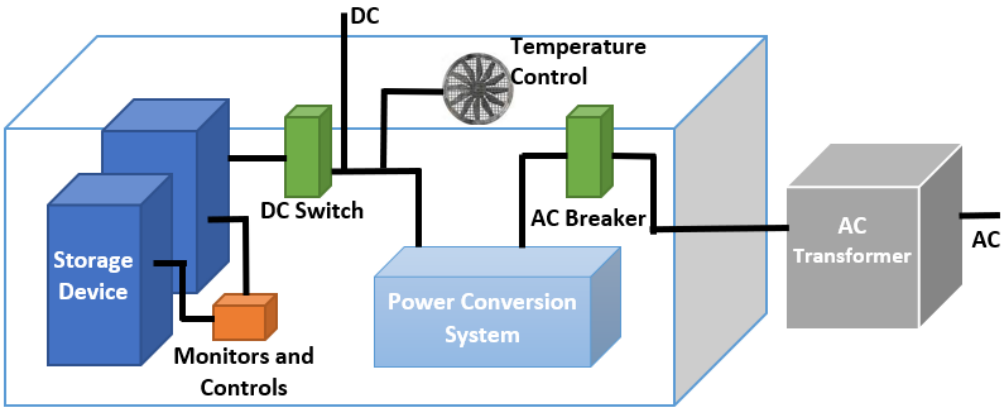

Figure 3: Schematic Diagram of a Typical BESS (Adapted from AMDC Energy, n.d.)

2.2. Trends in the Adoption of BESS

In the last two decades, there has been an upward trend in using and deploying behind-the-meter (BTM) battery storage capacity in the U.S and other developed nations. California, which accounted for more than 80% of the rise in BTM battery storage capacity in 2018, was a major contributor to the United States' growth in battery storage capacity (Shuai and Raufer, 2021). Figure 4 below shows the upward trend of BESS adoption in the California market in the last 12 years.

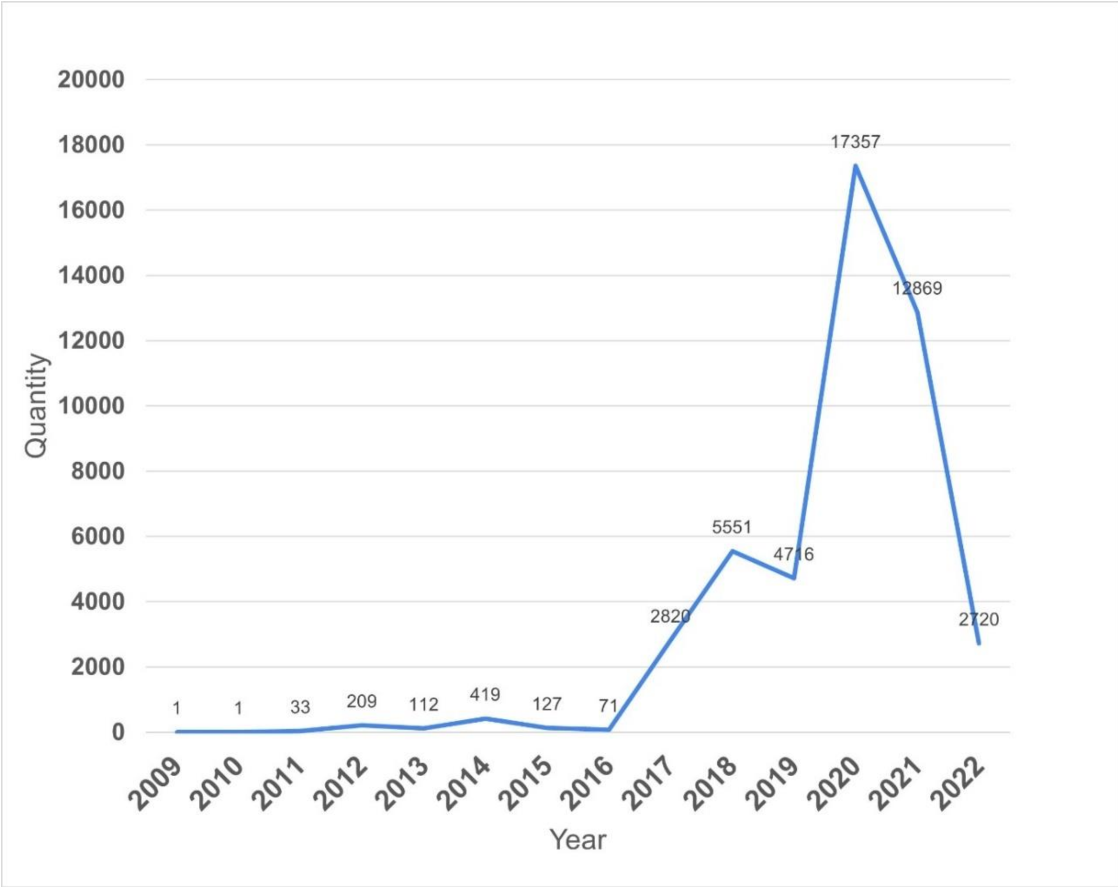

Figure 4: Growth of DER Installations in California Since 2009

2.3. Early Adopters of a New Technology

Making decisions in policy and business requires an understanding of the characteristics of early adopters in the renewable energy space (Araújo et al., 2019). This study also seeks to know BESS's diffusion of innovation in California and outside the U.S. BESS for C&I customers may be considered a new technology; most adopters are not sure of its outcome with respect to meeting energy needs and providing the desired benefits in later years. According to Rogers et al. (2014), the idealized categories of new technology adopters are innovators, early adopters, early majority, late majority, and laggards. The innovators and early adopters represent the first

16% of people adopting a technology (Rogers et al., 2014). Early adopters of new technologies are motivated by different factors ranging from economic or environmental benefits or policies. More knowledge of these factors will support strategies for increasing the adoption of BESS technology.

Since BESS are still relatively new to the market, this study reviews the role early adopters of similar technologies in the energy sector played in the success of the technology. Palm (2020) showed that environmental concerns and technophilia drove early adopters of solar photovoltaic technologies in Sweden, while economic gains drove later adopters. A study by Nygren et al. (2015) in Finland on the diffusion of small-scale energy solutions further substantiated the idea that environmental concerns were the most crucial reason more than 80% of their study's respondents adopted renewable energy solutions. In Wisconsin, Schelly (2014) studied the motivations of early adopters of residential solar electricity, and the behavior differs from that observed in European countries. Adoption was mainly due to the respondents wanting to learn more about the new technology, not the environment.

Particularly to battery technology, Agnew and Dargusch (2017) found that adopters of the technology in Australia were motivated because of the hope of disconnecting from the centralized electricity grid. The differences among study results shows there are different factors motivating adopters of new technologies. Hoffman and Mohaupt (2020) also evaluated consumer attitudes on sharing energy storage in a community using group discussions and an online survey. Although this research was on residential installations in Germany, consumers were receptive to the idea; their only challenge was the fairness of the distribution and billing for energy use. This review shows that the motivation for adopting new technologies is particular to a location, and several factors in a place may drive the adoption and response of adopters of technology.

2.4. Stationary Application of BESS

The most critical services of BESS today are demand side management/peak shaving, electric service reliability/resilience, energy arbitrage, fast response frequency regulation, microgrids, off-grid systems, utility demand response programs, load leveling, backup power, and transmission/distribution system deferral. Most C&I customers install BESS for more than one of these applications (Oudalov et al., 2007; Shuai and Roger, 2021; Malhotra et al., 2016; Ahlen et al., 2020). BESS bridge idle time in one service with operation time in another making them beneficial all the time. The use of BESS is based on the type of customer and the facility where it is used (Oudalov et al., 2007). Depending on the market conditions, storage systems have helped customers save on their electricity bills where time-of-use tariffs are in place. The most common use and services of BESS by C&I customers and how they benefit the users are discussed below.

2.4.1. Peak Shaving

C&I customers usually have an uneven load that often peaks several times in the day. The peak load may occur during peak price periods or off-peak periods. However, the more significant benefit is seen when the peak load reduces through peak shaving during peak price periods. When there is a peak load with a high electricity tariff, the owner of a BESS saves energy costs through peak shaving (Karmiris and Tengnér, 2013).

The primary purpose of peak shaving is to minimize the installation of capacity to deliver a facility's peak load, which is highly variable. For instance, when the peak load of a facility is 20kW, but the typical load is 12kW, this facility may invest in energy storage to reduce its energy bill and the capital investment required to meet the variable peak load (Karmiris and Tengnér, 2013). Everyday operations of C&I facilities, such as starting some high electricity consuming appliances, increasing production processes, or heating some materials, may cause fluctuating loads on the grid, resulting in peak demand for these customers. In most cases, this peak demand often lasts for a short time and the demand charge should not be the only determining factor in an increased energy bill. Hence, the importance of BESS for peak shaving (Kraftwerke, n.d.).

The Peak demand of C&I customers often differs from the average load demand. Several techniques have been used and recommended to reduce peak demand, such as demand response programs. However, BESS allows customers to go about their activities without switching off some equipment to reduce their peak demand charge. Peak shaving is regarded as the most effective way to manage utility costs for customers with demand charges (Chua et al., 2016; Ideal Energy, 2019)

2.4.2. Frequency Regulation

Demand and supply of the grid's alternating current need to be kept within limits at every point in time to maintain frequency; BESS are often used to meet this need (Malhotra et al., 2016). BESS typically provides "frequency response to facilities by injecting/absorbing power to/from the grid in response to decrease/increase in frequency" (Akram et al., 2020, p. 1). BESS provides a fast response compared to other technologies used and used in the past for frequency regulation (Akram et al., 2020). The fast response of energy storage technologies makes them a reliable source to meet the frequency regulation requirements in power systems with the increased penetration of intermittent energy sources (Akram et al., 2020). Akram et al. (2020) discussed the potential of using BESS for frequency regulation service, modeled the mathematical review models and use of single storage technologies, and highlighted the gaps in using rapid response energy storage technologies for modern power systems.

2.4.3. Demand Charge Management

BTM BESS are particularly of great value to C&I customers as they can effectively manage peak loads and reduce demand charges. Like peak shaving, demand charge management reduces the electricity costs accumulated for the short period of peak demand. For example, in the United States, more than 50% of the electricity bill for C&I customers comes from demand charges which have led to the need to mitigate that peak demand. California particularly has the highest demand charges of $47.08 for C&I customers in the United States; the outstanding demand charge reduction opportunity is why BTM storage offers more benefits for C&I customers in California compared to other states in the U.S (Shuai and Raufer, 2021; McLaren et al., 2017).

2.4.4. Time-of-Use (ToU) arbitrage

ToU arbitrage is similar to demand charge management because it is simply charging the BESS during off-peak periods and using the stored energy during peak periods to lower electricity bills.

2.4.5. Utility Demand Response Programs

Utility Demand Response programs are ways electric utilities offer rewarding incentives to the customers willing to shift some of their peak period activities to off-peak periods. Some customers resolve to use BESS to meet their electricity loads while participating in the demand response programs.

2.4.6. Backup Power

Backup power is not the most common application of BESS for SGIP because the guideline does not support BESS for backup power for emergency purposes alone. BESS for backup power is used for operations that avoid any power outage, such as telecommunication. BESS used for backup application requires batteries with a high energy density that can provide energy for a full backup time (Asakura et al., 2003).

3.Methodology

3.1. Definition of a "Product"

As previously described, BESS comprises the battery pack and the balance of systems. This study considers BESS based on how they are sold to C&I customers. This method is by evaluating the "provider" of an entire system. An entire system includes the battery pack, all other components of a BESS, and the installation and commissioning activities until the BESS becomes functional. Most providers of BESS are technology agnostic which means they are at liberty to choose the manufacturer of the battery pack.

For example, Provider A may use battery packs from Manufacturer X, Y, or Z for assigned projects. However, in some instances, Manufacturer X can also be the provider of the BESS and be the battery pack manufacturer. Hence, a provider of a system is not necessarily the manufacturer of that product but one who integrates the battery pack with other components; then sells it as a package. This package often includes the entire set of hardware, software, and related documentation; and may also include the installation, maintenance, commissioning, and some post-installation services.

This study used data from the SGIP database because the SGIP database is assumed to be 80% accurate for all DER installations in California (Jungers et al., 2020).

3.2. About Self-Generation Incentive Program (SGIP)

SGIP is an incentive program by the state of California and administered by the California Public Utilities Commission (CPUC). The program provides financial support to drive the market transformation of distributed energy resources (DERs) technology. SGIP has been offered since 2001 and has increasingly driven the adoption of energy storage technologies in California (SGIP, 2017).

The purpose of the incentive program is to contribute to reducing greenhouse gas (GHG) emissions, grid electricity demand reduction, and reduction in the bills for electricity purchases for the users of the incentive programs across different sectors. The incentive program is funded with taxes paid by ratepayers and is managed by the CPUC with the support of the Program Administrators. Program administrators meet the needs of customers in their assigned territories, and there are four of them, namely: Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SoCal Gas), and the Center for Sustainable Energy (CSE) who is the administrator for the San Diego Gas and Electric (SDG&E) territory.

There has been lots of adjustment in the incentive program over the 21 years of its existence. These changes range from the adjustment of budget values to the application process, the technology eligibility requirement to incentive level per year, and the location of the technology manufacturer. The CPUC uploads all the versions of the SGIP guidelines on its website and often includes the changes year-on-year in the most recent edition (SGIP Handbook, 2022).

3.2.1. Steps Involved in Getting SGIP Incentives

In the last few years, BESS has experienced an upward growth in its adoption as can be seen in the SGIP data analyzed. As policies have been driving adoption, so is the ease of doing business and the marketing strategies of the providers contributing to its growth (SGIP

Handbook, 2022). Figure 5 shows the application process for public and non-public facilities that requires BESS with rated capacity equal to or greater than 10kW. The first stage of funding a BESS acquisition through SGIP is the Reservation Request stage. The next stage is the Proof of Project Milestone stage and this stage can last up to 18 months or more in some cases. The next and final stage of the process is the Incentive Claim stage. All projects are expected to be in conformity with the description in the conditional and confirmed reservation letter and if the program administrator notices a discrepancy, the project can be canceled. Furthermore, all changes to the specification of a BESS must be sent to the program administrator for approval on a case-by-case basis before acting on them (SGIP Handbook, 2022)

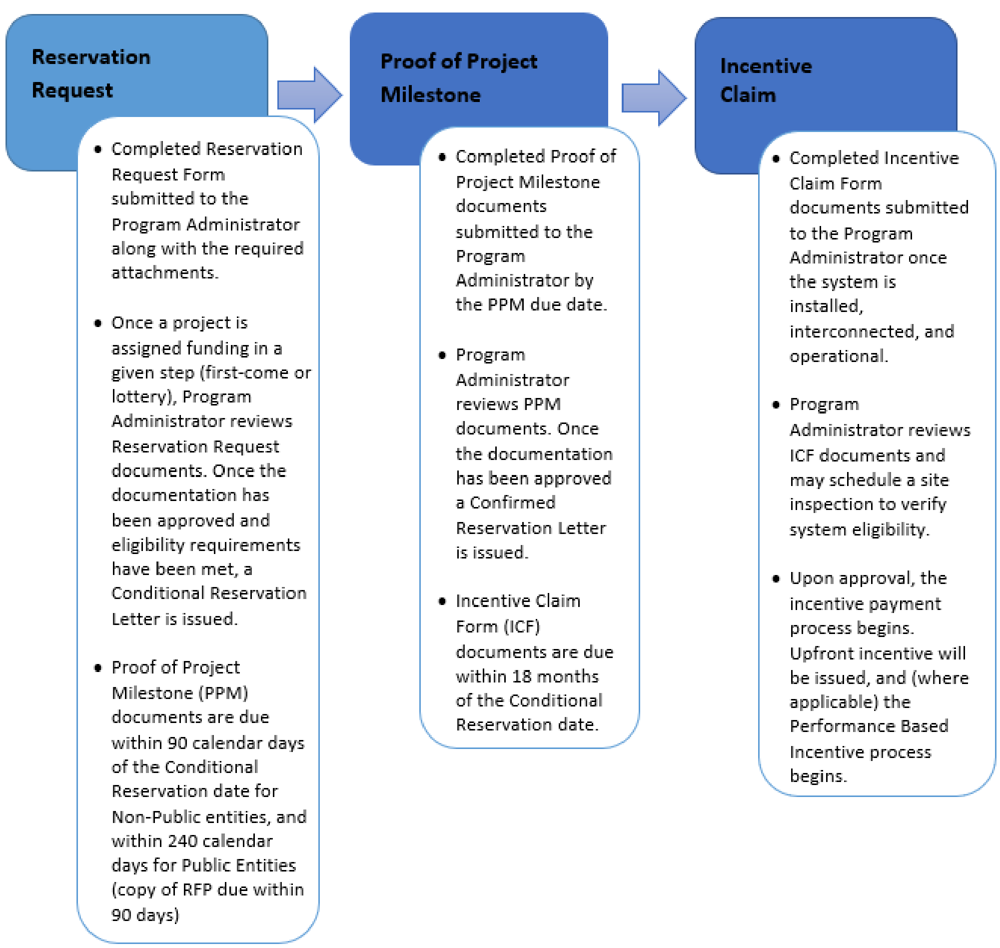

Figure 5: SGIP Incentive Procedure for C&I Installations (SGIP Handbook, 2022)

3.2.2. Budget Categories in SGIP

SGIP distributes its budget into two categories: Energy Storage Technologies (EST) and Renewable Generation Technologies (RGT). 88% of the funds are allocated to EST, while 12% are allocated to RGT. EST is subdivided into Large Scale Storage, Small Residential Storage, Residential Storage Equity, Non-Residential Storage Equity, Equity Resiliency, San Joaquin Valley Residential, and San Joaquin Valley Non-Residential. Figure 6 shows the percentage of the budget assigned to the different categories.

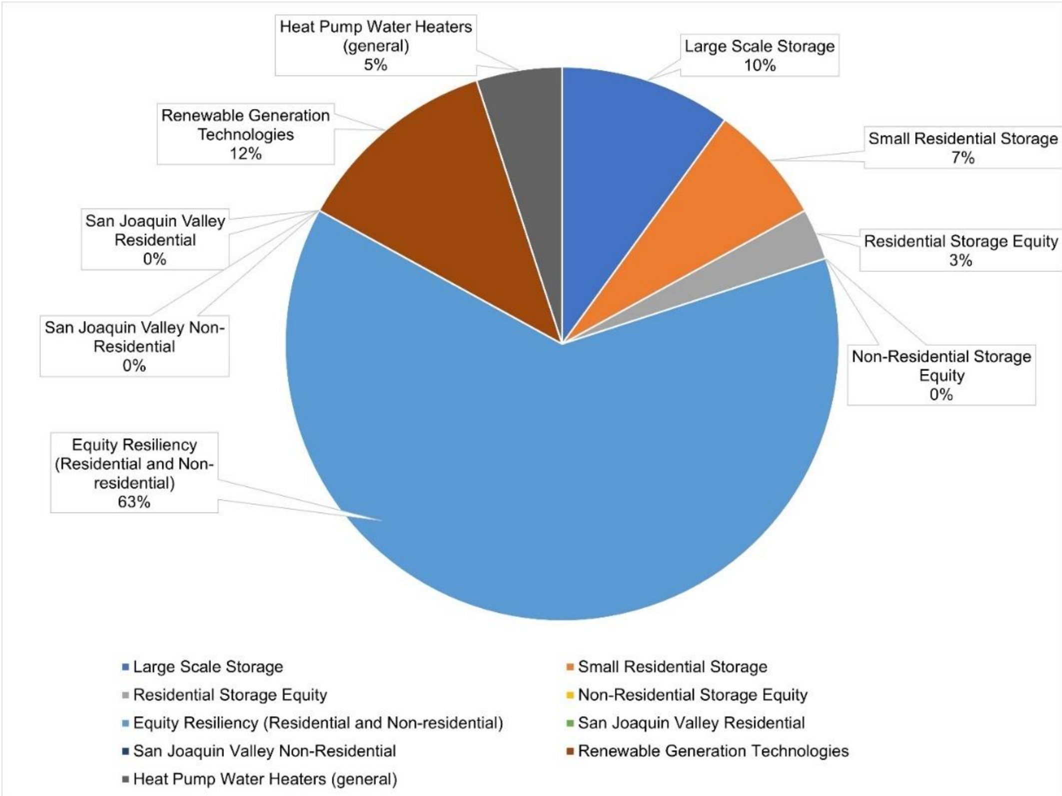

Figure 6: Allocation of SGIP Budget Categories

3.2.3. Determining the Eligibility of a BESS for SGIP

Not all BESS installations are eligible for the SGIP incentive; the program has set some parameters to disqualify some projects. BESS projects for backup power solely intended for emergency use are not eligible. Systems that can switch to diesel fuel for the startup or continuous operations are also ineligible. Refurbished, relocated systems and installations used for field demonstrations and research are also ineligible. All other types of BESS without the above exceptions can apply the incentive and will be approved if the budget is not exceeded (SGIP Handbook, 2022).

The most crucial characteristic of eligible systems is that they must be stand-alone or be paired with a generating system and be capable of fully discharging at least once daily. BESS participating in SGIP must also maintain a Round Trip Efficiency (RTE) equal to or greater than 69.6%. The 10-year average RTE of 66.5% is a must for all participating BESS, and this is verified by the performance warranties and other supporting documents sent to the program administrator (SGIP Handbook, 2022).

Another vital characteristic of BESS participating in SGIP is that system sizing is based on the 12-month annual peak demand in kilowatts of the facility where it will be installed or the estimated peak demand for new facilities. The operational requirement for all BESS in the SGIP program is that all systems will only be tagged compliant if they discharge a minimum of 130 full discharges per year, and a full discharge does not mean 100% depth of discharge, but that the aggregate of all discharges after one year must sum to 130 full discharges (SGIP Handbook, 2022).

3.3. Quantitative Data Methodology

The details of the SGIP database which has 10,174,164 data points as at May 22, 2022 was analyzed for this study.

3.3.1. Data Source

The SGIP database currently has about 80% of the DER installations in California and is considered the most up-to-date database of distributed energy resources installations (Jungers et al., 2020). Hence, the reason for selecting this dataset, which is available from the CPUC. The remaining installation data unavailable on SGIP are mostly installations where organizations did not see a reason to collect the incentives, for example if repurposed batteries were used, and may not negatively impact the result of this study. The SGIP non-anonymized data was received in July 2021 from the CPUC to identify all distributed energy resources projects across the State of California. An updated version was received in May 2022 to further update the progress made in the last year and increase the sample size for this study.

3.3.2. Data Filtering

The SGIP data has 154 columns which contain the status, capacity, contact information, customer sector, financial information, milestone dates, budget type, manufacturer, provider, address, and other information about each DER project in California. These details provide information on where each installation is, the type of system it is paired with, incentives amount, and provide an opportunity to understand trends and make observations.

The earliest DER installation on the SGIP database dates as far back as 2009, and there has been a yearly growth in the tickets raised since then. However, there was a significant leap in 2020 because more incentives were assigned to residential installations, which continued in 2021, as seen in Figure 4 above. A preliminary review shows this sharp increase was for BESS installed primarily in residential homes. More analysis will show details on the trends found from the data.

This study focuses on SGIP tickets raised in the last five years (2017 to 2022); this is because of the technological advancement in recent years and all for new entrants into the California market to have equal proportion. The equipment type is the first and most critical filter because the DER resources supported by SGIP include electrochemical and non-electrochemical solutions. The non-electrochemical storage systems account for only 7% of the total number of SGIP tickets.

Projects often move fast or slow depending on the program administrator and the pace of the project owner in providing necessary documents. After filtering the numbers of electrochemical installations, the progress stage of each project was filtered. Figure 7 below shows the breakdown of all the stages of electrochemical installations in California for residential and commercial installations.

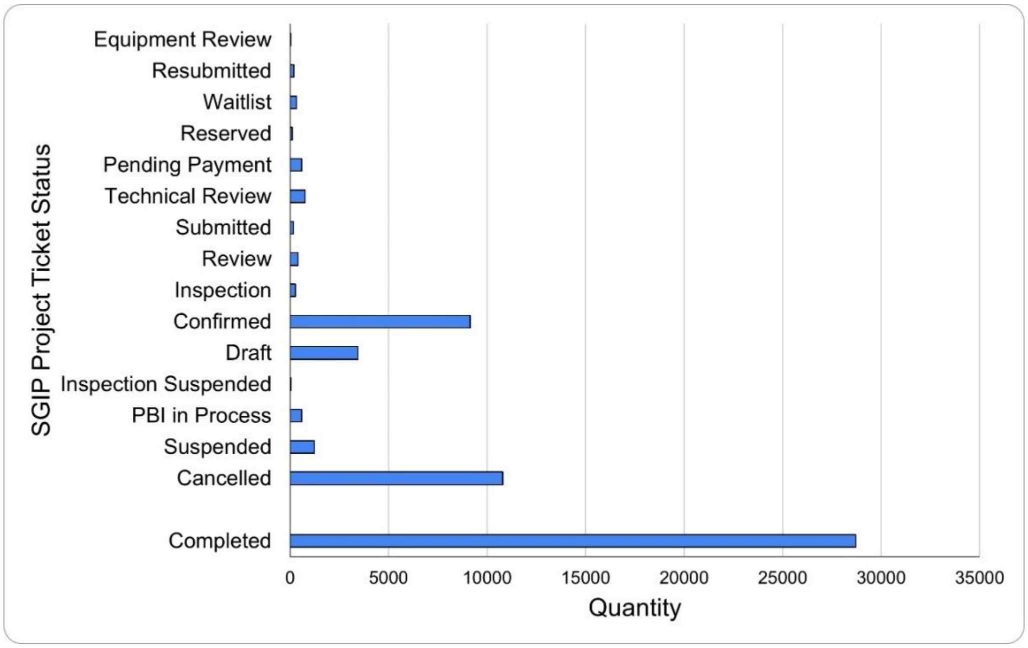

Figure 7: SGIP Stages of All Electrochemical Installations in California

Another observation from Figure 7 is that the number of canceled tickets in the SGIP database is substantial. More details on canceled tickets were filtered to identify the reasons for many cancellations. Figure 8 below shows a pie chart of why 19% of SGIP tickets raised for DER installations were canceled.

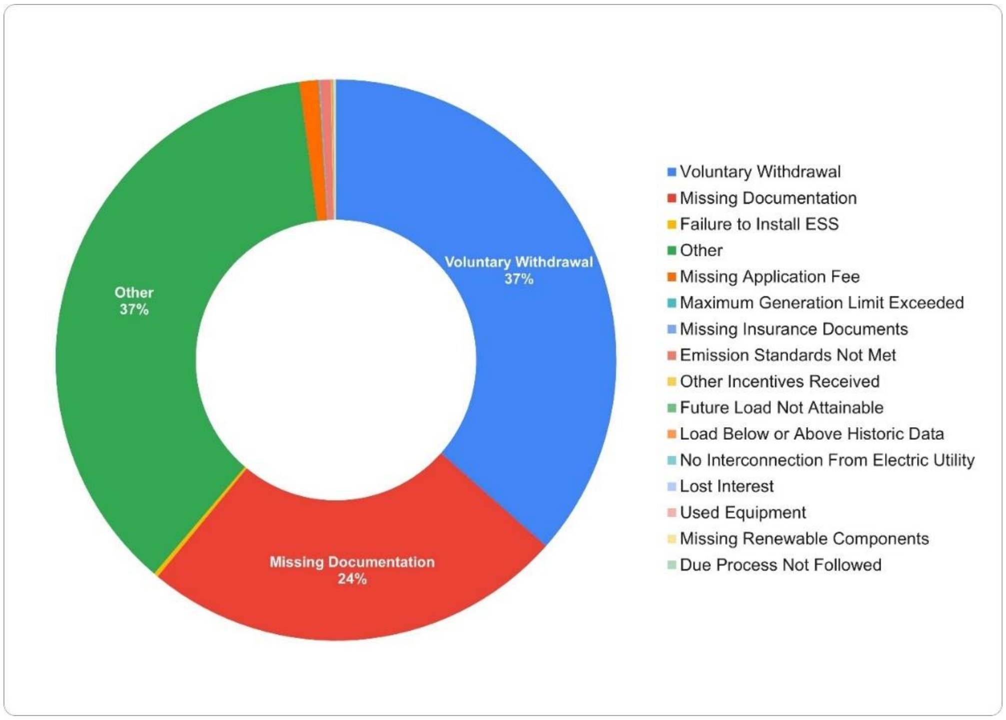

Figure 8: Canceled SGIP Tickets and Reasons for Cancellation

The most common reasons for canceling were voluntary withdrawal and missing documentation. As seen in the SGIP application procedure above, timeliness and the quality of data provided for documentation is essential for the SGIP program. The quantity of cancellation shows the compliance of program administrators with this requirement. Looking closely into the cancellation data for each host customer sector shows that cancellation is more prevalent in C&I sector than the residential sector. An average of 40% of the C&I tickets were canceled, while only 20% of the residential tickets got canceled.

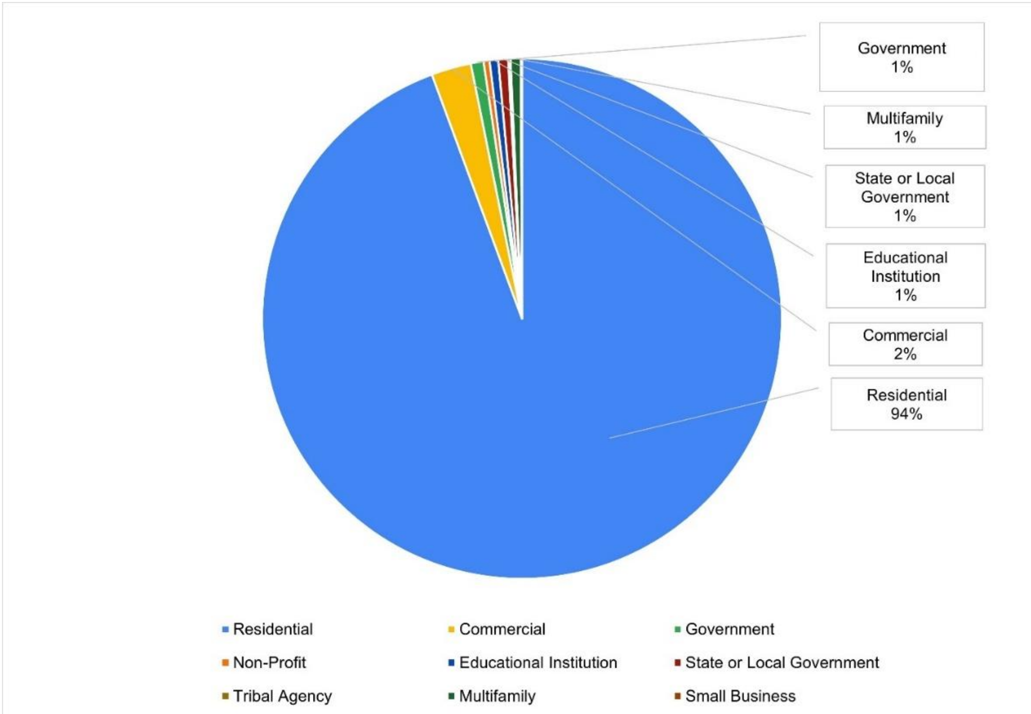

Figure 9: Categories of Customers with Electrochemical Installations in California

As we can infer from Figure 9 above, there are more residential installations than commercial ones, and this corroborates the literature that there has been a surge in residential use of BESS (Jungers et al., 2020).

The study went further to identify the different budget categories of all the installations, and Figure 10 shows the allocation for different budget categories. BESS used for residential buildings has the highest share of the budget in quantity; however, Equity Resiliency has the highest share of the budget allocation of the incentive in dollars (SGIP Handbook, 2022)

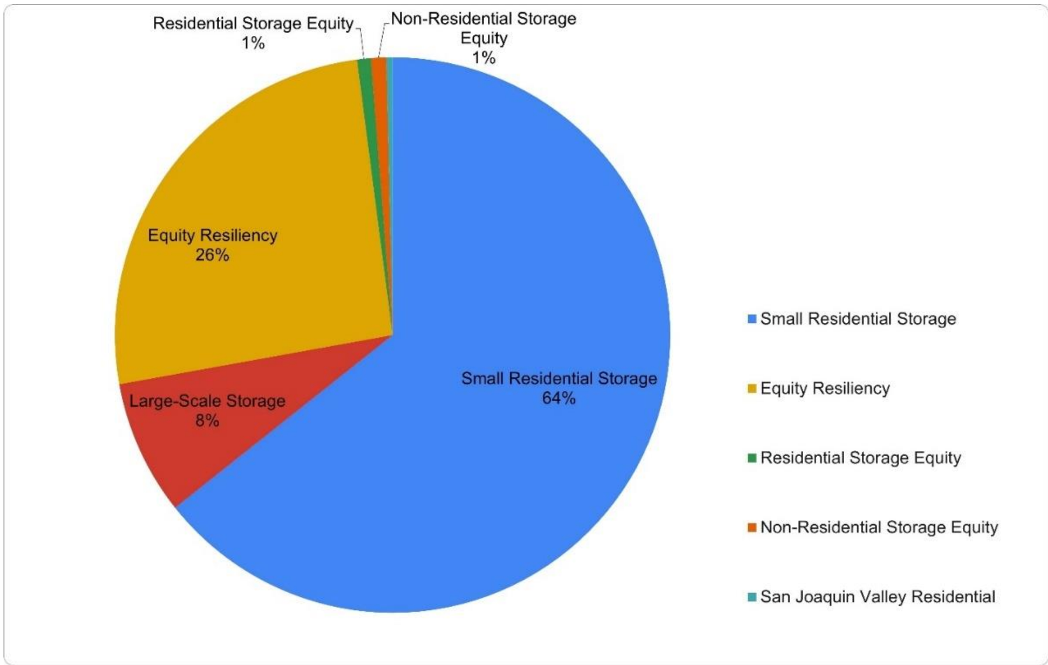

Figure 10: Breakdown of SGIP Tickets Based on Budget Categories

Furthermore, in getting more information from the SGIP data, the study filtered the rated capacity of the electrochemical tickets, excluding the canceled tickets. As seen in Figure 11, the result is that most of the BESS are rated less than 20kW. For the Energy Storage capacity, most installations were between 10kWh and 50kWh, as seen in Figure 12.

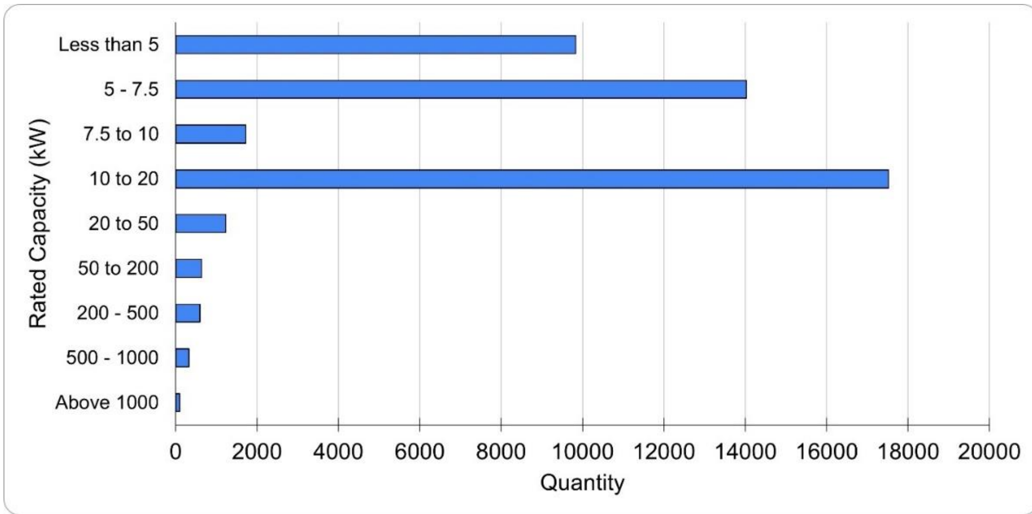

Figure 11: Distribution of BESS Based on Rated Capacity

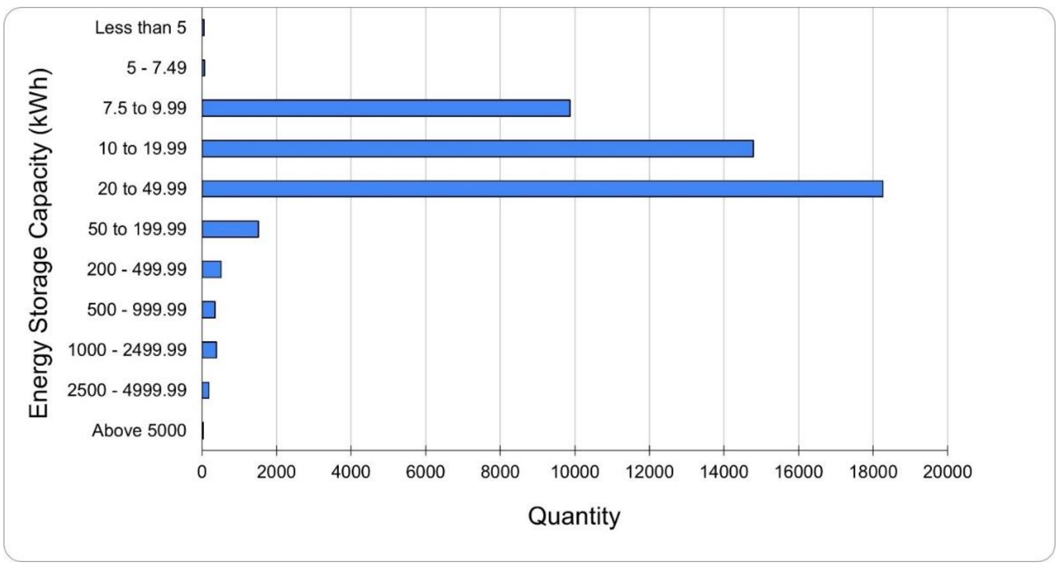

Figure 12: Distribution of BESS Based on Energy Storage Capacity

Since this study focuses on C&I customers, the data were filtered to capture only those installations. For this study, C&I classing is given to all installations whose host customer sectors are commercial, non-profit organizations, government entities, educational institutions, state and local government offices, tribal agencies, and multifamily homes. This grouping follows the guidelines of the National Renewable Energy Laboratory (NREL), as seen in the market survey on battery storage technology penetration in the U.S (McLaren et al., 2017). Multifamily homes were included even though they generally fall under the residential sector because they often use more rated energy capacity, require more storage capacity than single-family residential homes, and may have more capacity than some commercial facilities.

For these commercial installations, commercial offices and government facilities take the lead, as seen in Figure 13 below. Data for a more granular sector of the commercial building was not given, but these facilities range from food processing, school districts, and hospitals to cement-producing facilities based on the survey feedback and interviews with some customers.

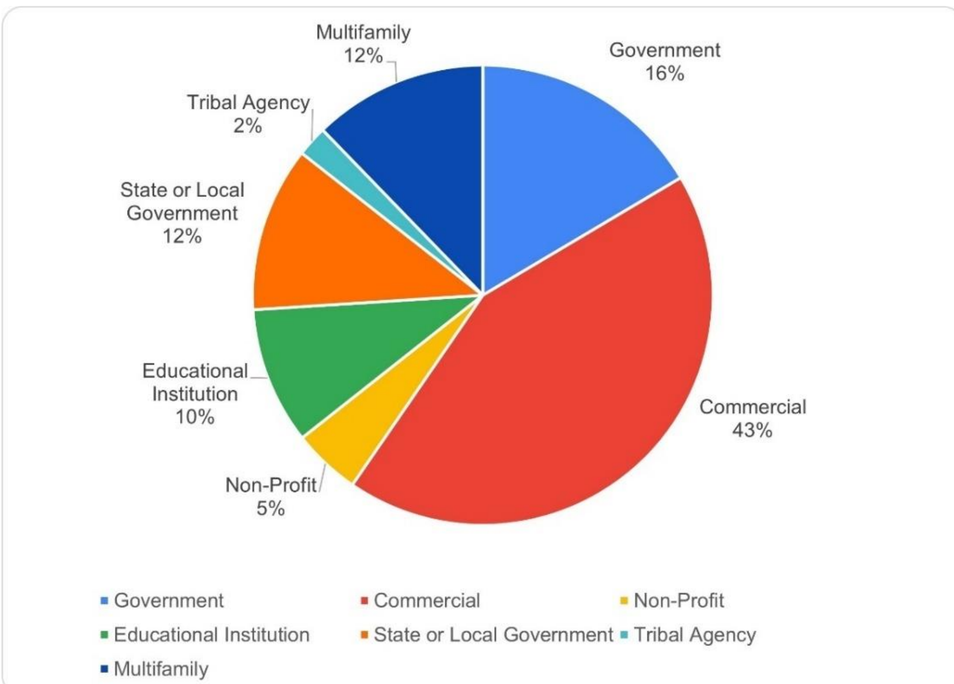

Figure 13: Distribution of BESS in the C&I Sector

As expected, for the commercial customers, the rated capacity and energy storage capacity also differs from that of the residential customers. Figure 14 shows the chart of the rated capacity, most of which are rated between 50 and 500kW. For Energy storage capacity, most installations have a capacity between 50 and 2500 kWh, as seen in Figure 15.

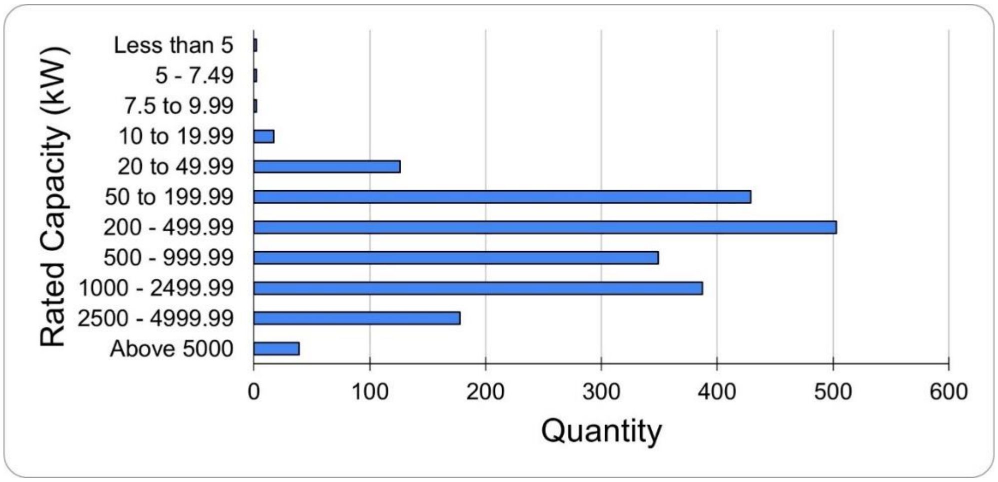

Figure 14: Distribution of BESS in the C&I Sectors Based on Rated Capacity

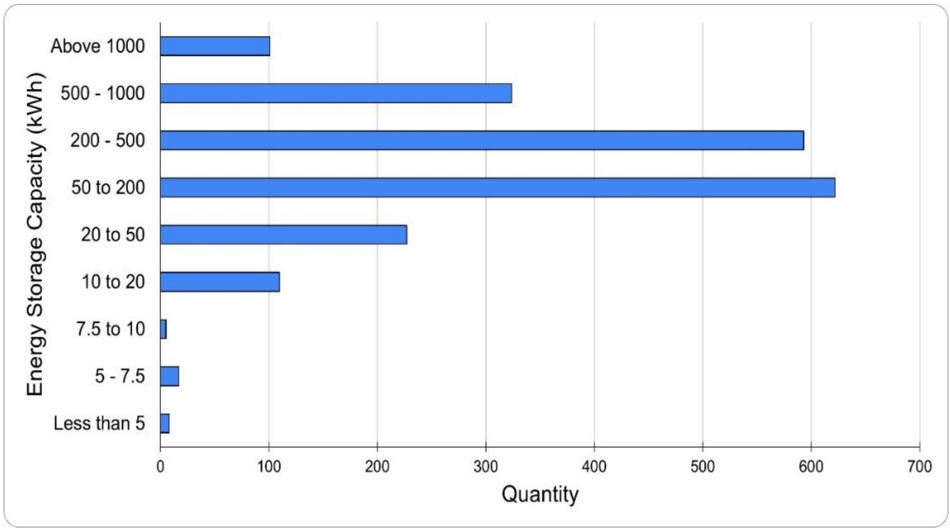

Figure 15: Distribution of BESS in the C&I Sectors Based on Energy Storage Capacity

Another useful piece of information from the SGIP data is on the leaders and drivers of the market. For most BESS in the SGIP database, the equipment manufacturer is often different from the developer (also known as the provider); as previously mentioned, most developers do not care about the battery pack manufacturer when installing products because the behavior of battery packs is assumed to be similar and there is no difference in the chemistry of lithium-ion batteries. Figure 16 shows the pie chart of manufacturers with the largest market share regarding the number of installations.

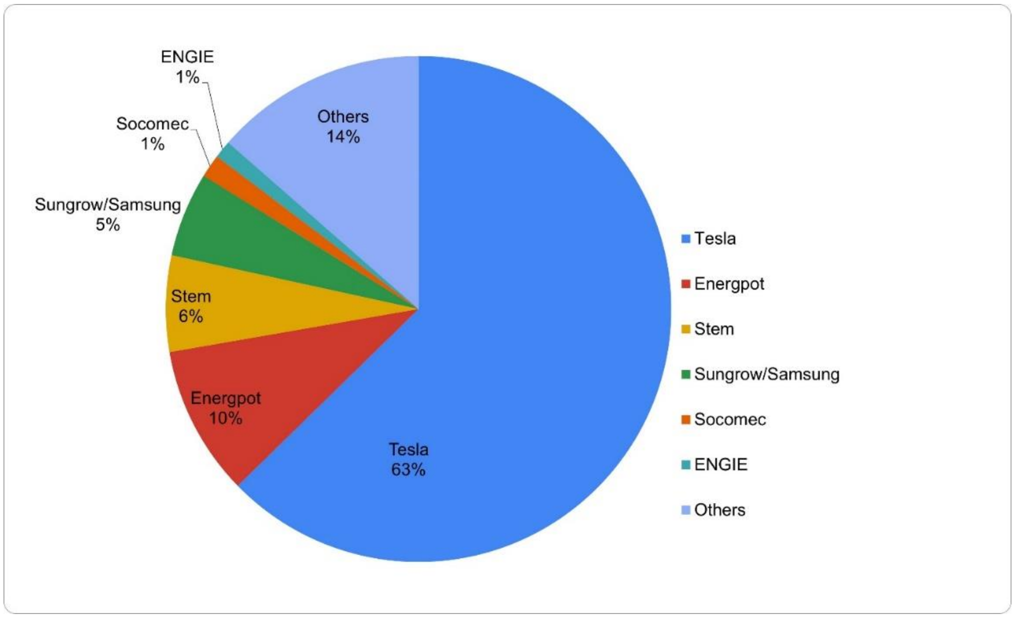

Figure 16: Market Share of BESS Manufacturers in California for C&I Customers

Similarly, these manufacturers also wield the same power in terms of rated capacity in kW and energy storage capacities. Figure 17 and 18 shows the contribution of each manufacturer to the total energy storage capacity in California. It is worth mentioning that Tesla acquired SolarCity, and all installations from SolarCity in 2017 were included in Tesla's cut.

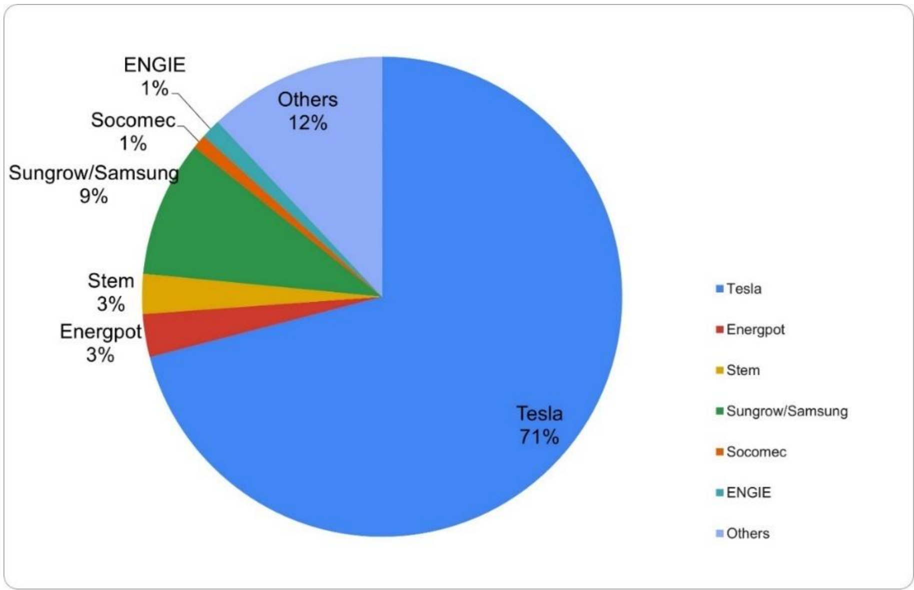

Figure 17: Market Share of BESS Manufacturers in California for C&I Customers Based on Rated Capacity in kW

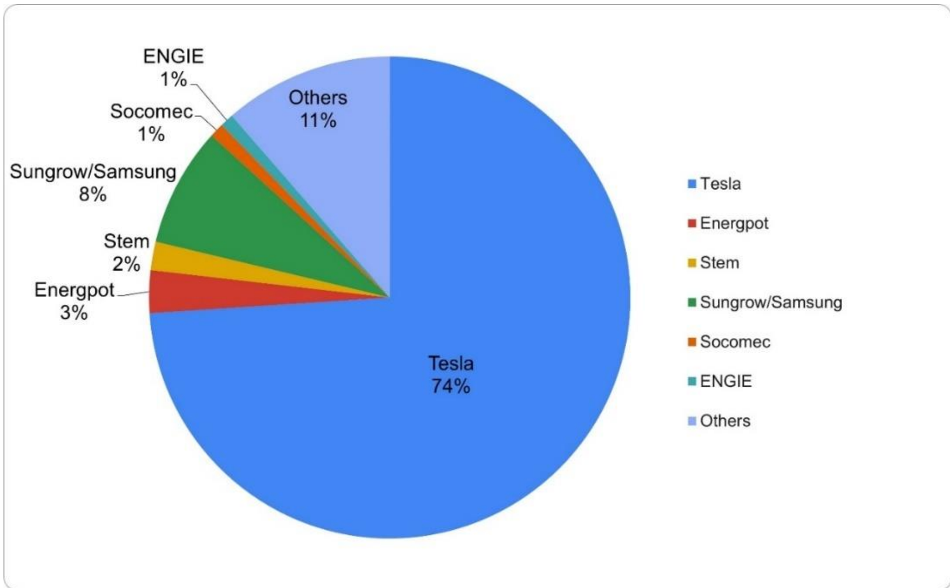

Figure 18: Market Share of BESS Manufacturers in California for C&I Customers Based on Energy Storage Capacity in kWh

This study conducted surveys based on the providers because, as previously discussed, this study focuses on the BESS as a package, not just the battery pack. Figure 19 shows the chart of the leading providers and “others” has 159 other providers that are players in the market.

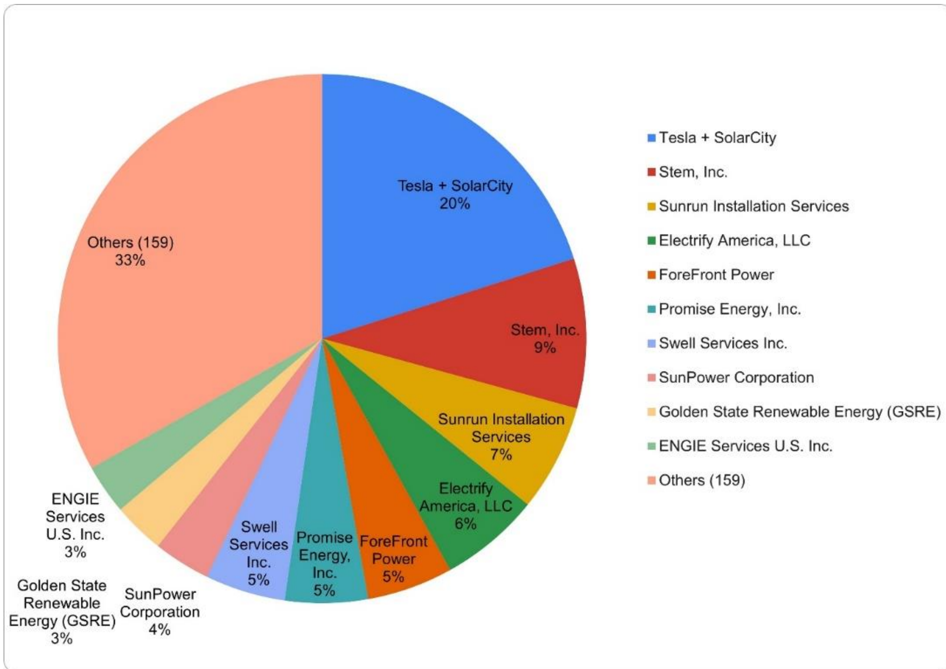

Figure 19: Market Share of BESS Providers in California for C&I Customers

Figure 20 and 21 also shows the market share of each provider in terms of total rated capacity and energy storage capacity respectively.

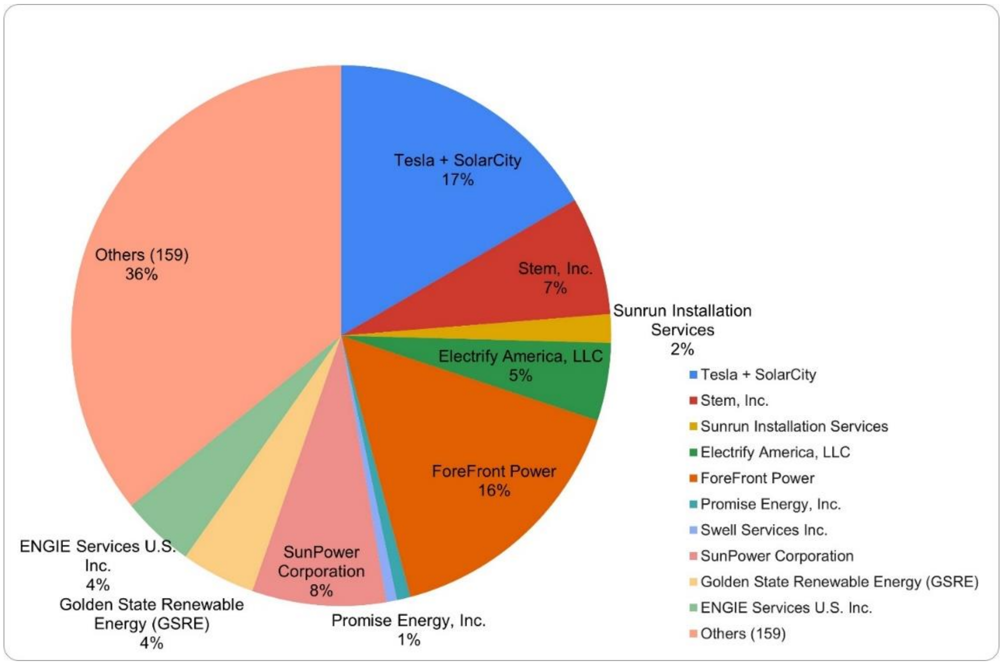

Figure 20: Market Share of BESS Providers Based on Rated Capacity

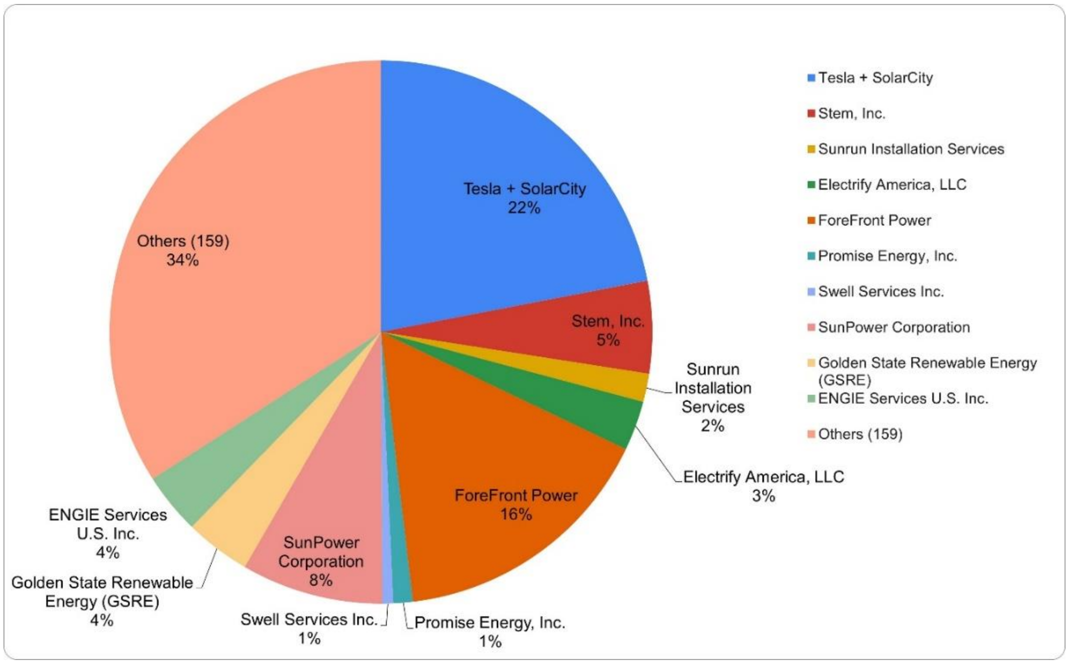

Figure 21: Market Share of BESS Providers Based on Energy Storage Capacity

3.4. Qualitative Evaluation Protocols Used for This Research

This study followed the method used by NREL in its survey for identifying the potential market for BTM BESS, where C&I customers were qualified by private and non-profit businesses, community facilities, public buildings, and multifamily housing properties (McLaren et al., 2017).

3.4.1. Round-Trip Efficiency

Energy losses occur while charging, operating, and dispatching energy from a BESS. Round-trip efficiency quantifies the level of losses a BESS incurs during these processes. For a BESS, round-trip efficiency is the quantity of energy discharged from the BESS compared to the quantity of energy consumed to charge the BESS in percentage. Round-trip efficiency (RTE) is calculated based on the SGIP 2018 SGIP Advanced Energy Storage Impact Evaluation method. RTE will be calculated by using 15-minute BESS battery operation interval data gathered from the performance data gotten from the BESS Performance Data Provider (PDP) (SGIP, 2020).

3.4.2. Financing Solutions Offered

BESS providers offer several financing solutions and options to their customers. The financing and ownership structures present an additional benefit to the owners of a BESS. The BESS providers will respond to this evaluation metric to ascertain what choices customers have and how customers have benefited from the options. Some of the structures seen in the market are cash transactions, leasing, shared savings agreements, Power Purchase agreements, and others.

3.4.3. Customer Satisfaction

This portion is the most critical feedback in this study; it ascertains customer satisfaction and gets feedback on customers' experience from adopting BESS in their facilities. A widely used scale in psychometric response was used, the Likert scale, to measure customer satisfaction. The Likert scale expects responders to specify their level of agreement with a statement in five or seven points. For this study, a five-point Likert scale was used throughout, and the five points were: (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree (Mcleod, 2008). The Likert scale assumes that attitude strength is linear from strongly agree to strongly disagree and that attitude can be measured. The response from the respondents will be ordinal data that allows for rank order by which the data can be sorted. However, the order does not allow for a relative degree of difference between them. Since there is no fixed distance between the responses, the mean, median, and standard deviation for this data are meaningless (Stevens, 1946; Sauro, n.d.).

This satisfaction has been divided into several sections, from installation and commissioning to ease of using the BESS and general comments on the BESS.

Table 1: Likert Scale used for evaluating customer's satisfaction feedback

Description	Scale
Strongly Disagree	1
Disagree	2
Neither agree nor disagree	3
Agree	4
Strongly Agree	5

3.4.3.1. Installation and Commissioning

The installation process and the time it takes to complete it plays a significant role in the quality of the BESS and meeting customers' expectations. The installation often includes permitting, getting drawing approvals, positioning, and adequate siting of the BESS to meet safety, space constraints, and human resources availability. The customers were asked to comment and grade the installation process and time on a Likert scale.

3.4.3.2. Cost Effectiveness

Customers invest time and financial resources in requesting and installing BESS in their facility. At the point of installation, the providers often promise lots of returns and cost savings or revenue increases from the installation of the BESS. This metric measured customers' satisfaction with the price, financing, and return on investment from their BESS. This metric was on a Likert scale.

3.4.3.3. Operation and Maintenance

After the installation and initial running of a BESS, it often requires maintenance, and the pace is mutually determined by the provider and owner of the BESS or only the provider. Some factors that may drive the feedback for this metric are the cost of maintenance, the frequency of the planned and unplanned maintenance, and how disruptive the maintenance is to the operations of the facility where the BESS is installed. Another feedback that would drive this is the reliability of the BESS and BESS downtime per year. For this survey, customers were informed to exclude Public Safety Power Shutoff (PSPS) events from the data reported. This metric is on a Likert scale as described above, and customers gave comments to back up the feedback.

3.4.3.4. System Integration

Integrating BESS with existing power systems in a facility and modularity is important because BESS are not stand-alone systems but complement the full functionality of the electrical systems of a facility. This metric measured customers satisfaction with integrating BESS with other electrical appliances and the communication protocols of their facility. This metric is on a Likert scale.

3.4.3.5. Remote Access and Reporting (Communication)

Accessibility of data, information, and updates on a BESS are vital in the quickly changing technological environment. This metric requested BESS customers to give feedback on how they monitor their BESS remotely and the quality and quantity of data they can access. In addition to accessibility, the mode of accessing data and the usability of the mode of the system monitoring. This metric also requested details of reports received from BESS providers and the frequency of the updates. The reports are essential because of post-installation feedback on the use of the BESS, comparison of pre-installation and post-installation benefits, and providing best practices that may help a particular installation. This metric requested all the modes customers use in monitor their system. Customers also commented on exceptions and additional information on monitored data.

3.4.3.6. Systems Aesthetics and Siting

Depending on the facility where a BESS is used, the siting may be indoor, outdoor, wall mount, or in a shipping container. This metric allowed providers of BESS to give the options available for C&I customers and gives customers the opportunity to give feedback on the BESS positioning to meet their specific site requirements and design.

3.4.3.7. Performance Data

Based on the requirements of SGIP, all C&I customers are mandated to report the monthly performance data of their BESS. This performance data management is done by the Performance Data Provider (PDP), and the system owner is mandated to keep a contract with the PDP for at least five years. This study reviews the quality of data provided by the PDPs and will calculate Round Trip Efficiency (RTE), unit downtime, and actual revenue optimization based on the performance data provided by users of BESS.

3.4.3.8. Resiliency Features

Resilience is the ability of a system to quickly recover from an extreme event or unexpected occurrences such as PSPS events and storm watches. This metric asked the resiliency features of the products in the California market, and it mainly measures how the BESS anticipates these events based on data supplied by providers or weather information. The providers of the BESS gave the response to this feature.

3.4.3.9. Safety Features, Industry Certifications and Protocols

Given the sensitive nature of batteries and the potential hazards of having batteries installed in various facilities across the state, this study evaluated the customer satisfaction with safety certifications and safety protocols followed by the different BESS providers. This metric requested from the providers for the safety certifications and protocols their BESS products have. To compile the list of standards included in the survey, safety certifications protecting the BESS from hazards like thermal runaway, stranded energy, and inflammation from toxic gases were considered.

3.4.4. System Usability Scale (SUS)

The system usability scale (SUS) is a simple, ten-item Likert scale used in industrial engineering to give a global view of subjective usability assessments. John Brooke developed the SUS in 1986, and it has been accepted as a way of measuring the usability of systems. ISO standard ISO 9241 Part 11 defines that the usability of a system can be measured only by considering the context of system use. The usability measurement in SUS is divided into effectiveness, efficiency, and satisfaction (Brooke, 1996).

3.5. Summary of Feedback from the Survey

The survey was conducted using Qualtrics for selected customers and providers of BESS in December 2021. The selected customers were C&I that submitted SGIP tickets between 2017 and August 2021. The sample size was later increased to include customers who submitted tickets between August 2021 till May 2022.

3.5.1. Customer Survey

Table 2 below shows a breakdown of the number of responses received from customers for the survey. The survey lasted from December 2021 to June 2022. Emails were sent to survey participants, and a $50 incentive was given to all participants that provided feedback except those who opted out of receiving the incentive. As a follow-up to the emails, phone calls were placed to some of the offices to encourage participation in the survey. As of June 2022, 95 customers had opened and partially or fully completed the survey.

Of the 95, only 33 completed the survey and had fully installed, functional, and live BESS. Most of the remaining 62 participants had the BESS installed but not live or were still in the process of getting the BESS interconnected. For the quality of the response, the study ensured that only customers with live BESS were considered in the final cut.

The 33 feedbacks considered in this result section apply to 91 stand-alone installations that these customers have in different locations across California. Some of the C&I sectors these customers are from include senior living homes, food companies, high schools, water districts, movie theaters, construction companies, community health centers, plastic molding companies, city centers, concrete making companies, etc. A summary of the evaluation metrics as well as the survey questions has been included in Appendix A.

Table 2: Breakdown of Respondents of the Customer Survey

Description	Count
Total Number of Survey Sent	439
Total Number of Partially Filled Responses	95
Total Number of Fully Filled Responses	34
Total Number of Respondents With Installed and Live ESS	33
Total Number of Stand-Alone BESS	91

3.5.2. Provider Survey

The top ten providers of BESS in the California market based on the SGIP database were contacted for their feedback on their offerings in the market. A survey as seen in Appendix B was sent to the providers and six filled the survey. One of the providers declined to respond and three neither filled nor declined to respond. Table 3 below shows a breakdown of the number of responses received from providers.

Table 3: Breakdown of Respondents of the Provider Survey

Description	Count
Total Number of Providers Contacted	10
Total Number of Fully Filled Responses	6
Total Number of Providers That Declined to Participate	1
Total Number of Providers That Did Not Respond	3

4. Results and Discussion

The sections below summarize the feedback received from customers and providers of BESS. Each section has the result from the survey and a discussion of the implication of the result and how it relates to literature.

4.1. Operating Modes of the BESS

The evaluation metric requested for the operation modes of the BESS used by the customers and the purpose for which the customers got the BESS. As seen in the literature review, demand charge management is the most common use of BESS for C&I customers and was followed by ToU arbitrage and Backup power. The feedback obtained, as seen in Figure 22 shows that 85% of all C&I customers used their BESS for Demand charge management, and 39% used it for ToU arbitrage and backup power, respectively. Two customers used their BESS to smooth out power interruptions and frequency regulation, respectively. This survey feedback shows that most C&I customers align with SGIP's goal of reducing the expenses on electricity.

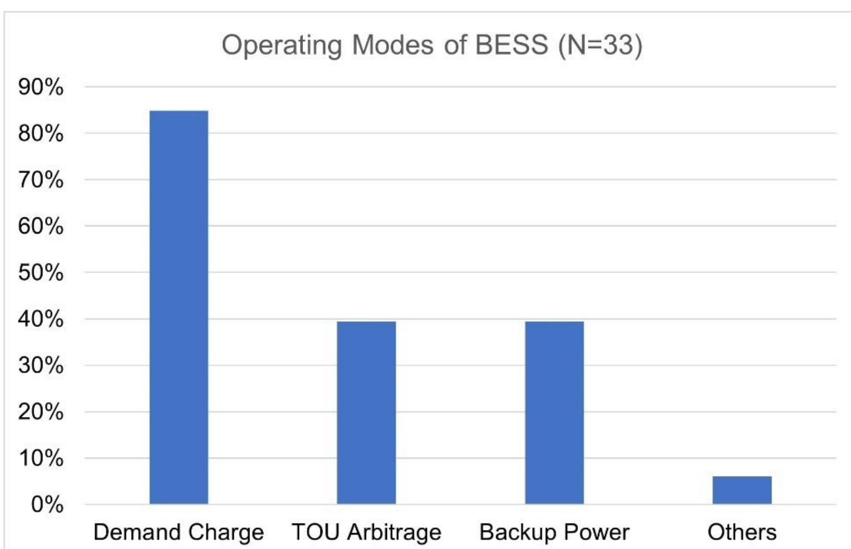

Figure 22: Operating Modes of BESS for C&I Customers in California Based on Survey Feedback

4.1.1. Discussion

The result shows that demand charge management is the most important benefit of the customers. This result buttresses the point by Shuai and Raufer (2021) that C&I customers can effectively manage peak loads and reduce demand charges by using BESS. Since California has the highest demand charges in the United States, the customers with these installations are getting the benefit of reduced energy bills. 39% of the survey respondents also use their BESS for ToU arbitrage and backup power; since ToU tariffs are in place in California, these customers further reduce their electricity bills by using their BESS during peak periods. Even though SGIP does not support BESS used exclusively for backup power, some customers use their BESS for backup power which helps prevent unplanned shutdown of their facility during Public Safety Power Shutoff (PSPS) events. Surprisingly, only one customer uses their BESS for frequency regulation, and this may be a result of the quality of the frequency of the electricity delivered by the electric utility companies since the California Independent System Operator (CAISO) ensures the frequency is always regulated and has made provision for discrepancies that may occur suddenly (CAISO, 2022)

4.2. Benefits of Energy Storage Systems

The metric evaluated the benefits customers have gotten since the installation of the BESS or a comparison of the benefits the BESS providers promised the C&I customers during the proposal phase of the project and the actual benefits after the system is operational. Based on the feedback and as seen in Figure 23, 85% responded that the financial benefits from installing the BESS were reported by the providers, which aligns with SGIP objectives. 33% of the respondents also confirmed the environmental benefit from installing the BESS were reported, while 12% mentioned that the benefits reported to them were primarily linked to reliability, resilience, using multiple operating parameters, and battery utilization.

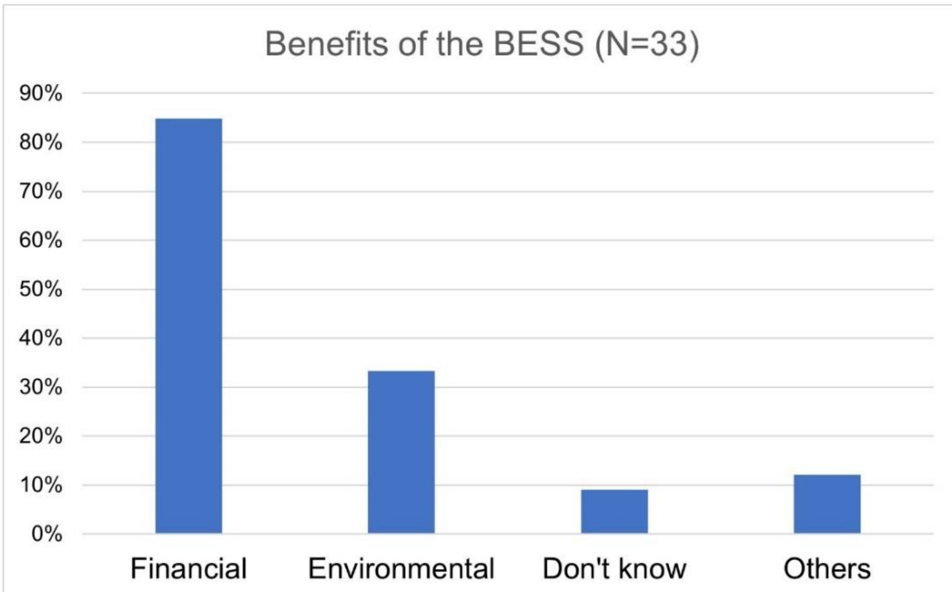

Figure 23: Benefits of BESS for C&I Customers in California Based on Survey Feedback

Customers were asked about the other benefits that BESS providers offered at the proposal stage and how frequently those benefits were reported. Some of the financial benefits were that the providers sent invoices to customers on the monthly and yearly energy savings from their BESS; a particular provider also provides the demand charge saving in $/kWh by comparing the facility's energy bill with and without the BESS. More than half of the respondents also mentioned that they have access to a website or dashboard or received monthly/quarterly email reports where they can see the benefits of installing the BESS.

In spite of the positive feedback from most respondents, one customer complained about their disappointment in the energy savings. Below is the comment from the customer; it is slightly paraphrased to remove the sector of the customer:

"We have been underwhelmed by the financial benefits of our energy storage system. The 2MWh system saves [this facility] only about $10,000 per year".

15% of the customers also mentioned that GHG emission reduction from their BESS was also reported on an annual or semi-annual basis and this has helped track emissions and for environmental, social, and corporate governance (ESG) data reporting.

4.2.1. Discussion

Customers provided the benefits reported by the providers of their BESS, and the survey gave the options of financial, environmental, and a text box to mention other benefits besides these two. BESS generally provides benefits to customers; however, reporting the benefits to customers is the responsibility of the providers.

Most respondents got a report of the financial returns from installing their BESS; the savings were directly from electricity bills through demand charge management. One of the research plans was to calculate the actual annual revenue or cost avoided compared to the maximum potential revenue/cost avoided. However, insufficient data from BESS customers hindered this plan. Calculating actual revenue is an area other researchers can explore to ascertain the gains of the BESS customers.

33% of the customers agreed that environmental benefits were reported from greenhouse gas savings due to a reduction in non-renewable electricity sources often used for peak demand.

Fisher and Apt (2007) noted that SGIP mandated that incentivized technology should have a net emission rate lower than the grid. This research could not ascertain if the net emission from these installations is lower than that of the grid. However, the emission reduction targets set for SGIP were not met according to the SGIP impact report published in 2020 (SGIP, 2020). Though energy storage technologies do not directly produce emissions during operation, the results presented in Hittinger and Azevedo (2015) shows that net CO_2 emissions from energy storage are small compared to emissions from electricity generation. Further study is needed to know the exact emission reduction from the incentive program.

4.3. Product Setup/Installation

The metric seeks to measure how satisfied the customer was with setting up the BESS, permitting, installation, and commissioning. Several questions on the satisfaction level of the customer on the ease of scheduling the installation, the pace of the provider in starting and finishing the installation, the ease of using the BESS with other electrical systems in the customer's facility, and also the interconnection with the grid when required, the time it took for the permit to be received and the ability of the providers to take charge of connecting the BESS to the customer's facility.

The customer feedback, as seen in Figure 24, shows that 61% were satisfied with scheduling the BESS installation and the speed of the installation process; however, 21% were indifferent, and the last 18% were unsatisfied. Customers were primarily indifferent to the ease of integrating the BESS with onsite electrical systems and getting the permit for the BESS.

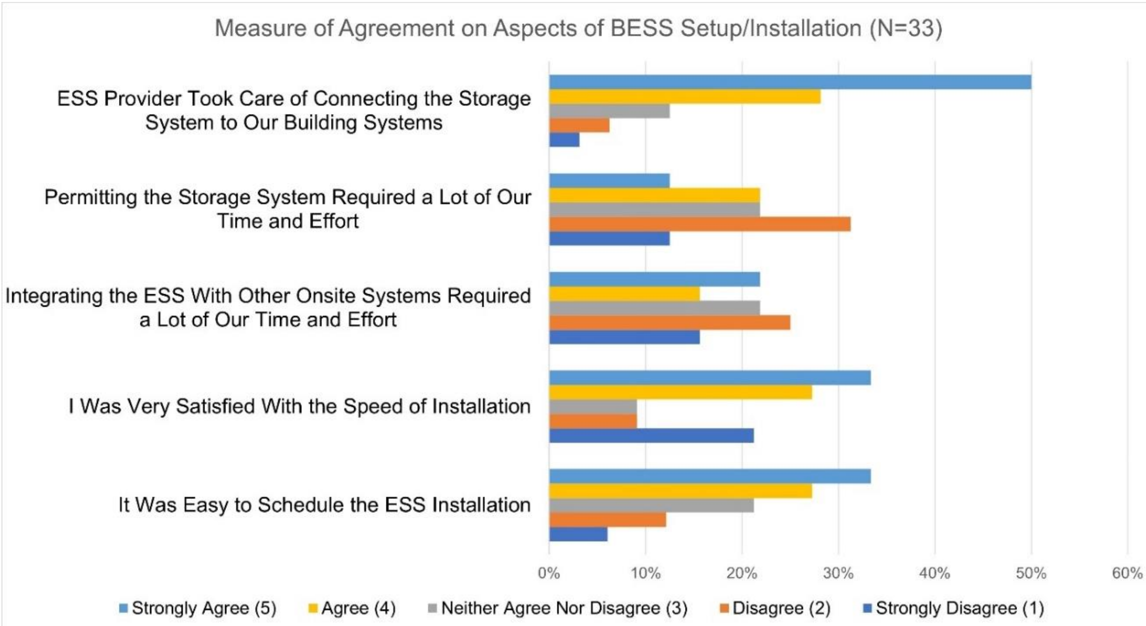

Figure 24: Measure of Agreement on Aspects of BESS Setup/Installation Based on Customer's Feedback

Some customers had neutral feedback on the installations, and only two had positive feedback on their experience. A significant number of the customers were not satisfied with the installation process and gave comments such as the below:

"Coordination with the utility agency was challenging. Interconnect agreement and reviews took longer than anticipated",

"The installation took way too long, with very little communication. Terrible",

" Very slow. Years behind schedule on install and commissioning. Still is not performing as advertised years later",

"The installation took 3 years after contract signed"

These comments show the providers of the BESS need to improve on the services offered to customers and provide a better user experience for BESS users.

4.3.1. Discussion

Besides the financial benefits, most customers were, on average, satisfied with their BESS but some had negative comments on the installations process. This average result may have been because of the COVID-19 pandemic because some installation engineers could not attend the sites during the lockdown. The overall feedback suggests that providers need improvement on the installation process because an excellent satisfaction would have given a one-sided result from all customers. This study did not factor the influence of COVID-19 pandemic on availability of personnel to carry out installation of BESS.

The study asked for the frequency of reporting benefits to the customers. Most customers responded that providers reported financial benefits one way or the other through anticipated annual energy savings, quarterly and monthly reports, frequent emails, a live dashboard, and a website in some cases. The providers seem to have adequately communicated the financial benefits to their customers because 67% of respondents were satisfied with the reports generated by the BESS. Furthermore, environmental benefits were recorded, which helps customers calculate their annual GHG reduction from their BESS, which helps them in reporting their ESG investments. The reportage of environmental benefits from the BESS helps C&I customers approximate their GHG emissions reduction from using the BESS. Although more details were not asked on how all the customers use this data, it is good for the data to be accessible.

4.4. Product/System Use and Performance

4.4.1. Remote access and reporting (communication)

The ease of accessibility of data was requested, and 82% of the customers confirmed they could remotely access the data of their BESS. The modes of accessing these data include phone applications, desktop applications, websites, and direct network connections. Figure 25 shows that most customers could access their data through the website or desktop application provided by the providers of the BESS, and Figure 26 gives detailed feedback on the specific technologies available to the customers. Figure 27 shows that most customers are comfortable and satisfied with the modes of accessing the data and found it easy to navigate the website, computer desktop application, and phone application provided. The only customer that uses a direct network connection for accessing data is also satisfied with the means of accessing BESS information.

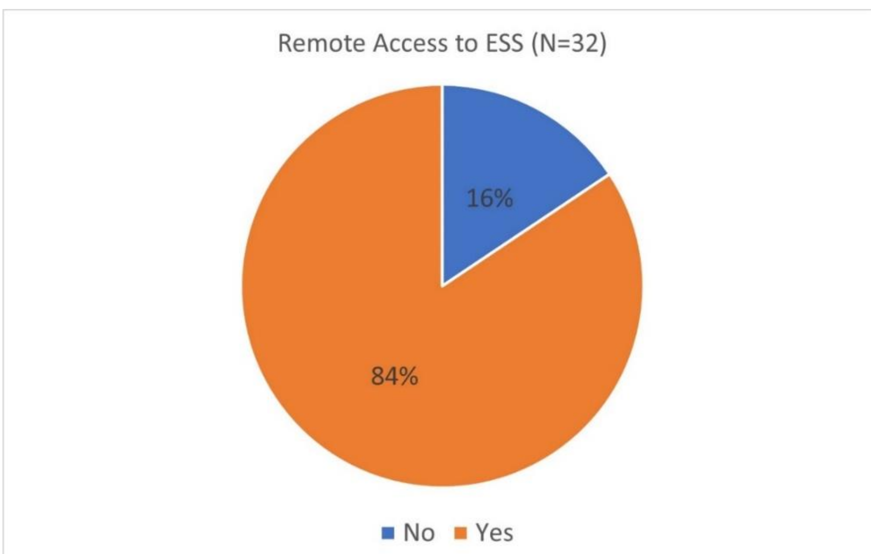

Figure 25: Remote Access to BESS for C&I Customers

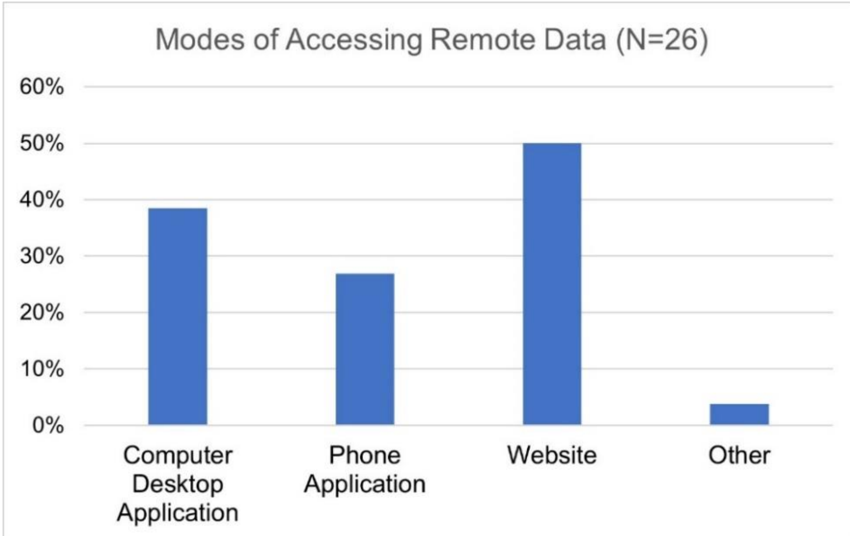

Figure 26: Modes of Accessing Remote Data of BESS

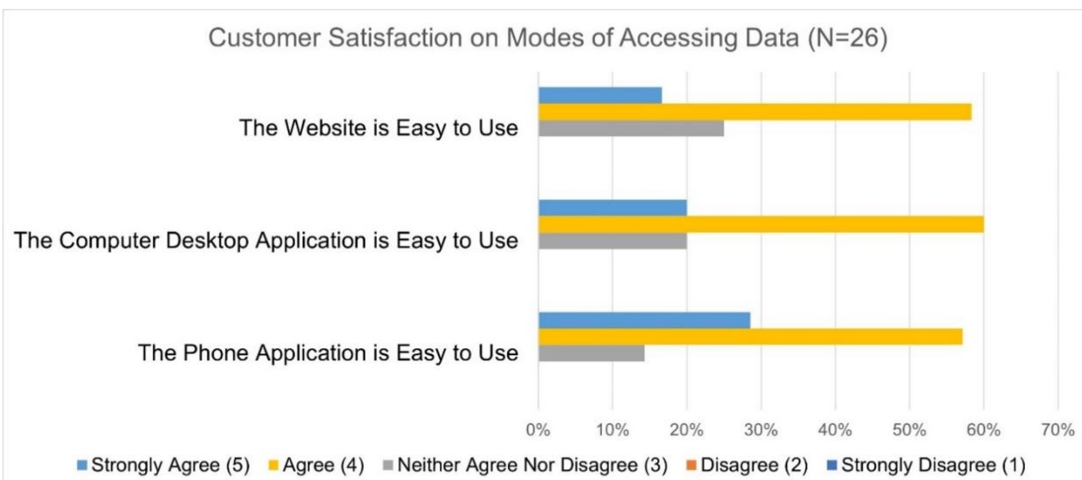

Figure 27: Customer Satisfaction on Modes of Accessing Remote Data of BESS

4.4.1.1. Discussion

The first subsection was the accessibility of data and reporting updates from the BESS and the BESS providers. 85% of respondents said they could remotely access the data from their BESS. The data preview modes included a website, computer applications, and phone applications. Some customers access information from more than one of the sources, and this gives the customer flexibility on the most appropriate mode suited for their facility or team. The most common mode of viewing data was from a website, and this shows that BESS providers integrated communication protocols that allow for remote monitoring of BESS for the providers and users. 22% of the respondents showed no interest in remotely monitoring their data but did not give a response on their reason. SGIP requires all users of projects larger than 30 kW to install performance meters to determine the net energy generated by their generation equipment. Customers without data access may have opted out because they are not compelled to report the data and may have systems with a rated capacity lesser than 30kW.

The second subsection was a Likert chart on the modes of accessing remote data from the BESS. The results from the section show that customers were pleased with the different options for accessing remote data that providers gave them. Twelve of the respondents monitored their data from websites, and nine were satisfied with the ease of navigating and extracting data from the website. Seven respondents used phone applications for monitoring, and six agreed to the ease of using the application for monitoring; the last user was indifferent. Of the users with computer applications, 80% were satisfied with the ease of using and accessing data.

4.4.2. Data Accessible Remotely

The data accessible remotely helps customers keep track of the progress made with their load profile and how beneficial the BESS is. The customers ticked boxes of the data that can be accessed from the website and desktop applications of the providers. Figure 28 shows that 85% of respondents can access current building (net) load data, and 65% can access the BESS operating mode, which gives customers information about their savings. 21% of the respondents chose not to give feedback on this question; this may be due to limited knowledge of the data they access remotely or the usefulness of the data to their organization's decision-making process.

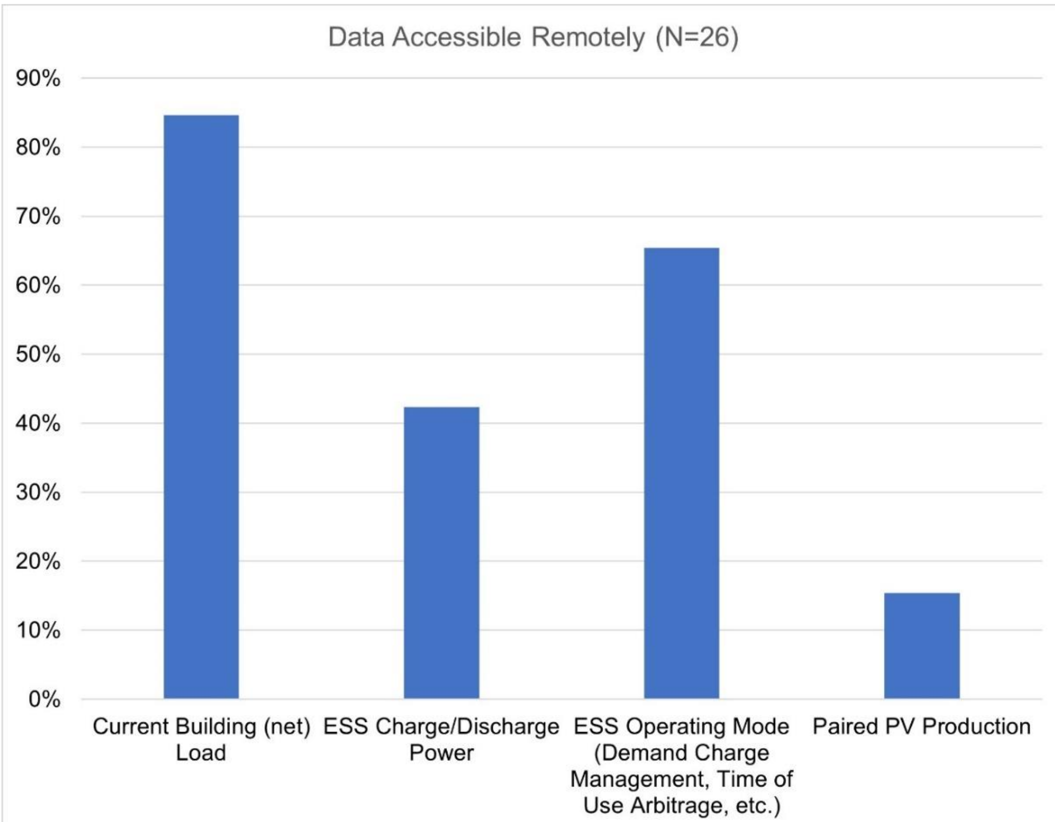

Figure 28: Data Accessible Remotely for BESS

4.4.2.1. Discussion

This section of product use is the type of data accessible and the quality of the data provided. Customers prioritized the different data based on the motive for getting the BESS. 85% of the customers were interested in viewing their facility's current (net) load data; this is not surprising because tracking this data helps them know the direct savings from the BESS. 65% of the customers monitor BESS operating mode remotely; this helps users to make quick changes if need be. 42% of the customers can access the BESS charge and discharge data remotely. The flexibility of choosing the data accessible to the customer would help customers make better choices. This flexibility makes it easier for customers to track energy savings, financial benefits, and returns on investment.

4.4.3. Customer Satisfaction on Product Use/Performance

Figure 29 shows customers' responses to their satisfaction with the BESS performance. 75% of the customers feel the BESS operates well and 76% of the survey respondents agreed that their BESS had not experienced performance issues since being installed. 65% of the survey respondents attested to the reliability of their BESS, and 63% felt they got a good financial return on investment on their BESS. An average of 60% of the customers are fully satisfied with the BESS installed in their facility. However, a caveat from some of the customers is that the system has not served enough time to give more concrete comments. The caveat applies mostly to customers that have been running their BESS for less than a year.

Some customers also had comments and complaints about the performance of their BESS. One of them is linked to the fact that for new facilities, SGIP stipulates that the estimated energy/electricity consumption of a facility should be used to set up the BESS of the building, and this may have led to an underestimation of the energy use for that installation. Below are the comments:

"There was (and is) a problem getting the correct rate schedule in order to maximize our return. *the system has been in for over a year and a half and I am hoping to have the right rate within a month."*

"When designing the system, actual operations plans for the facility were not used. Historical utility usage data was the only information used, resulting in an inaccurate system. Therefore, it is not functioning as planned and we are not realizing the savings anticipated."

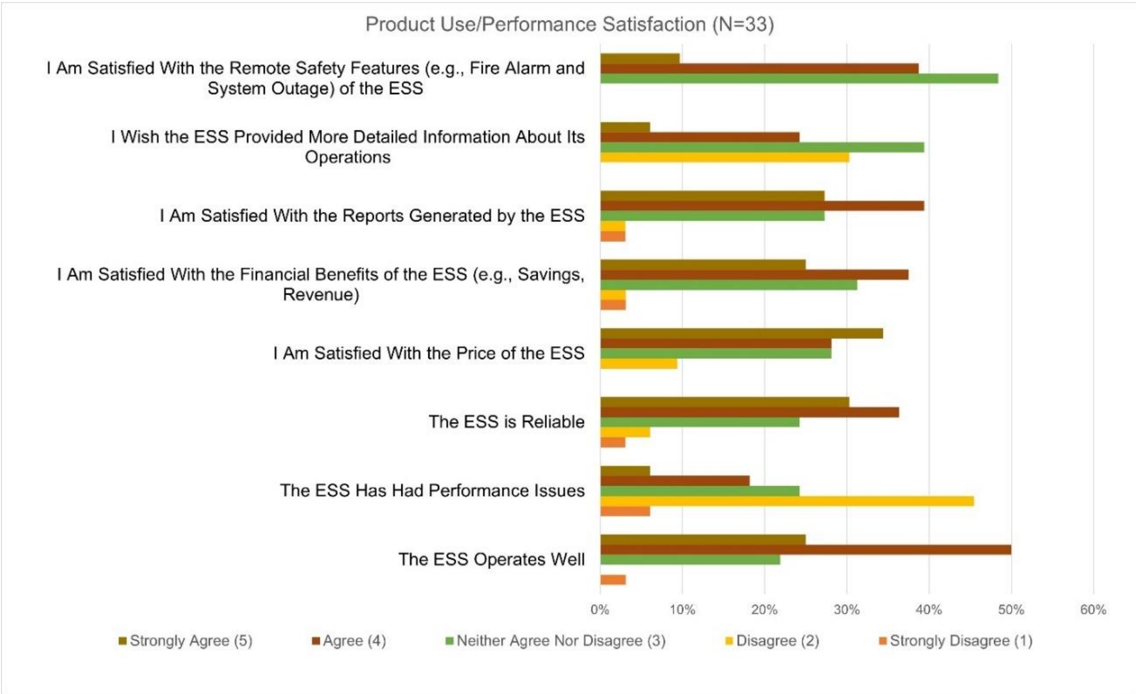

Figure 29: Product Use/Performance Satisfaction of BESS Customers

Overall usability of the BESS based on the SUS is seen in Figure 30. Most respondents found the BESS easy to use and did not require any training to operate the systems. 50% of the respondents were satisfied with the bit of complexity in operating the BESS, needed no external technical support to use the system, and felt the BESS components were well integrated to perform on all its modes. This feedback shows that most users are satisfied with their BESS performance. The discussion section provides a detailed explanation of the feedback based on SUS.

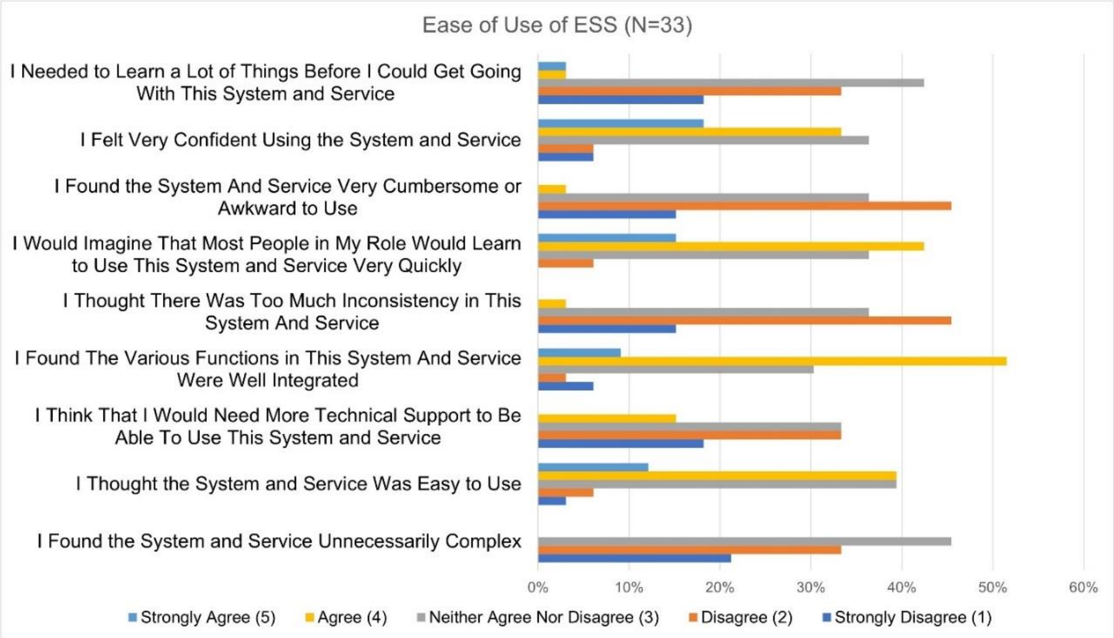

Figure 30: Ease of Use of BESS

4.4.3.1. Discussion

The feedback on the performance of the BESS was provided using the Likert scale. 75% of the respondents agreed to a flawless operation of their BESS, and 22% were indifferent. The result shows there is general satisfaction with the operations of the BESS. When asked about performance issues, 24% of the respondents agreed to have performance issues with their BESS, and this may be because of system design. A customer complained about the provider using their historical utility usage data to design their BESS. However, the calculation was inaccurate and resulted in the BESS not performing optimally. According to SGIP guidelines, historical data can be assumed for new installations; however, there should be more accurate calculations to account for unplanned loads.

63% of the respondents agreed to being satisfied with the financial benefits of their BESS; however, a customer complained of not being able to maximize their savings because of the unavailability of the correct rate schedule for more than 18 months. This experience shows there may be a disconnect among all the stakeholders contributing to effectively getting the best out of each installation. These stakeholders include the battery manufacturers, integrators, installers, consultants, site engineers and project managers. For example, an installation with a different manufacturer than the provider malfunctioned due to misinformation between both companies. For BESS to function optimally, there needs to be smooth communication among all the stakeholders mentioned above starting with the utility companies to the providers, installers, and users of a BESS.

Customers were asked about their satisfaction with the BESS based on the system usability scale. After calculating the feedback from the 33 customers that responded, the SUS for these BESS is 70. Usability does not exist in an absolute sense, but this scale measures a system's effectiveness, efficiency, and satisfaction by asking ten questions. This metric would have calculated the individual usability of different providers of BESS, but that is beyond the scope of this study. Since the questions of the SUS cover various aspects of systems usability, including the need for support, training, and complexity, it is a justifiable approach to measuring usability. Based on Bangor et al. (2008) interpretation of the SUS, a score of 70 shows that BESSs are acceptable for C&I users in the California market.

4.4.4. Product Maintenance

Beyond the installation of a BESS, weekly, monthly, quarterly, and annual maintenance is often required for BESSs to ensure they are running smoothly. This maintenance also helps to detect faults and decrease the possibility of unplanned downtime. Customers were asked who maintains their BESS and the maintenance frequency. As seen in Figure 31, 67% of the BESS by the respondents were maintained by an external service provider, which is usually the provider of the BESS itself. 27% of the BESS were maintained by a combination of the customer's engineers and the service providers, and only 6% of the respondents entirely maintained their BESS. The result shows that BESS providers are still actively involved during the entire life cycle of their products, even after the total deployment to the customer's facility

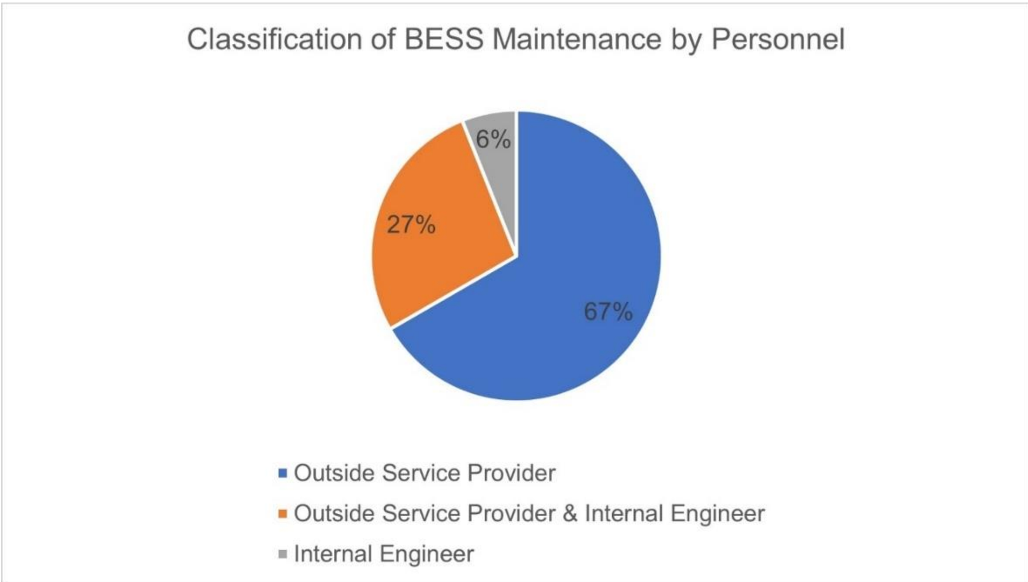

Figure 31: Maintenance of BESS

The customers were also asked to give details on the frequency of the maintenance activities on their BESS and their satisfaction with the maintenance services provided by the BESS providers. Figure 32 shows the distribution of how often maintenance of the BESS was performed. More than 50% of the customers said they never maintained or did not know about the maintenance of their BESS; this may be because the BESS is still new and may not have reached a certain number of operating hours before needing maintenance.

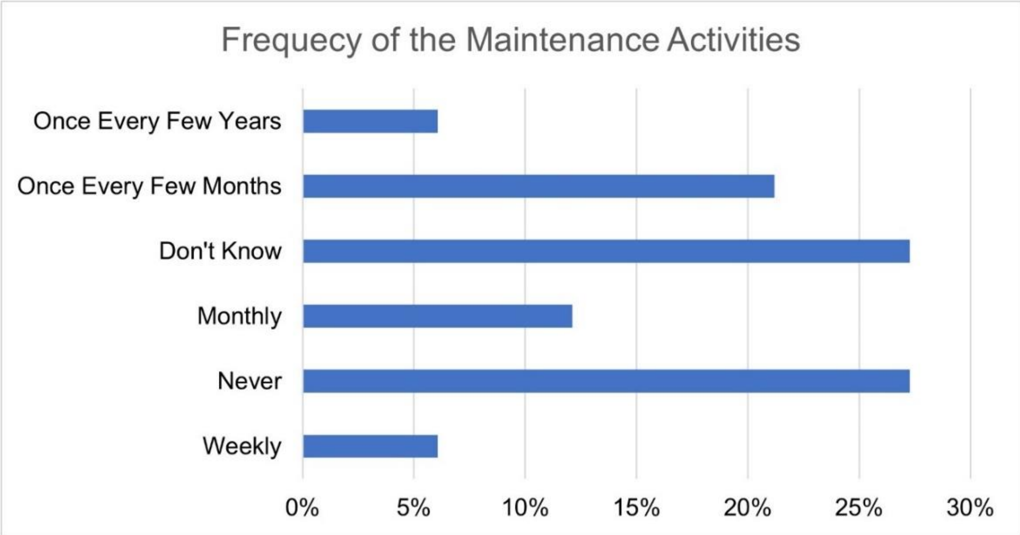

Figure 32: Frequency of Maintenance Activities of BESS

The customers were asked to give feedback on their satisfaction with the maintenance activities of the BESS; the feedback was divided into the customer who outsources the maintenance activities to the providers and those resident engineers/personnel who maintain the BESS. Figure 33 shows customer satisfaction with the maintenance activities carried out by the providers of the BESS, and more than 50% of the customers agreed that it is easy to find a service provider to do the maintenance activity. 60% of the customers are satisfied with the frequency of the maintenance, and 30% are indifferent about the frequency. 46% of the customers are satisfied with the cost of the maintenance activities, and 43% are indifferent on the cost.

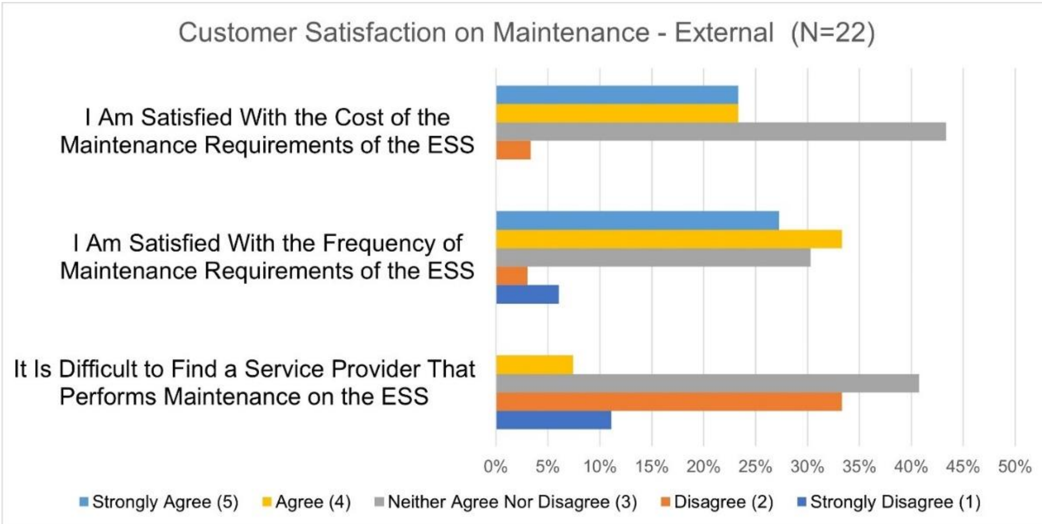

Figure 33: Customer Satisfaction on Maintenance Activities of BESS by External Service Providers

For an installation where the customer and external providers do the maintenance, 60% of customers mentioned that special training is required to maintain the BESS, and this leads to extra expenses for the customers, as seen in Figure 34. These customers are generally satisfied because only 13% mentioned that special tools are required for the maintenance activities, and 73% are satisfied with the effort required from them for the maintenance activities.

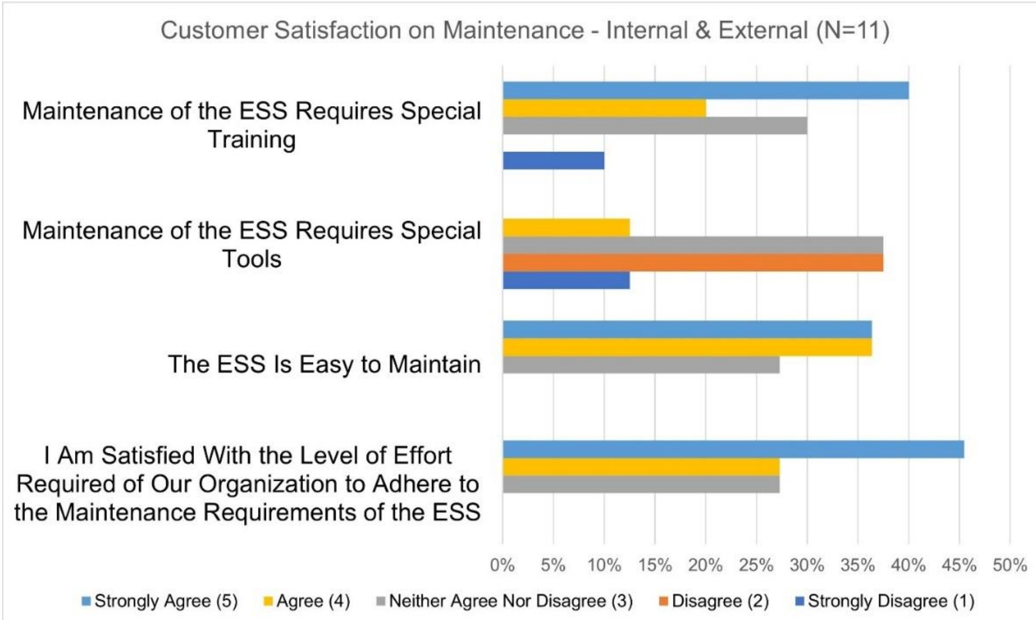

Figure 34: Customer Satisfaction on Maintenance Activities of BESS by External Service Providers and Customer's Personnel

Some of the customers also gave specific comments on the maintenance challenges they had and their experience with providers of the BESS. Below are some of the comments from customers:

"Just in the beginning stages. Also we contracted with [the provider] to maintain the system and performance."

"We just started operating these batteries so we will know more in the future."

"Maintenance covered by [provider] for 10 years, then it is on us"

"I believe that the system is extremely good and efficient and will satisfy my ROI"

"[The provider] is responsible for maintenance, but the frequency and interruptions to our facility is aggravating."

The customers whose BESS were installed in the last year had limited comments, and these comments indicate that more BESS users may have more positive or negative comments to give after a long period has passed from the initial installation of their BESS.

4.4.4.1. Discussion

Regular and timely maintenance of electrical and mechanical appliances often increases their longevity. It also helps to detect faults on time and quickly make corrections before a breakdown leads to downtime. Routine maintenance also applies to BESS; customers gave feedback about the maintenance of their systems. 67% of the respondents relied on external service providers for their maintenance activities, while 27% depended on a mix of external service providers and in-house engineers. Customers were satisfied with the maintenance of their BESS and the frequency of this maintenance. Timely maintenance would likely help early detection of faults and the ability to replace faulty parts since the provider that installed a product also maintains it during its lifetime. Customers were also satisfied with the steps they took to maintain the BESS. The customer that used their engineers for maintenance needed special training to do maintenance activities adequately. Some customers commented that their provider offered to cover maintenance for ten years and will subsequently pass on the responsibility. However, the fact that a provider helps with the maintenance did not stop a customer from complaining of increased maintenance activities and interruptions in their facility.

4.5. General Satisfaction of Customers with BESS

The customers were asked about their overall satisfaction with BESS installed in their facility. This overall satisfaction is cumulative of all the factors from cost savings to ease of use, to the promptness of installations, communication with the providers, and the seamless process of acquiring the BESS. Figure 35 highlights that 73% of the respondents were satisfied with their BESS, and 67% confirmed that they would buy from the same provider if they had the opportunity to purchase another BESS. 9% of the respondent were indifferent about their satisfaction and 15% were also indifferent on using the same provider if the opportunity presents itself. 18% of respondents were unsatisfied with their BESS and would not consider the provider, which can be linked to one of the comments below from a customer. The comment has been slightly modified to exclude the name of the provider of this BESS.

"The provider's product may be excellent, but their construction team (actual provider's staff) were challenging to work with. They seem disorganized, overworked, and relatively uninterested in general project management fundamentals. [The provider] has an air of we're a global name, meaning that they don't follow traditional local government protocol, and often ask for forgiveness rather than permission. [The provider] did a great job in hiring local subcontractors for the projects. They handled the SGIP extremely well. "

"When we need them to address a non-critical problem it takes them a long time to come on site and fix things."

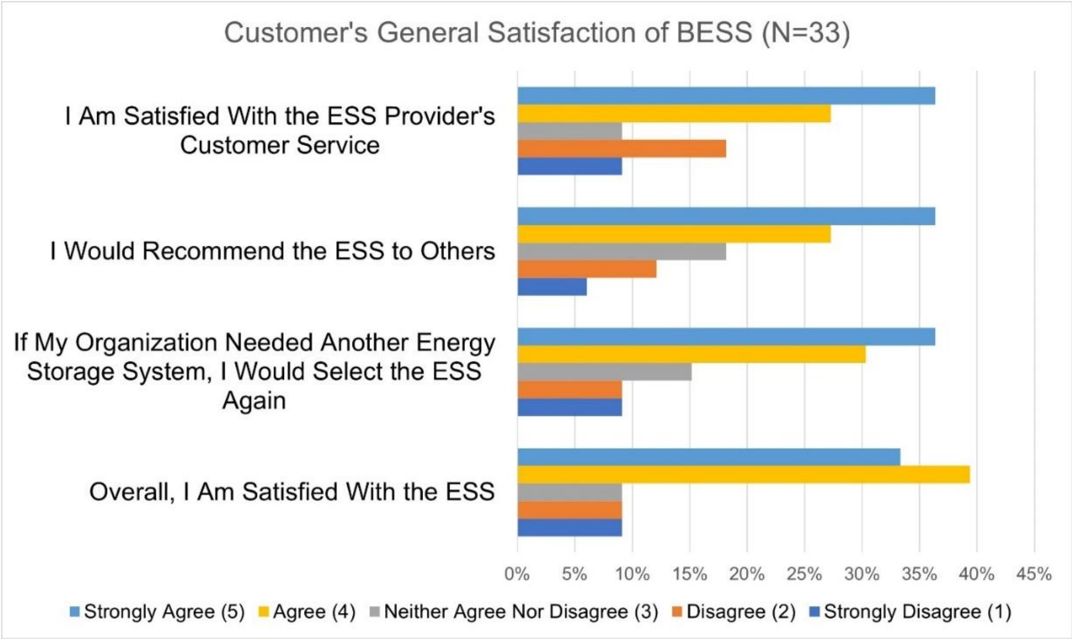

Figure 35: Overall Customer Satisfaction with BESS

Figure 35 also shows the feedback received on recommending the provider to other potential customers of BESS. 64% of respondents confirmed that they would recommend the provider to other people and are satisfied with the customer service experience with the provider. 18% of the respondents will not recommend the BESS to other users, and 27% were unsatisfied with their providers' customer service experience.

4.5.1. Discussion

An all-inclusive satisfaction of the BESS and services delivered by the providers was gotten, and the feedback was largely positive. This overall satisfaction is cumulative of all the factors, from cost savings to ease of use to the promptness of installations, communication with the providers, and the straightforward process of acquiring the BESS. 73% of the customers were satisfied with their BESS; this score bolsters the SUS score of 70. Since BESS is a relatively new technology and policies were adjusted to drive BESS adoption growth, we may have a better result in the coming years. This study only focuses on C&I customers, so residential customers may have more positive or negative feedback on adopting the technology.

A customer commented about how great the product from a provider was but was disappointed in the staff because of how disorganized they were. Another customer complained about the turnaround time for the provider's engineers to fix problems associated with the BESS. Despite the feedback, customers were still interested in recommending their BESS provider to others and will also get a repeat order if need be. Summarily, customers are satisfied with the BESS providers from the feedback.

4.6. Provider's Feedback

The top ten providers of BESS in the California market based on the SGIP database were contacted for their feedback on the offerings in the market. A survey as seen in Appendix B was sent to them and only 6 of 10 filled the survey. One of the providers declined to respond and three neither filled nor declined to respond. The summary of the feedback from the six respondents are as below:

4.6.1. Grid Service Capabilities

All providers that responded to their BESS can be used for demand charge management, ToU arbitrage, and backup power. Five confirmed that BESS could be used for utility demand response programs, and three can be used for frequency regulation and resource adequacy. The additional capabilities providers mentioned were microgrid and signing a custom contract with some electric investor-owned utilities and Community Choice Aggregators.

4.6.2. Performance Benefits

All providers confirmed reporting financial benefits to their customers. However, only four confirmed reporting environmental benefits.

4.6.3. Systems Aesthetics and Siting

The feedback shows that providers are flexible on the siting of their technology. All the providers confirmed that their BESS could be used both indoors and outdoor. One confirmed offering wall-mounted solutions to their customers. All providers also confirmed that their BESS is equipped for future augmentation. There is an anticipation of customer load increasing, and the support provided is usually tailored to the customer's request.

4.6.4. Resiliency Features

Feedback from five providers confirmed the availability of resiliency features in their ESS. All five provide advanced services such as the BESS using solar for recharging during a grid outage, integration of a generator to the BESS, and dynamic load shedding. The BESS offering of four providers has PSPS event anticipation. In addition, all providers confirmed the availability of fire, theft, and system outage alarm systems on their BESS. In the event of such an occurrence, notification is sent to providers and customers through emails and phone calls.

4.6.5. Industry Certifications and Safety Features

All providers had the certification required for BESS in the market. These certifications include the UL 9540, NFPA 855, UL 9540A, UL 1973, UL 1741 SA and others. Providers are compliant with industry-recommended standards for BESS.

4.6.6. Discussion

When the provider's feedback is compared to the responses from customers, it can be inferred that most customers are making the best use of the services provided by the providers of the BESS. However, it was also noted that some customers might not be maximizing the benefits reported by the providers. The provider's feedback also shows that most providers are technology agnostic and often purchase and operate battery systems, then tailor them to the use cases of the end users.

5. Conclusions and Future Work

The goal of this study was to evaluate the perception of C&I customers using BESS in their facilities. The study was centered on C&I customers in California who are SGIP beneficiaries between 2017 and 2022. The policy analysis shows how policies have helped the growth of the adoption of BESS in California and how this has resulted in reduced GHG emissions and electricity bills. Furthermore, the study sought to assess the incentive program of the CPUC and customers' satisfaction with the program. The study also evaluated top providers of BESS in the California market to identify the products, services, and technological improvements in their products and how it meets the needs of C&I customers.

The literature reviews show how energy storage already contributes to solving the challenges of the electricity grid. It reviewed the energy storage technologies available to meet intermittent renewable energy storage challenges. It also discusses components of a typical BESS and the trends in the adoption of BESS globally. The literature continues by discussing the stationary services of BESS for C&I customers and how these services benefit the users. The literature then discusses the behavior of early adopters of new technology in the renewable energy sector and other industries and what may motivate later adopters of the same technology in different locations.

The result determined that most customers are satisfied with the BESS installed in their facility and would recommend their provider to other users. Additionally, BESS sold in the California market capabilities meet and exceed safety standards for C&I use. Furthermore, customers are satisfied with the reportage of financial and environmental benefits of their ESS.

The SUS score for the BESS of the major providers was 70, which is acceptable based on the literature review. The result also shows that for customers with BESS whose battery manufacturer is different from the BESS provider, there needs to be a better synergy with all stakeholders from the utility companies to the providers, installers, and users of a BESS for better overall customer satisfaction.

This study is useful because it shows how the early adopters of BTM BESS for C&I services have maximized the technology. The study also shows how incentives can drive the adoption of new technology and gives other states or countries a template to follow in assessing similar policies.

The initial plan of the study was to access the performance data of the BESS of the major providers of BESS in the market. Then compare the competitive edge of one provider to another. However, the unavailability of performance data from customers with installed BESS, time constraints, and legal implications of that information limited this study. Future studies for other technologies in the renewable energy sector in different states and countries can hopefully refer to this study and use or adapt some of the methodologies to produce results specific to the early adopters of their technology or incentive program.

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Supplementary Information

Appendix A

Table A1 - Operating Modes of BESS

#	Mode	Count
1	Demand Charge Management (Peak Shaving)	28
2	Time of Use Arbitrage (Peak Shifting)	13
3	Backup Power	13
4	Others	2

Table A2 - Product Benefits

#	Benefit	Count
1	Financial	28
2	Environmental	11
3	Don't know / No benefits communicated	3
4	Other (please specify):	4

Table A3 - BESS setup/Installation

#	Field	Minimum	Maximum	Mode	Count
1	It was easy to schedule the BESS installation.	1	5	5	33
2	I was very satisfied with the speed of installation.	1	5	5	33
3	Integrating the BESS with other onsite systems required a lot of our time and effort.	1	5	2	32
4	Permitting the storage system required a lot of our time and effort.	1	5	2	32
5	BESS Provider took care of connecting the storage system to our building systems.	1	5	5	32

Table A4 - Modes of accessing remote data on BESS

#	Mode	Count
1	Computer desktop application	10
2	Phone application	7
3	Website	13
4	Other (please specify):	1
5	N/A	6

Table A5 - Customer Satisfaction on Modes of Accessing Data

#	Field	Minimum	Maximum	Mode	Count
1	The phone application is easy to use.	3	5	4	7
2	The computer desktop application is easy to use.	3	5	4	10
3	The website is easy to use.	3	5	4	12
4	The BESS is easy to use.	4	4		1

Table A6 - Data that can be accessed remotely

#	Data that can be accessed remotely	Count
1	Current building (net) load	22
2	BESS charge/discharge power	11
3	BESS operating mode (demand charge management, time of use arbitrage, etc.)	17
4	Paired PV production	4

Table A7 - Product use/performance satisfaction of BESS

#	Field	Minimum	Maximum	Mode	Count
1	The BESS operates well.	1	5	4	32
2	The BESS has had performance issues.	1	5	2	33
3	The BESS is reliable.	1	5	4	33
4	I am satisfied with the price of the BESS.	2	5	5	32
5	I am satisfied with the financial benefits of the BESS (e.g., savings, revenue).	1	5	4	32
6	I am satisfied with the reports generated by the BESS.	1	5	4	33
7	I wish the BESS provided more detailed information about its operations.	2	5	3	33
8	I am satisfied with the remote safety features (e.g., fire alarm and system outage) of the BESS.	3	5	3	30

Table A8 - Ease of use of BESS

#	Field	Minimum	Maximum	Mode	Count
1	I found the system and service unnecessarily complex.	1	3	3	33
2	I thought the system and service was easy to use.	1	5		33
3	I think that I would need more technical support to be able to use this system and service.	1	4		33
4	I found the various functions in this system and service were well integrated.	1	5	4	33
5	I thought there was too much inconsistency in this system and service.	1	4	2	33
6	I would imagine that most people in my role would learn to use this system and service very quickly.	2	5	4	33
7	I found the system and service very cumbersome or awkward to use.	1	4	2	33
8	I felt very confident using the system and service.	1	5	3	33
9	I needed to learn a lot of things before I could get going with this system and service.	1	5	3	33

Table A9 - Product Maintenance by who Administers it

#	Who is responsible for Maintenance	Count
1	Outside service provider	22
2	Both (a) and (b)	9
3	Someone in my organization	2

Table A10 - Frequency of Maintenance activities

#	Frequency of Maintenance	Count
1	Weekly	2
2	Never	9
3	Monthly	4
4	Don't know	9
5	Once every few months	7
6	Once every few years	2

Table A11 - Customer Satisfaction on Maintenance (1-3 is external and 4-7 is internal & external)

#	Field	Minimum	Maximum	Mode	Count
1	It is difficult to find a service provider that performs maintenance on the BESS	1	4	3	25
2	I am satisfied with the frequency of maintenance requirements of the BESS.	1	5	4	33
3	I am satisfied with the cost of the maintenance requirements of the BESS.	2	5	3	28
4	I am satisfied with the level of effort required of our organization to adhere to maintenance requirements of the BESS.	3	5	5	11
5	The BESS is easy to maintain.	3	5		11
6	Maintenance of the BESS requires special tools.	1	4		8
7	Maintenance of the BESS requires special training.	1	5	5	10

Table A12 - General satisfaction with BESS

#	Field	Minimum	Maximum	Mode	Count
1	Overall, I am satisfied with the BESS.	1	5	4	33
2	If my organization needed another energy storage system, I would select the BESS again.	1	5	5	33
3	I would recommend the BESS to others.	1	5	5	33
4	I am satisfied with the BESS provider's customer service.	1	5	5	33

Table A13 - Canceled SGIP tickets and reasons

Reason	Quantity
Voluntary withdrawal	3945
Missing documentation	2640
Failure to install BESS	28
Other	3961
Missing application Fee	119
Maximum generation limited exceeded	5
Missing insurance documents	5
Emission standards not met	65
Other incentives received	4
Future load not attainable	3
Load below or above historic data	7
No interconnection from electric utility	1
Lost interest	3
Used equipment	1
Missing renewable components	7
Due process not followed	6

Appendix B

Survey Questions

Providers/Manufacturers Survey

Part 1 - Screening

What is your role?
a. Product manager
b. Business development personnel
c. Marketing personnel
d. Other: _________

Name of Provider:
- ENGIE
- Tesla
- Forefront Power
- SunPower
- EDF Renewable Energy
- Stem
- Promise Energy
- Golden State Renewable Energy (GSRE)
- Enel X
- Swell Energy
- Other__________

For the remaining questions, we will use {Manufacturer's} energy storage system ("{Manufacturer's} BESS") to refer to the entire suite of technologies and services that {Manufacturer} provides, unless otherwise specified.

Part 2 - Grid services offered

1. Which grid service capabilities does the {{Manufacturer}'s BESS} provide? *Check all that apply.*
    a. Demand charge management
    b. Time-of-use (TOU) arbitrage
    c. Utility demand response programs
    d. Resource adequacy
    e. Backup power
    f. Other: ____________
    g. Don't know
2. *Display logic: If Q1 "utility demand response programs" is selected.* Please list the utility demand response programs {Manufacturer}'s BESS can participate in: _______________

3. *Display logic: If Q1 "resource adequacy" is selected.* To which California Load Serving Entities does the {Manufacturer}'s BESS provide Resource Adequacy? ____________

Part 3 - Financing solutions offered

4. Which financing or ownership structures does your company offer its customers? *Check all that apply*.
    a. Cash transactions
    b. Leasing
    c. Shared savings agreements
    d. Power purchase agreements
    e. Loan
    f. CPACE Loan
    g. Other: ___________
    h. None of the above.
    i. Don't know

Part 4 - Resiliency features

5. Which resiliency features are included with {Manufacturer}'s BESS?
    a. PSPS event anticipation
    b. Storm watch/anticipation
    c. Dynamic Load shedding
    d. Integration of Generator at a system level
    e. Operate solar for recharge during an outage
    f. Other: ______________
    g. No resiliency features are included.
    h. Don't know

Part 5 - Industry certifications and protocols

6. Which industry certifications and protocols does the {{Manufacturer}'s BESS} currently hold? *Please select all that apply*.

	Yes	Pending	No	N/A	Don't Know
NFPA 855					
EN 62477-1 (2012)					
UL 9540					
UL 9540A Testing					
UL 1973					
UL 1741 SA					
UL CRD - Import Only					
UL CRD - Export Only					

IEEE 2030.5					
Other: ________					

Part 6 - Modularity

7. Can {Manufacturer}'s BESS be expanded to accommodate more storage after initial installation? Y/N/DK

8. (If yes) What steps and equipment are required to expand the capacity (power and/or energy) of {Manufacturer}'s BESS? ________________________________

Part 7 - System alarms included with product

9. Select alerts that go to:

	Customer	Provider
Fire Alarms		
Gas Leak Detection		
Theft Alarms		
System Outage		
Other		

10. Which mode(s) of communication to customers does each type of alarm use? *Check all that apply. {Display logic: Pipe in items selected in Q9 under "customer" column.}*

	Email	Call	Text	Push notification	Other: _____	Don't Know
Fire alarms						
Gas leak detection						
Theft alarms						
System outage						
Other (pipe text entry from 9)						

If Q10 “other” is selected for any of the alarms:
Please describe what you mean by “other” [one large text box]
____

Part 8 - BESS PerformanceBenefits Reporting

11. Which performance benefits of the {Manufacturer}’s BESS are reported to customers?
    a. Financial benefits
    b. Environmental benefits
    c. Other benefits: ____________

12. How are performance benefits reported?
    a. Reports are sent to customers
    b. Customers can access reports through their account
    c. Customer can request reports
    d. Other_____

13. (If 12=a) How often are reports sent to customers?

14. Is there anything else you would like us to know about your BESS performance reporting?
    ____

Part 9 - System Aesthetics and Siting

15. In which of the following locations/configurations can the {Manufacturer}’s BESS be installed. *Check all that apply.*
    a. Indoors
    b. Outdoors
    c. On a wall mount
    d. Freestanding
    e. Other_________

16. Please describe anything else we should know about the physical design and siting of your systems: ___________________

Part 10 - Data Accessibility

17. Many energy storage systems have the ability to interface with existing building data systems (e.g., information management systems, energy management systems). How does {Manufacturer}’s BESS integrate with a customer's centralized asset management system? Select the most appropriate option.

1	2	3	4	5	
Black box	Proprietary protocol, no API	Full API	Partial local data read/write	Full local data read/write	N/A

Customer Survey

Part 1 - Screening

Has your BESS been installed
Yes
No

1. Do you have knowledge of the {system}?
   - ☐ Yes
   - ☐ No (if no, end survey and find another respondent)
2. Which company provided your energy storage system? ______
   - o ENGIE
   - o Tesla
   - o Forefront Power
   - o SunPower
   - o EDF Renewable Energy
   - o Stem
   - o Promise Energy
   - o Golden State Renewable Energy (GSRE)
   - o Enel X
   - o Swell Energy
   - o Other__________
   - o Don't know → kick out

For the remaining questions, we will use {Manufacturer's} energy storage system (BESS) to refer to the entire suite of technologies and services that {Manufacturer} provided, unless otherwise specified.

3.
4. Please check the box(es) next to all the operating modes your BESS is used for:
   - ☐ Backup Power
   - ☐ Demand Charge Management (Peak Shaving)
   - ☐ Time of Use Arbitrage (Peak Shifting)
   - ☐ Other: ___________
   - ☐ Don't know
5. Please check the box(es) next to all the product benefits {Manufacturer} reports to you about your BESS performance:
   - ☐ Financial
   - ☐ Environmental
   - ☐ Other: __________
   - ☐ Don't know / No benefits communicated _________________
6. *Display logic: display if Q4 "financial benefits" is selected.*
   - ☐ Please describe how financial benefits are reported to you: _____________
   - ☐ At what frequency are financial benefits reported? ______________
7. *Display logic: display if Q4 "environmental" is selected.*
   - ☐ Please describe how environmental benefits are reported to you: _____________
   - ☐ At what frequency are environmental benefits reported?: _______________
8. *Display logic: display if Q4 "other" is selected.*

- ☐ Please describe how other benefits are reported to you: ______________
- ☐ At what frequency are other benefits reported?

Part 2 - Installation

9. *Please state your level of agreement with the following aspects of product setup/installation.*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	N/A
	(1)	(2)	(3)	(4)	(5)	.
It was easy to schedule the {system} installation.						
I was very satisfied with the speed of installation.						
Integrating the {system} with other onsite systems required a lot of our time and effort.						
Permitting the storage system required a lot of our time and effort.						
{Company name} took care of connecting the storage system to our building systems.						

10. *Is there anything else we should know about installation of the {system}?*
*Comments*_____________

Part 3 - System use and performance

11. Can you monitor your system remotely?
    - ☐ Yes
    - ☐ No
12. *Display Logic: display if Q10 "yes" is selected.* Please check the box(ex) next to the ways in which you can monitor your system.
    - ☐ Phone application
    - ☐ Computer desktop application
    - ☐ Website
    - ☐ Other _________

13. *Please state your level of agreement with the following statements. {Display logic: pipe in the items selected in Q11}*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't Know
	(1)	(2)	(3)	(4)	(5)	.
The phone application is easy to use.						
The computer desktop application is easy to use.						
The website is easy to use.						
The {Other} is easy to use.						

14. *Is there anything else we should know about the various ways of monitoring the {system}? Comments______________*

15. Which of the following types of data can you access remotely.
    - ☐ Current building (net) load
    - ☐ BESS charge/discharge power
    - ☐ BESS operating mode (demand charge management, time of use arbitrage, etc.)
    - ☐ Paired PV production
    - ☐ Other_____

16. *Please state your level of agreement with the following aspects of product use and performance.*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	N/A
	(1)	(2)	(3)	(4)	(5)	.
The {system} operates well.						
The {system} has had performance issues.						
The {system} is reliable.						
I am satisfied with the price of the {system}.						
I am satisfied with the financial benefits of the {system} (e.g., savings, revenue).						
A different alert system						

would work better for me.						
I am satisfied with the reports generated by the {system}.						
I wish the {system} provided more detailed information about its operations.						
I am satisfied with the remote safety features of the {system}.						

17. *Is there anything else we should know about performance or operation of the {system}? Comments______________*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
	(1)	(2)	(3)	(4)	(5)
I found the system and service unnecessarily complex.					
I thought the system and service was easy to use.					
I think that I would need more technical support to be able to use this system and service.					
I found the various functions in this system and service were well integrated.					
I thought there was too much inconsistency in this system and service.					
I would imagine that most people in my role would learn to use this system and service very quickly.					

I found the system and service very cumbersome or awkward to use.					
I felt very confident using the system and service.					
I needed to learn a lot of things before I could get going with this system and service.					

Systems Usability Scale

18. *Tell us the extent to which you agree or disagree with the following statements with respect to the {system} installed in your building. Choose "Neither agree nor disagree" if you're not sure how to answer.*

19. *Comments*______________

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	N/A
	(1)	(2)	(3)	(4)	(5)	
{if 19=b,c} It is difficult to find a service provider that performs maintenance on the {system}.						
{if 19=a,b,c} I am satisfied with the frequency of maintenance requirements of the {system}.						
{if 19=b,c} I am satisfied with the cost of the maintenance requirements of the {system}.						
{if 19=a} I am satisfied with the level of effort required of our organization to adhere to maintenance requirements of the {system}.						

{if 19=a} The {system} is easy to maintain.						
{if 19=a} Maintenance of the {system} requires special tools.						
{if 19=a} Maintenance of the {system} requires special training.						

Part 4 - Product maintenance

20. *Who is responsible for the maintenance of the {system}?*
    a. Someone in my organization
    b. Outside service provider
    c. Both (a) and (b)

21. Approximately how often has the {system} needed repair or maintenance?
    - ☐ Weekly
    - ☐ Monthly
    - ☐ Once every few months
    - ☐ Once every few years
    - ☐ Never
    - ☐ Don't know

22. *Please state your level of agreement with the following aspects of system maintenance.*

23. *Is there anything else we should know about maintenance of the {system}?* ______________

24. *Overall satisfaction. Please state your level of agreement with the following statements.*

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	N/A
	(1)	(2)	(3)	(4)	(5)	
Overall, I am satisfied with the {system}.						
If my organization needed another energy storage system I would select the {system} again.						

I would recommend the {system} to others.						
I am satisfied with {Manufacturer}'s customer service						

25. *Please share any final comments you may have on the {system}?* _____________