2021 SGIP ENERGY STORAGE MARKET ASSESSMENT STUDY

Submitted to:
Pacific Gas and Electric Company
SGIP Working Group

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1 EXECUTIVE SUMMARY

This study is an evaluation of the market for behind-the-meter (BTM) energy storage and how that market interacts with and is influenced by ratepayer funded programs like the Self-Generation Incentive Program (SGIP). The study uses SGIP tracking data, collected throughout the past five years, and supplements that with current market survey data of BTM storage customers – both within the SGIP and outside of SGIP – and customers who do not currently have storage installed. Surveys with storage and solar photovoltaic (PV) installers or developers were also administered to gain their perspective on how the storage market operates currently, and if they foresee any significant changes within that market moving forward.

The objectives of the SGIP participation analysis and the customer and market actor surveys are to better understand; 1) the different cost components of energy storage, 2) how those real and perceived costs differ across societal groups or have changed over time, 3) the influence of the SGIP on storage adoption, 4) the key barriers and drivers to storage adoption, and 5) how the installation of storage is linked to other distributed energy resources (DERs) like solar PV.

This study combines these forward looking and retrospective analyses to better equip the California Public Utilities Commission (CPUC), California policy makers, program administrators (PAs), and other relevant stakeholders with an understanding of the costs, benefits, and market conditions of BTM energy storage. The research questions within this study are multi-faceted and address specific legislative and regulatory requirements set forth in Senate Bill 700 and the 2019 SGIP Equity Resilience Decision (D.19-09-027), along with ongoing CPUC proceedings and SGIP goals.

Introduction

The SGIP provides financial incentives for the installation of BTM distributed generation and energy storage technologies that meet all or a portion of a customer's electricity needs. The SGIP is funded by California's ratepayers and managed by PAs representing California's major investor-owned utilities (IOUs). The CPUC provides oversight and guidance on the SGIP.

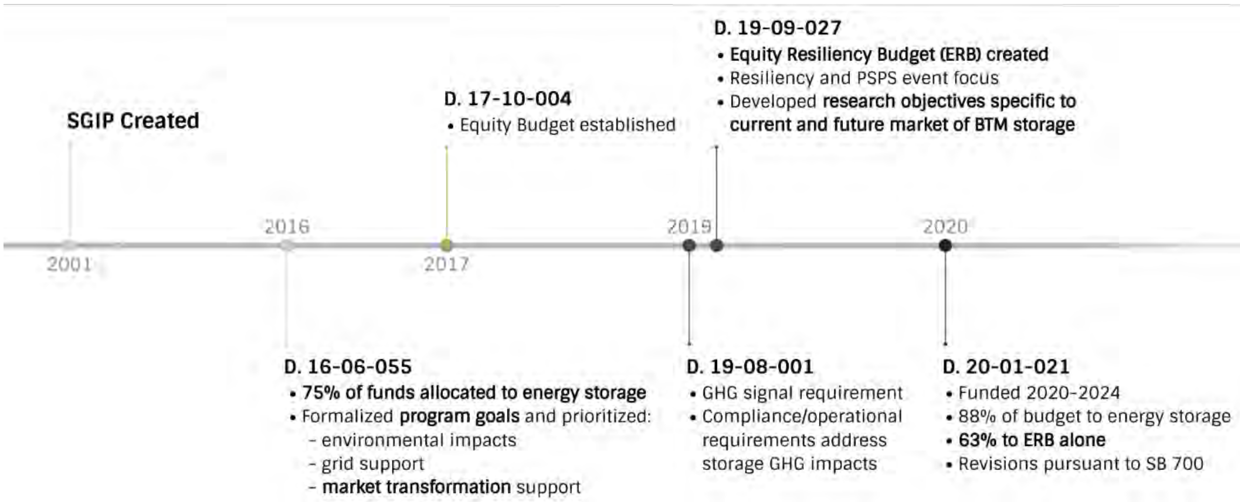
Since its inception in 2001, the SGIP has provided incentives to a wide variety of DERs. While the program was initially designed to help address peak electricity problems in California,[1] the program has been revised and extended multiple times since 2001, with eligibility requirements, program administration, and incentive levels all changing over time. Over the years, the program focus has transitioned from peak-load reduction to greenhouse gas (GHG) emission reductions as climate change has moved to the forefront of statewide public policy. Over the past decade, energy storage has experienced a significant

1 California Assembly Bill 970, Ducheny. September 6, 2000. http://www.leginfo.ca.gov/pub/99-00/bill/asm/ab_0951-1000/ab_970_bill_20000907_chaptered.html

increase in budget allocation, applications, and incentive payments within the SGIP, as technological advancements, policy interventions and ratepayer funding have targeted the technology.

Figure 1-1 presents the timeline of major changes to the budget and eligibility requirements for energy storage since the inception of the program. In bold, we highlight some of the key provisions within each of those regulatory decisions which specify this study's key research questions. Decision 16-06-05 first revised how the SGIP is administered and formalized the program's goals, which included tracking and prioritizing market transformation.[2] Decision (D.) 19-09-027 followed three years later and established the SGIP Equity Resiliency Budget (ERB), which set aside budget to help deal with critical needs resulting from wildfire risks in the state.[3] This decision also developed research objectives specific to understanding the current and future market for energy storage, like the value of lost load (VLL), barriers to storage adoption, and specific market actor behaviors. ***These research objectives, along with the program's intent to achieve market transformation, are the primary drivers of this research and the motivation behind this market assessment.***

FIGURE 1-1: KEY DECISIONS INFORMING MARKET ASSESSMENT RESEARCH



This study also builds on the SGIP Storage Cost-Effectiveness and Market Assessment Study[4] completed in 2019 and supplements some of the research questions proposed in the 2020 SGIP Energy Storage Impact Evaluation.[5] It also helps to assess how fundamental changes to the SGIP program design, eligibility

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2 CPUC Decision D.11-00-055. June 23, 2016. http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=163928075

3 CPUC Decision D. 19-09-027. September 18, 2019. http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=313975481

4 2019 SGIP Energy Storage Market Assessment and Cost-Effectiveness Report. https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442463457

5 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/self-generation-incentive-program/sgip-2020-energy-storage-impact-evaluation.pdf

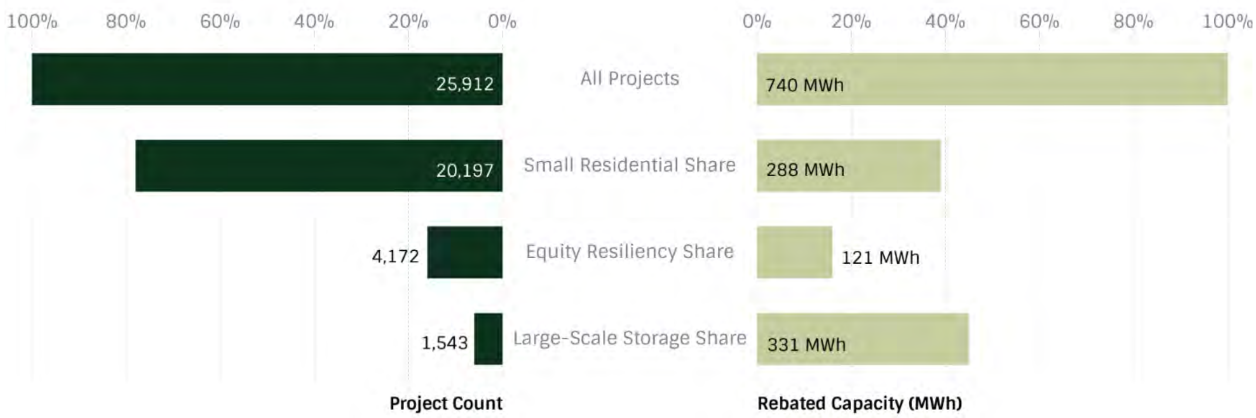
requirements, and incentive levels in the past two years, especially since passage of D.19-09-027, have affected the program's progress toward market transformation.

SGIP Program Participation

The programmatic changes brought forth by passage of D. 16-06-055 in 2016 changed how the SGIP was structured and administered starting in 2017. Standalone energy storage had been the predominant configuration in the program from the introduction of storage into SGIP, but new budget categories with differing incentive levels allowed newer, more sophisticated energy storage configurations access to the program across multiple sectors. These changes have contributed to where the program is today.

The residential sector began seeing increased participation with energy storage paired with on-site solar generation as the predominant configuration and, more recently, the program has re-focused to equity and customer resiliency as wildfire threats have compelled utilities to exercise their authority to carry out public safety power shutoffs (PSPS). Since 2017, the SGIP has issued incentives to roughly **26,000 residential and non-residential energy storage projects** representing roughly **740 MWh of rebated capacity** (Figure 1-2).

FIGURE 1-2: 2021 SGIP STORAGE PROJECT COUNT AND CAPACITY MWH BY BUDGET CATEGORY



Key Market Assessment Research Areas and Findings

Below we present key findings from this storage market assessment. These findings were developed based on an analysis of SGIP participant tracking data, utility interconnection data, and results garnered from market surveys with customers and storage project developers. More specifically, they included online surveys of residential and non-residential customers who have installed battery storage systems (both inside and outside of the SGIP), customers with solar but no storage installed, and a representative sample of non-interconnected solar or storage customers (non-distributed energy resource or non-DER customers). In-depth interviews (IDIs) and online surveys were also conducted with battery storage project developers. The specific research questions informing these findings can be found in Section 2.4 and in-depth findings and analyses can be found in Section 3 and Section 5 of this report.

Key Storage Market Assessment Study Findings

Storage System Characteristics

- Significant differences in storage sizing across SGIP residential budget categories
- Average system sizes have increased over the past several years
- Increase in share of non-SGIP storage installations across utilities relative to SGIP

Storage Cost Characteristics

- Developers self-reported eligible costs have increased over the past several years
- Reported costs are dominated by capital equipment and labor costs
- Nearly half of installations require an electrical panel upgrade

Storage and Solar PV

- 45% of SGIP and 27% of non-SGIP storage owners self-report that solar PV was installed prior to storage
- 48% of SGIP and 72% of non-SGIP storage owners self-report simulataneous installation
- Higher share (78%) of ERB customers self-report solar installed before storage

Developer Characteristics

- 400% increase in the total number of developers operating within the SGIP since 2019
- Storage developers also sell solar with the majority selling more solar than storage
- Residential customers are target segment -----> 89% of projects were residential

Storage Customer Characteristics

- Households who have installed storage tend to be high income, highly educated, live in suburban locations, consider themselves early adopters, and own their homes
- Equity Resiliency (ERB) customers are lower income ---> more likely to live in rural and high wildfire locations ---> less likely to be early adopters ---> more likely to be households with medical needs

Drivers of Storage Adoption

- 50% of SGIP and non-SGIP storage respondents state that backup is the number one reason for installation
- Roughly 60% of SGIP and non-SGIP respondents list bill savings - or load shifting from on-peak hours to off-peak hours - as one of their top 3 drivers
- Consuming more solar generation and environmental reasons (reducing GHG emissions) are also drivers
- 69% of solar customers and 28% of customers with no DERS are considering storage adoption

Barriers to Storage Adoption

- Upfront capital costs are the primary reason non-storage respondents have not installed energy storage
- Project developers confirm that upfront battery costs and unfavorable economics are the greatest current and near-term barriers
- How multi-family dwellings are classified within California and the unfavorable economics for rental properties have led to focused attention on single-family installations within the SGIP
- Project developers report electric panel upgrades from $1,200 to $6,500

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Key Storage Market Assessment Study Findings (continued)

Customer Resiliency

- 92% of SGIP participants self-reported experiencing an outage in the past two years (longer duration from ERB customers)
- 90% of non-SGIP customers and 88% of non-DER respondents reported an outage during that time period
- 65% of ER participants have a household member with a medical need requiring power for equipment
- 93% of SGIP and non-SGIP respondents said storage provided necessary resilience during outages
- Small systems (less than 5 kW) provided less resilience during longer duration outages
- The share of storage owners with a fossil fuel generator is much lower than for non-DER customers, and solar owners (without storage) have the highest share of fossil fuel generator ownership (roughly 24%)

Customer Willingness-to-Pay (WTP) for Storage

- Respondents with battery storage have a higher WTP for whole house storage and lower valuation for partial house (30% of electrical needs) storage compared to customers who do not have storage installed
- SGIP customer WTP ---> $19,928 for whole house is very similar to non-SGIP customer WTP ---> $19,443
- Non-storage solar customer WTP ---> $11,157 for whole house storage ---> $5,072 for partial house
- Non-DER customers WTP ---> $6,520 for whole house storage ---> $4,741 for partial house
- SGIP participants are WTP slightly more for whole house storage than they actually pay
- Much lower WTP for storage from non-storage solar customers and non-DER customers
- Total eligible costs would need to be lower and/or incentive would need to be greater to reach the next group of storage adopters
- Overall, customers in rural areas are WTP more than customers in suburban areas for whole house storage
- Non-DER households with medical needs are willing to pay 50-60% more for whole house storage than non-DER households without medical needs

SGIP Influence

- Self-reported likelihood of installing energy storage without an SGIP incentive
  - -Equity Resiliency: 7% extremely ---> 34% somewhat ---> 57% not at all
  - -Large-Scale Residential: 17% extremely ---> 61% somewhat ---> 22% not at all
  - -Small Residential: 24% extremely ---> 51% somewhat ---> 20% not at all
  - -Non-residential: 10% extremely ---> 17% somewhat ---> 63% not at all
- Developers estimate 50% of residential and 33% non-residential projects would be completed if the SGIP incentive was no longer available. They self-report ERB customers would likely not complete the project without an incentive

Conclusions and Recommendations

This report is a comprehensive overview of the state of the market for BTM storage in California. Verdant Associates surveyed a variety of market actors to understand awareness of and attitudes towards energy storage. Customers who installed battery storage shared their experiences with their systems, including their performance during outages. The surveys included a battery of questions that provided key inputs to a willingness to pay analysis. Interviews with project developers and manufacturers shed light on the drivers and barriers to increased storage adoption and the influence of the SGIP. Data suggest that the market for battery storage systems in California is shifting, with an increasing proportion of customers installing battery storage systems without support from the SGIP. New manufacturers are entering the marketplace and project developers are consolidating. However, trends in installed costs have continued to increase steadily since 2017. Looking ahead, supply chain concerns, inflation, labor costs, and Net Metering reform create uncertainty in the market. Below we present key takeaways and conclusions from this evaluation. Where possible, we also provide recommendations.

Conclusion 1. **The proportion of residential general market energy storage systems installed without receiving an SGIP incentive has steadily increased.** Fifty four percent of systems interconnected during 2017 received an incentive from the SGIP. Only 24 percent of systems interconnected during 2021 received an SGIP incentive.[6] While the proportion of systems receiving SGIP incentives has steadily declined, we caution that this metric alone should not be taken as an indicator of market transformation. Other metrics that are commonly used to designate market transformation include mass market adoption and falling technology prices. The current market for energy storage systems in California, however, has relatively few customers adopting storage, flat or increasing prices with challenging customer payback periods, and a large share of customers who self-identify as early adopters.[7]

Conclusion 2. **The Equity Resiliency Budget (ERB) is successfully reaching a different cohort of customers than the small residential and large scale (residential) energy storage budgets.** SGIP participants in the ERB have lower household average incomes than both SGIP small residential participants and customers who adopted storage outside of the SGIP. Furthermore, ERB customers are more likely to live in a high fire threat district (HFTD) and are less likely to identify as early adopters. Lastly, 41 percent of customers in the ERB said they would have installed energy storage even without an SGIP incentive, compared to 75 percent of customers in the small residential budget. The ERB was designed to reach customers who are most in need of resiliency. The ERB is effectively reaching these customers with high resiliency needs and

6 This study was developed in 2021 and samples were drawn during the second and third quarter of 2021. This percentage does not reflect interconnections and SGIP participation for the entirety of the year.

7 The residential survey respondents were asked if they were usually the first to try a new product, in the middle, or last to try. These results are presented in Figure 5-4, showing that storage owners self-identify as early adopters.

who would otherwise not have installed battery storage systems. ERB customers are less likely than other SGIP participants to have paired their storage with solar (94 percent versus 98 percent) limiting their level of resiliency. **Recommendation: The SGIP should ensure ERB customers are knowledgeable of existing programs (such as DAC-SASH) that can help offset the cost of installing solar**.

Conclusion 3. **The ecosystem for behind the meter (BTM) storage manufacturers and project developers continues to expand.** The number of distinct SGIP project developers has nearly quadrupled from 103 active project developers (defined as developers who submitted an SGIP application) in 2019 to 405 active developers by the end of 2021. Despite some consolidation in the industry and a small number of bankruptcies, the number of developers entering the market has exceeded the attrition rate, indicating the growth of a healthy market. Similarly, we observe increased diversity in the hardware and software offerings being marketed to consumers. While two primary battery storage systems dominated the early stages of the market, we see increased adoption of new offerings from firms such as Enphase and SunPower. New products in the market offer a diverse set of capabilities and features including basic self-consumption, time-of-use arbitrage, storm/outage prediction for resiliency, and virtual power plants.

Conclusion 4. **Customers are generally satisfied with the ability of their battery storage systems to maintain electrical service during multi-day outages.** Fourteen percent of surveyed customers reported experiencing an outage lasting 48 hours or longer. Among these customers, 85 percent reported being either very satisfied or extremely satisfied with the ability of their systems to provide resiliency during outages and sustain critical medical equipment. Satisfaction levels were highest for customers with larger energy storage systems that can back up the entire home rather than a portion of their home. Customers with smaller energy storage systems were only able to back up a portion of the electrical end uses in their homes. The most common end uses backed up by customers with partial home energy storage systems were refrigeration, lighting, and telecommunications equipment.

Conclusion 5. **The average size of residential energy storage systems in the SGIP has increased from 12 kWh in 2017 to 20 kWh by the end of 2021.** Storage systems are getting larger, reflecting an increased demand for resiliency benefits. Larger energy storage systems can provide multiple days of whole-home backup. Ninety nine percent of Large-Scale Storage survey respondents stated that resiliency was one of their top three reasons for installing battery storage. Conclusion 4 highlights the increased satisfaction of customers with whole-home backup relative to partial home backup systems. The increased size of storage systems is observed both within and outside the SGIP,[8] suggesting the trend is not necessarily driven by SGIP incentives.

[8] See Figure 3-23 and Figure 3-24 for a comparison of SGIP and non-SGIP storage system capacities over time.

Conclusion 6. **Project developer self-reported battery storage installed costs in the SGIP small residential budget have increased from $0.83/Wh during 2017 to $1.18/Wh by the end of 2021. If this trend continues project costs and equity incentives will grow further apart.** Increased costs are a result of myriad factors including the emergence of new products and developers/installers at higher price points and increasing labor costs. Storage systems are increasingly being installed by non-manufacturer channel partners which have increased installed costs. Additionally, new products have entered the market with enhanced control features that customers value but that add costs. Looking ahead, supply chain constraints, wage and price inflation, and availability of key inputs will continue to place upward pressure on installed storage costs. **Recommendation: If the CPUC wants ERB and Equity Budget incentives to continue to pay all, or nearly all, of the costs for battery storage installation within these budget programs, it will be necessary to regularly review and revisit project costs and incentives.**

Conclusion 7. **Supply chain issues and availability of a highly trained workforce emerge as key barriers to increased battery storage supply.** Developers report difficulties finding sufficient trained labor to market, sell, and install battery storage systems. **Recommendation: Training courses offered through community and technical colleges are needed to facilitate a sufficiently trained labor market.**

Conclusion 8. **Customers who have not yet installed battery storage report upfront costs as the main barrier.** Upfront costs and electrical panel upgrades were ranked as higher barriers to adoption than battery safety concerns among potential future adopters. **Recommendation: Financial assistance, including on-bill-finance programs could be designed to help customers pay the upfront and electrical panel upgrade costs.**

Conclusion 9. **Nearly half of all customers who installed energy storage systems required an electrical panel upgrade.** Upgrades are required to increase the overall amperage of the panel or to create a subpanel of critical loads. These upgrades are emerging as a barrier across building and transportation electrification policies – current California heat pump water heater incentive programs include adders to accommodate electrical panel upgrades. In the context of electrification, panel upgrades can unlock other technologies since, in theory, they should only be required once to enable the adoption of additional distributed energy resources. **Recommendation: The ERB and EB programs should consider including a panel upgrade adder to help enable storage, and other electrification upgrades, for these populations.**

Conclusion 10. **Customers in the non-DER (or non-interconnected) cohort who have not yet installed solar have an estimated willingness to pay of $6,520 for a system that can back up their entire homes.** Willingness to pay is higher for customers with solar PV, likely due to these customers on average having higher incomes than non-DER customers. Willingness to pay is higher for customers in rural areas and customers self-identified as living in a high fire threat district. Unlocking the next tranche of DER adopters will continue to require significant incentives to bring energy storage costs down to current willingness to pay values. **Recommendation: While considerable adoption of storage exists outside of the SGIP, incentives will continue to be necessary to reach certain customers. Information from the willingness to pay analysis should inform or guide incentive rates for general market customers.**

2 INTRODUCTION AND OBJECTIVES

California's Self-Generation Incentive Program (SGIP) provides financial incentives for the installation of behind-the-meter (BTM) distributed generation and energy storage technologies that meet all or a portion of a customer's electricity needs. The SGIP is funded by California's ratepayers and managed by Program Administrators (PAs) representing California's major investor-owned utilities (IOUs). These PAs include Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company and the Center for Sustainable Energy (CSE), which implements the program on behalf of San Diego Gas and Electric (SDG&E) customers. The California Public Utilities Commission (CPUC) provides oversight and guidance on the SGIP.

This section discusses the regulatory framework of the SGIP and provides an overview of the role of energy storage within the SGIP from program inception through today. This section also identifies the study objectives – which are informed by this framework and other policy interventions through the years – and discusses the overall approach to fulfilling the study objectives.

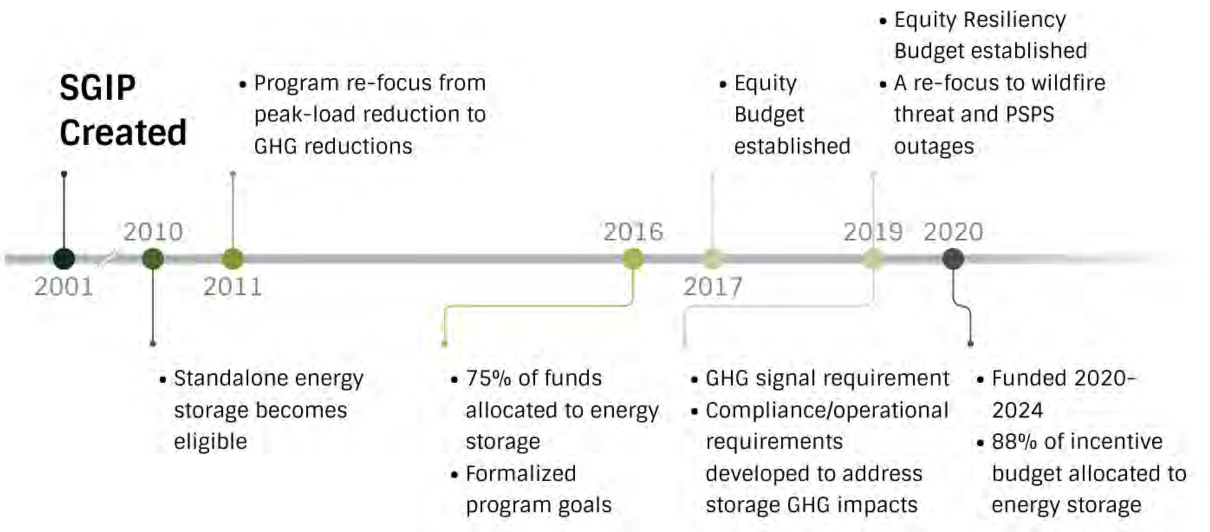
2.1 PROGRAM OVERVIEW AND HISTORY OF ENERGY STORAGE IN THE SGIP

Since its inception in 2001, the SGIP has provided incentives to a wide variety of distributed energy technologies including combined heat and power (CHP), fuel cells, solar photovoltaic (PV), wind turbine systems and energy storage. While the program was initially designed to help address peak electricity problems in California[9], the program has been revised and extended multiple times since 2001, with eligibility requirements, program administration and incentive levels all changing over time. Over the years, the program focus has transitioned from peak-load reduction to greenhouse gas (GHG) emissions reductions as climate change has moved to the forefront of statewide public policy. Over the past decade, energy storage has experienced a significant increase in budget allocation, applications, and incentive payments within the SGIP, as technological advancements, policy interventions and ratepayer funding have targeted the technology.

Figure 2-1 presents the timeline of major changes to the budget and eligibility requirements for energy storage since the inception of the program. This is followed by a brief discussion of the regulatory decisions which have shaped the program throughout the years and have informed the research objectives this study aims to address.

9 California Assembly Bill 970, Ducheny. September 6, 2000. http://www.leginfo.ca.gov/pub/99-00/bill/asm/ab_0951-1000/ab_970_bill_20000907_chaptered.html

FIGURE 2-1: HISTORY OF ENERGY STORAGE IN THE SGIP



In March 2001, the CPUC formally created the SGIP, and it received the first application in July 2001. Eight years later — in 2009 — energy storage systems that met certain technical parameters and were coupled with eligible SGIP technologies — wind turbines and fuel cells — became eligible for incentives.[10] In 2011, standalone storage systems — in addition to those paired with SGIP eligible technologies or PV — were made eligible for incentives.[11] In 2011, the CPUC issued Decision (D.) 11-09-015, which added SGIP eligibility requirements based upon greenhouse gas (GHG) emissions reductions.

This was followed by D. 16-06-055 in 2016, which, among other changes, revised how the SGIP is administered.[12] Beginning in 2017, the SGIP was administered on a continuous basis. This change was made largely to curb potential issues with incentives being depleted during program opening, as the program is typically oversubscribed. D. 16-06-055 also supplemented the first-come, first-served reservation system with a lottery and formalized the program's goals:

- **Environmental.** The reduction of GHGs, the reduction of criteria air pollutants, and the limitation of other environmental impacts such as water usage.

10 CPUC Decision D.08-11-044. November 21, 2008. http://docs.cpuc.ca.gov/PublishedDocs/PUBLISHED/FINAL_DECISION/94272.htm

11 CPUC Decision D.10-02-017. February 25, 2010. http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/114312.PDF

12 CPUC Decision D.16-06-055. June 23, 2016. http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=163928075

- **Grid Support.** Reduce or shift peak demand, improve efficiency and reliability of the distribution and transmission system, lower infrastructure costs, provide ancillary services, and ensure customer reliability.

- **Market Transformation.** To create lasting change that increase the adoption and penetration of DER technologies through strategic intervention in defined markets.

In 2017, D. 17-10-004 established the SGIP Equity Budget, where 25 percent of SGIP funds collected for energy storage projects were reserved for single family and multifamily low-income housing, including disadvantaged communities.[13] More recently, the CPUC issued D. 19-08-001 approving greenhouse gas emission reduction requirements for the SGIP storage budget.[14] This decision requires SGIP PAs to provide a digitally accessible GHG signal that provides marginal GHG emissions factors (kilograms CO_2/kWh) and directs the SGIP storage impact evaluator to provide summary information on the GHG performance of developer fleets as part of annual SGIP storage evaluations. This decision also defined compliance pathways and operational requirements for residential and non-residential SGIP energy storage projects.

On September 12, 2019, the CPUC issued D. 19-09-027 that established an SGIP equity resiliency budget, modified existing equity budget incentives, and approved the transfer of certain unspent funds to the Equity Resiliency budget.[15] To help deal with critical needs resulting from wildfire risks in the state, D. 19-09-027 set-aside a budget for vulnerable households located in Tier 2 and Tier 3 high fire threat districts, critical services facilities serving those districts, and customers located in those districts that participate in low-income/disadvantaged community solar generation programs.

This decision also developed research objectives specific to understanding the current and future market for energy storage, like the value of lost load (VLL), barriers to storage adoption, and specific market actor behaviors (this is discussed in more detail in Section 5). ***These research objectives, along with the program's intent to achieve market transformation are the primary drivers of this research and the motivation behind this market assessment.***

Most recently, in January of 2020, the CPUC issued D. 20-01-021.[16] The decision authorized the collection of ratepayer funds totaling $166 million dollars per year from 2020 to 2024 across the four program administrators. This decision also increased the financial incentive budget for energy storage technologies to 88 percent of total SGIP funding and carved out funding for the remaining eligible technologies. Table

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13 CPUC Decision D. 17-10-004. October 12, 2017. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M197/K215/197215993.PDF

14 CPUC Decision D. 19-08-001. August 9, 2019. http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=310260347

15 CPUC Decision D. 19-09-027. September 18, 2019. http://docs.cpuc.ca.gov/SearchRes.aspx?DocFormat=ALL&DocID=313975481

16 CPUC Decision D. 20-01-021. January 27, 2020. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M325/K979/325979689.PDF

2-1 summarizes the key provisions from each of the decisions which have shaped the energy storage program structure.

TABLE 2-1: CPUC DECISIONS INFLUENCING ENERGY STORAGE IN THE SGIP

CPUC Decision	Decision Date	Key Provisions
D. 08-11-044	11/2008	▪ Energy storage systems that met certain technical parameters and were coupled with eligible SGIP technologies (wind turbines and fuel cells) were eligible for incentives
D. 10-02-017	02/2010	▪ Standalone storage systems – in addition to those paired with SGIP eligible technologies or PV – were made eligible for incentives
D. 11-09-015	09/2011	▪ Modified program to include eligible technologies that achieve GHG emission reductions
D. 16-06-055	06/2016	▪ SGIP administered on a continuous basis ▪ Supplemented the first-come, first-served reservation system with a lottery. ▪ Energy storage allocated 75% of program funds ▪ **Formalized program goals** of prioritizing environmental impacts, providing grid support, and **supporting market transformation**
D. 17-10-004	10/2017	▪ 25% of funds collected for energy storage projects are reserved for the SGIP Equity Budget
D. 19-08-001	08/2019	▪ Requires SGIP PAs to provide a digitally accessible greenhouse gas (GHG) signal ▪ Defines compliance pathways and operational requirements for "new" and "legacy" projects and "developer fleets" ▪ Directs the SGIP storage impact evaluator to provide summary information on the GHG performance of developer fleets
D. 19-09-027	09/2019	▪ Established the Equity Resiliency budget ▪ Modified existing equity budget incentives ▪ **Developed research objectives specific to the current and future market for energy storage within and without SGIP.**
D. 20-01-021	01/2020	▪ Authorized ratepayer collections of $166 million per year from 2020-2024 to fund the SGIP ▪ 88% of incentive budget reserved for energy storage technologies ▪ **Implemented program revisions pursuant to Senate Bill 700** and other program changes

2.2 CURRENT PROGRAM STATUS OF ENERGY STORAGE IN THE SGIP

As in previous years, the SGIP budget continues to heavily emphasize storage technologies. The overall share of the SGIP budget reserved for storage technologies increased from 75 percent in 2017 to 88 percent in 2020-2024. This coincides with several changes made to the SGIP budget allocation process and program eligibility requirements in 2020. In previous program years the residential storage budget category, which was open to any residential IOU electric or gas customer, represented over 90 percent of all SGIP applications. Starting in 2020, the program shifted focus towards equity projects, primarily in the equity resiliency budget category. The SGIP energy storage budget is broken out into seven categories: Large-Scale, Small Residential, Residential Equity, Non-residential Equity, Equity Resiliency, San Joaquin Valley Pilot and Heat Pump Water Heaters.[17] Most of the new collections for the energy storage budget (63 percent of the overall 2020-2024 budget) is allocated to the Equity Resiliency budget category. The remaining 12 percent of budget is carved out for renewable generation technologies. Table 2-2 presents the overall distribution of budget allocation along with a brief description of the eight budget categories.

TABLE 2-2: DESCRIPTION OF PY 2020 – 2024 BUDGET CATEGORIES

Budget Category	Budget Allocation	Brief Budget Category Description
Equity Resiliency	63%	▪ Intended for vulnerable households located in Tier 2 and Tier 3 High Fire Threat Districts (HFTDs) or customers who have been subjected to two or more Public Safety Power Shutoff (PSPS) events.
Renewable Generation	12%	▪ Open to generation technologies. All new generation projects must be 100 percent fueled with renewable biogas.
>10 kW Large-Scale Storage	10%	▪ Open to non-residential projects or residential projects greater than 10 kW.
≤10 kW Small Residential Storage	7%	▪ Open to residential projects less than or equal to 10 kW.
Heat Pump Water Heaters	5%	▪ $4 million in accumulated unused incentive funds were transferred to this category ▪ As of December 2020, this budget category has not opened. Funds for this category are on hold pending a CPUC decision on how to structure the incentives.[18]
Residential Equity	3%	▪ Open to single-family low-income housing or multi-family low-income housing, regardless of project size.
Non-residential Equity	0%	▪ Open to local, state, or tribal government agencies, educational institutions, non-profit organizations or small businesses. ▪ The project site must be in or provide service to a disadvantaged community.
San Joaquin Valley Pilot	0%	▪ Open to residential and non-residential storage projects located in 11 San Joaquin Valley disadvantaged communities

[17] There are two additional budget categories – Non-residential equity budget and the San Joaquin Valley Pilot (SJVPP). As per the SGIP 2020 V9 Handbook, the authorized collection for non-residential equity storage has been suspended once existing carryover is exhausted. The SJVPP has $10 million set aside from SCE and PG&E's unused non-residential equity budget.

[18] For more information see the SGIP HPWH Staff Proposal (April 19, 2021): https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442468802

2.3 REPORT PURPOSE

As discussed previously, SGIP eligibility requirements and incentive levels have changed over time in alignment with California's evolving energy landscape. To help measure and evaluate the progress and impacts of the SGIP, the CPUC has directed the program administrators to develop measurement and evaluation (M&E) plans. The most recent M&E plan was developed for PY 2016-2020 in response to requirements set forth in D. 16-06-055.[19] The M&E plan develops key performance metrics and program requirements, many of which are measured and tracked through impact evaluations. These impact evaluations serve as an important feedback mechanism to assess the SGIP's effectiveness and ability to meet its goals.

The CPUC SGIP M&E plan does not describe the specific research questions to be addressed by the 2021 SGIP Market Assessment Study. This study is guided by the overall program objective to measure and track market transformation of energy storage and by the research questions detailed in D.19-09-027. Several questions posed in D.19-09-027 related to the energy, environmental, and economic impact of SGIP rebated energy storage systems have been addressed in the 2020 SGIP Energy Storage Impact Evaluation Report. However, many research questions detailed in the decision regarding customer behaviors, barriers, and value of lost load (VLL) are not traditionally addressed in an impact evaluation. Instead, these types of questions are typically answered as part of a market assessment.

This study builds on the SGIP Storage Cost-Effectiveness and Market Assessment Study[20] completed in 2019 and supplements some of the research questions proposed in the 2020 SGIP Energy Storage Impact Evaluation. It also helps to assess how fundamental changes to SGIP program design, eligibility requirements, and incentive levels in the past two years, especially since passage of D.19-09-027, have affected the program's progress toward market transformation.

2.4 RESEARCH GOALS AND OBJECTIVES

Verdant collected information from market actors and participating and non-participating customers to better describe the current market for battery storage and to provide data to help assess the market's progress toward market transformation. Table 2-3 presents a list of important research areas along with specific questions this study aims to address. We also identify whether the research questions were specifically addressed in D.19-09-027 and where in the report these questions are answered.

[19] At the time the plan was approved, the SGIP was set to expire in 2020. SB 700 extended the SGIP from 2020 to 2025. Currently, the CPUC, in consultation with the PAs, is developing an M&E plan which covers PY 2021-2025.

[20] 2019 SGIP Energy Storage Market Assessment and Cost-Effectiveness Report. https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442463457

TABLE 2-3: SUMMARY OF RESEARCH QUESTIONS AND OBJECTIVES

Market Assessment Research Goals and Objectives			
Research Questions	**D. 19-09-027 Based**	**Answered**	**Report Section Location(s)**
STORAGE SYSTEMS – ***What are the characteristics of storage within SGIP and outside of SGIP?***			
Does storage system sizing vary by SGIP budget category and/or over time?	No	Yes	3.1.1 | 3.2
What is the share of non-SGIP incented installations relative to SGIP installations and have those shares changed over time?	No	Yes	3.2
How does storage sizing within SGIP and outside of SGIP differ?	No	Yes	3.2
How does storage sizing differ for customers located in HFTDs?	No	Yes	3.2
STORAGE COSTS – ***What are the different equipment and installation costs associated with BTM Storage?***			
What are the actual costs of storage systems (equipment) and installations?	Yes	Yes	3.1.3 | 3.1.4
Do the equipment and installation costs differ by SGIP budget category?	No	Yes	3.1.3 | 3.1.4
Have costs increased in the past two years and are they likely to change over the next two years?	No	Yes	3.1.3
What percentage of total costs are out-of-pocket for SGIP customers and do these expenses differ by budget category?	No	Yes	3.1.4
What is the share of BTM storage requiring electric panel upgrades or circuit sub-panel upgrades and their associated costs?	Yes	Partial*	5.3 | 5.3.2
STORAGE AND SOLAR PV – ***How is installation of these BTM resources linked?***			
What share of SGIP BTM storage installations occur simultaneously with solar PV vs. retrofitted with existing solar PV? Are there discernable differences across budget category?	No	Yes	5.1.3
What share of non-SGIP BTM storage installations occur simultaneously with solar PV vs. retrofitted with existing solar PV?	No	Yes	5.1.3
How are storage and PV sizing related?	No	Yes	5.1.3

Research Questions	D. 19-09-027 Based	Answered	Report Section Location(s)
PROJECT DEVELOPER CHARACTERISTICS – *What does the storage installer market constitute?*			
How many different project developers are installing storage throughout California?	No	Yes	4.2.1 | 5.1.4
Do these installers only install storage or do they install solar PV as well?	No	Yes	5.1.4
Which customer sectors do they target?	No	Yes	5.1.4
STORAGE CUSTOMER CHARACTERISTICS – *What types of customers are installing storage?*			
What are the characteristics of customers installing storage, and do they differ based on budget category, income, location, home ownership, etc?	No	Yes	5.1.1 | 5.1.2
What is customer perceived risk for wildfires and outages?	No	Yes	5.1.1
What share of customers live within HFTDs and/or experienced PSPS event outages?	No	Yes	3.1.6 | 5.1.1
How do SGIP participants differ from non-SGIP customers?	No	Yes	3.2 |5.1.1 | 5.1.3 | 5.4 | 5.5
DRIVERS OF STORAGE ADOPTION– *What are the main drivers to installing BTM storage?*			
What are customers perceived drivers/benefits of installed BTM storage and are customers realizing those benefits?	No	Yes	5.4.1
How do these perceived drivers differ by budget category, and do they differ for SGIP participants relative non-SGIP customers?	No	Yes	5.4.1
What do developers perceive are the drivers of storage demand?	No	Yes	5.3 | 5.4.1
BARRIERS TO STORAGE ADOPTION– *What are the main barriers to installing BTM storage?*			
What are customers perceived barriers to installing BTM storage?	No	Yes	5.4.2
How do these perceived drivers differ by budget category, and do they differ for SGIP participants relative non-SGIP customers?	No	Yes	5.4.2
What do developers perceive are the barriers to storage adoption?	No	Yes	5.3 | 5.4.2
How do proposed regulatory changes and other exogenous factors influence future adoption?	No	Yes	5.2.4

Research Questions	D. 19-09-027 Based	Answered	Report Section Location(s)
CUSTOMER RESILIENCY – *Are customer resiliency benefits being realized?*			
What share of customers have experienced outages throughout the past two years, and how does the length of outage relate to SGIP budget category and customer location?	No	Yes	5.5.1
Do outages differ for storage customers, solar only customers, or customers with no BTM DERs?	No	Yes	5.5.1
What are the resiliency needs of participating customers?	Yes	Yes	5.5.3 | 5.5.4
For customers whose resiliency needs include backup for life-support systems, medical equipment, or any use where product failure could lead to injury or loss of life, did customers rely exclusively on their equity resiliency storage systems for backup? If no, what additional equipment did customers install or rely on, and how much did that equipment cost? If yes, did the storage systems successfully provide the needed backup?	Yes	Partial**	5.5.1 | 5.5.3
Is storage sized to provide back-up power for the whole home or only a portion of the home?	No	Yes	5.5.2
Besides medical equipment, what other equipment are customers backing up for primary resiliency?	No	Yes	5.5.4
To what extent did customers report use of the incentives to install storage as an alternative to gasoline powered generators?	Yes	Yes	5.5.5
Of that share of customers who purchased or considered fossil fuel generators as an alternative to energy storage, how does it differ based on across customer sectors?	No	Yes	5.5.5
WILLINGNESS-TO-PAY (WTP) – *How do customers value resiliency and what is their WTP for storage?*			
What are customers' WTP for storage resiliency and does it differ by partial or whole house backup?	No	Yes	5.6.2
How is resiliency valued by storage customers relative to customers who have not installed storage and by customer location?	No	Yes	5.6.2
What is the difference between the implied value of lost load ($/kWh) of Equity Resiliency storage systems versus gasoline powered generators? If the storage system is more expensive per kilowatt hour of backup energy provided, does the value of reduced GHG emissions per kilowatt hour ($/kWh) make up the difference?	Yes	Partial***	5.6.2
SGIP INFLUENCE – *How is the SGIP influencing adoption?*			
What is customer likelihood of installing BTM storage without an SGIP incentive and does it differ by customer sector or budget category?	No	Yes	5.7.1

Research Questions	D. 19-09-027 Based	Answered	Report Section Location(s)
What share of BTM energy storage is being installed outside of SGIP and has that share changed over time?	No	Yes	3.2 | 5.7.2
Why have customers installed storage without an SGIP incentive and how did they learn about energy storage?	No	Yes	5.2 | 5.7.2
Are SGIP customers likely to recommend SGIP and/or are storage customers, in general, likely to recommend storage?	No	Yes	5.7.3 | 5.7.4

*This study estimated the share of installations requiring electrical panel upgrades, but the developer costs associated with those upgrades represent a range given the unique nature of the installation.

**Our research did not fully capture what other additional equipment customers installed or relied on during an outage, and how much that equipment cost.

***Our research did not estimate the cost of gasoline powered generators, so we could not compare the implied value of resiliency between energy storage and fossil fuel generators.

2.5 RESEARCH APPROACH AND SOURCES OF DATA

The 2021 SGIP Energy Storage Market Assessment Study relies on participant data, interviews, and surveys with SGIP participants and non-participating customers, developers, manufacturers, and industry experts to better understand the key barriers, drivers, and progress toward battery storage market transformation. Figure 2-2 lists the research questions described above and the approaches Verdant used to gather data to inform the research objectives. The individual research approaches are described in detail in the sections that follow.

FIGURE 2-2: SUMMARY OF RESEARCH QUESTIONS AND RESEARCH ACTIVITIES

	Customer Surveys	Market Actor Interviews	SGIP Cost Analysis	Out of State Research
Market Structure	■	■	□	■
Storage Costs	■	■	■	□
Influence of SGIP on Adoption	■	■	□	■
Resiliency Needs and Value	■	■	□	□
Equity Needs	■	■	□	□
Drivers and Barriers to Adoption	■	■	□	■
Storage Relationship with Solar	■	■	□	■
Workforce	□	■	□	□
California and Other Markets	■	■	■	■

2.6 REPORT ORGANIZATION

This report is organized into sections as described below.

- **Section 1** provides an executive summary of the key findings and recommendations from this evaluation
- **Section 2** summarizes the purpose, scope, data sources, research approach and organizations of the report.
- **Section 3** provides an overview of energy storage within California and outside of California and discusses the composition of SGIP participants relative to non-program participants.
- **Section 4** presents the survey methods and sample design framework for the in-depth interviews and web surveys conducted as part of this study.
- **Section 5** presents the results from the market research surrounding SGIP participants, Storage non-SGIP customers, Solar non-storage customers, customers without BTM distributed resources and key market actors within the SGIP.
- **Appendix A** summarizes the key evaluation findings.
- **Appendix B** presents the market assessment survey instruments.
- **Appendix C** presents the survey banners.

3 OVERVIEW OF STORAGE IN CALIFORNIA

This section discusses the composition of energy storage within the SGIP and how this composition has changed throughout the past several years. We also examine how the composition of the SGIP compares to the general market of storage systems installed outside of the program and how those differences or similarities change over space and time. These assessments will help better frame the host customer and general market survey findings in Section 5 and provide key performance indicators of market transformation.

3.1 SGIP STORAGE POPULATION

Verdant collected the SGIP energy storage host customer data for this evaluation from the most recent version of the statewide project list at www.selfgenca.com. This dataset provides the current listing of all projects that have applied to the program, have a performance-based incentive (PBI) payment structure, and have been issued incentives. It contains important information, including project developer name, system size, system location, budget category, electric utility name, and whether a project is paired with a renewable generator, among other fields. As program eligibility and new budget categories have been carved out, the dataset also details whether a participant lives in a Tier 2 or Tier 3 High Fire Threat District (HFTDs) or has experienced more than two Public Safety Power Shutoff (PSPS) events. The statewide project list also captures self-reported total eligible costs and, more recently, itemized capital expenditures, installation, permitting and interconnection costs.

This dataset houses every project that ever applied to the program since 2001, including customers who have been waitlisted, cancelled, or have received their incentive payment. For the purposes of this market assessment, the host customer energy storage population is defined as all projects:

1) applying to the program on or after January 1st, 2017, **AND**
2) having fully qualified state of "Payment Complete" or "Payment PBI in Process**" AND**
3) where technology equipment type is an electrochemical battery.

By the end of 2021, the SGIP issued incentives to roughly **27,000 residential and non-residential energy storage projects** representing roughly **950 MWh of incentivized capacity** (Figure 3-1).

Residential systems comprise the majority of completed projects within the SGIP, while the capacity of the program is split between the two customer sectors. Non-residential systems are almost always larger and range in size from roughly 10 kWh to over 10,000 kWh, with an average capacity of almost 500 kWh. Residential systems are generally in the 10 kWh to 30 kWh range, with an average capacity of 17 kWh.

FIGURE 3-1: PROJECT COUNT AND REBATED CAPACITY BY CUSTOMER SECTOR (THROUGH THE END OF 2021)

Figure 3-2 presents the growth in SGIP storage capacity and project count throughout the past five program years. Also included are the counts and capacities of projects applying to the program before 2017 (pre-2017). However, these projects are not included in this evaluation. The programmatic changes brought forth by passage of D. 16-06-055 in 2016 changed how the SGIP was structured and administered starting in 2017. Standalone energy storage had been the predominant configuration in the program from its nascent years, but new budget categories with differing incentive levels allowed newer, more sophisticated energy storage configurations access to the program across multiple sectors. These changes have contributed to where the program is today.

FIGURE 3-2: SGIP STORAGE CUMULATIVE PROJECT COUNT AND CAPACITY (MWH) BY PROGRAM YEAR

The residential sector began seeing increased participation with energy storage paired with on-site solar generation as the predominant configuration and, more recently, the program has re-focused to equity and customer resiliency as wildfire threats have compelled utilities to exercise their authority to carry out public safety power shutoffs (PSPS).

This is evident from the slope of the project count line in Figure 3-2 and the growing increase in overall residential capacity, relative to the non-residential sector. Prior to PY 2017, residential projects represented roughly two percent of total program capacity and 42 percent by project count. At the end of PY 2021, they represented 47 percent of total program capacity and 96 percent by project count.

Figure 3-3 and Figure 3-4 present the program year total capacities and project counts by budget category, respectively. In PY 2017, the Large-Scale non-residential storage category represented roughly 14 percent of total project applications and 81 percent of capacity. By PY 2021, these projects represented two percent of all projects and 39 percent of capacity. Large-scale residential projects, currently represent four percent of projects and 6 percent of capacity. The Small Residential category represents the most significant share of projects overall. Beginning in PY 2020 – when the Equity Resiliency budget first opened – the program has experienced a greater increase in participation from this budget category. By the end of PY 2021, the Equity Resiliency category represents 16 percent of storage count and capacity.

The stunted growth in applications from PY 2020 to PY 2021 is attributed to the speed with which the Equity Resiliency budget subscribed in 2020. Almost all funding within that budget category was reserved within the first program year, with the remaining funding being reserved in PY 2021. We also observe modest growth in the Small Residential budget category from PY 2020 to PY 2021 as application submittals and subscription followed suit to that of the Equity Resiliency budget. The Small Residential budget category is currently in the final steps of subscription across PAs. The Large-Scale storage category remains open and not fully subscribed.

FIGURE 3-3: SGIP STORAGE CUMULATIVE CAPACITY (MWH) BY PROGRAM YEAR AND BUDGET CATEGORY

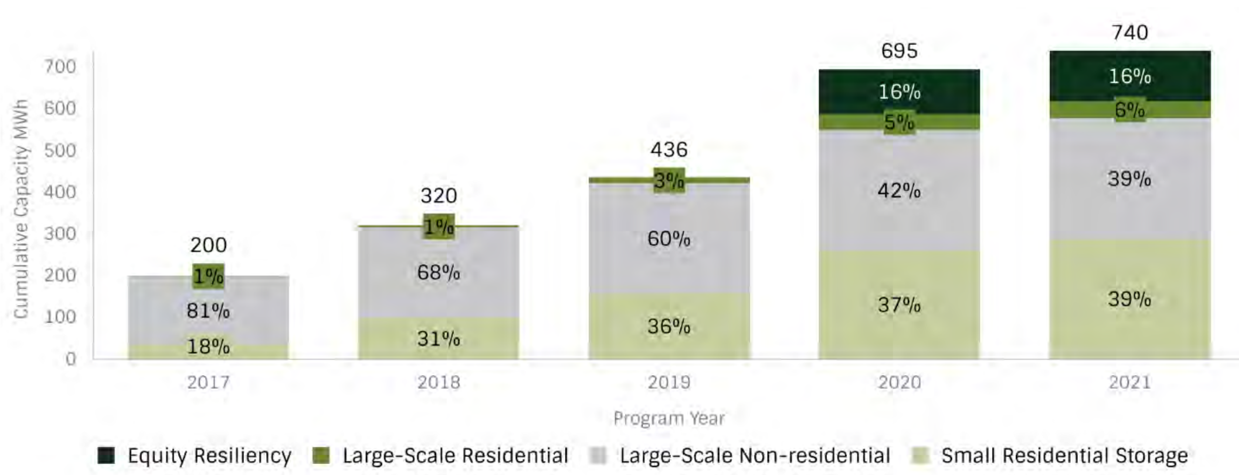


FIGURE 3-4: SGIP STORAGE CUMULATIVE PROJECT COUNT BY PROGRAM YEAR AND BUDGET CATEGORY

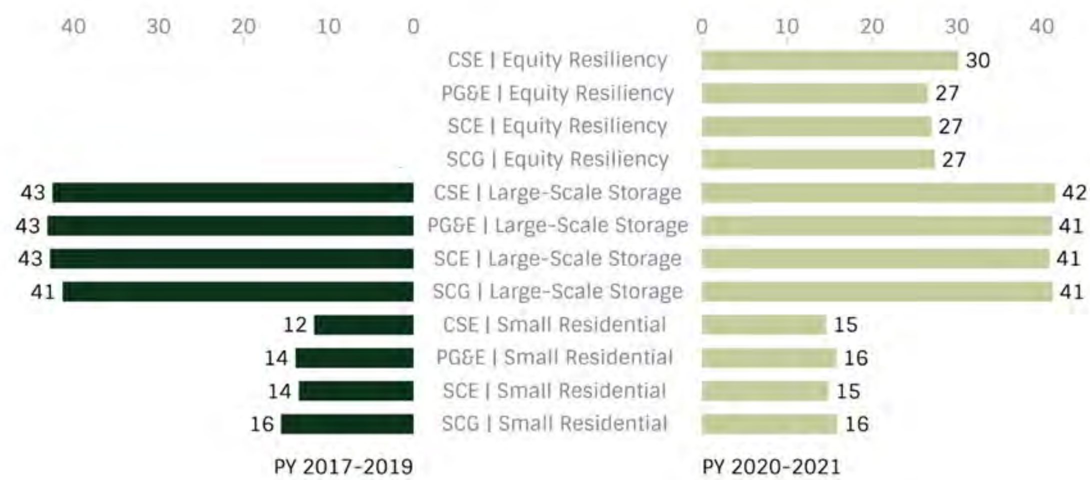
Each of the SGIP budget categories have specific participation requirements, budget allocations and incentive levels. There are geographic constraints for customers applying to the Equity Resiliency budget and there are storage size constraints for customers applying to the Small Residential budget category. Verdant reviewed the program tracking data to examine whether there were any material differences in storage system size, incentive, and project cost across each of the budget categories as well as over time. The forthcoming analyses focus on the residential sector, given their weight and recent contribution to SGIP participation, but we provide non-residential summaries where applicable. SGIP summaries presented for the Large-Scale storage budget category include only residential projects unless otherwise noted.

3.1.1 SGIP Storage System Sizing

Figure 3-5 presents the average residential storage capacity kWh for each program administrator and budget category by program year grouping. Program years have been grouped into 2017-2019 and 2020-2021. The 2020 and 2021 budget categories were combined so that comparisons to the Equity Resiliency budget could be made more transparently. While not presented below, non-residential projects incented through the Large-Scale storage budget are, on average, 564 kWh. Across program years within the Large-Scale residential and Small Residential budgets, there are minimal differences overall, but we observe a slight capacity increase in the Small Residential budget for CSE (SDG&E service territory) and PG&E. The key differences, overall, are the size ranges across budget category, independent of year.

Small Residential systems are the smallest as this category is open to systems sized less than or equal to 10 kW, with an average of 15 kWh. Large-Scale storage incentives are open to installations greater than 10 kW, with an average of 41 kWh. The Equity Resiliency budget has no sizing minimum or cap, and the average system size is roughly 28 kWh. Again, this category is open to customers residing within Tier 2 and Tier 3 HFTDs or have experienced more than two PSPS events. A larger system could provide more resiliency over a two- or three-day grid outage stemming from a PSPS event — which Verdant has regularly observed – than a smaller system.

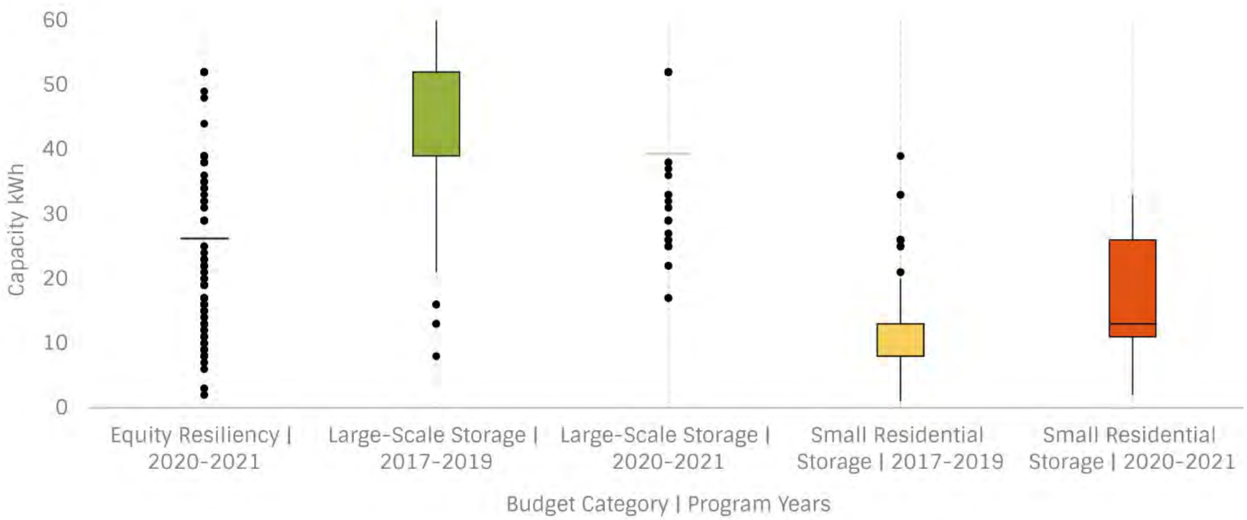
FIGURE 3-5: AVERAGE CAPACITY KWH BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING



Beyond differences across budget category and program year, Verdant also examined the variability of storage size within a specific budget category. The above estimates, while informative, are simple averages that don't consider the distribution of storage product offering capacities. Figure 3-6 presents box plots of energy storage capacities by budget category and program year grouping. The Equity Resiliency budget and PY 2020-2021 Large-Scale storage projects exhibit limited variability in capacity kWh — 70 percent of all Equity Resiliency projects are 26 kWh energy storage systems, and 76 percent of Large-Scale storage systems are 39 kWh. This is signified by the very narrow band around the observed project sizes within those budget categories. The PY 2017-2019 Small Residential budget category rebates the smallest storage systems, which is evident above, and the observations are normally distributed — with most systems in the 8 kWh to 13 kWh range. In the non-residential sector (not pictured), there is far more variability in project-specific size specifications given the varying load shapes, peak demand requirements and facility types represented within that sector.

We observe the most significant distribution of storage sizing in the PY 2017-2019 Large-Scale residential and PY 2020-2021 Small Residential categories. There is more heterogeneity in project size within these budget category-program years, with a greater incidence of larger systems when compared to their respective budget categories in other program years.

FIGURE 3-6: BOXPLOTS OF CAPACITY KWH BY BUDGET CATEGORY AND PROGRAM GROUPING



3.1.2 SGIP Storage Incentives

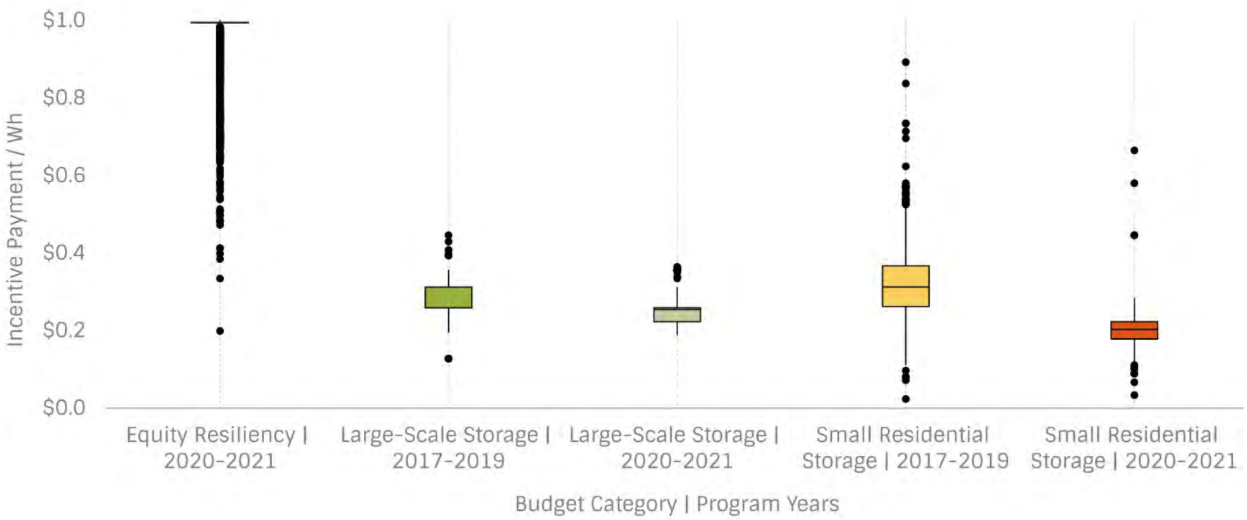
Verdant also reviewed the program tracking data to analyze the incentive payments SGIP customers received as part of program participation. These incentives are tied to the year in which a participant applied to the program and, more importantly, to their budget category. In PY 2017, the Large-Scale and Small Residential incentives began at $0.50/Wh and declined by $0.05 after each incentive step was fully subscribed and another was opened. When the Equity Resiliency budget was created in D. 19-09-027, the incentive was set to $1.00/Wh. The program previously had trouble garnering applications for the equity budget, which was carved out in D. 17-10-004 and offered an upfront incentive of $0.85/Wh. The program increased the incentive for the Equity Resiliency budget to $1.00/Wh in response.

Figure 3-7 presents the average incentive payments per watt hour of capacity for each of the program administrators (PA), by budget category and program year grouping. These estimates reflect the average incentive for that category by the end of 2021 and reflect an average across incentive steps and program years. The reduction in average incentive by program year group, particularly in the Small Residential category and independent of PA, illustrates this reduction in incentive as higher incentive steps fully subscribe and subsequent lower incentive steps open. While the Equity Resiliency budget incentive is set to $1.00 per watt hour, the incentive is also capped at the total cost of the project. A self-reported project cost of $0.70 per watt hour, for example, is eligible for a $0.70 per watt hour incentive.

FIGURE 3-7: AVERAGE INCENTIVE/WH BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING

Figure 3-8 presents the distribution of storage incentives per watt hour for each of the budget categories and program year groupings. As discussed above, we observe a tight clustering of incentive payment around $1.00 per watt hour in the Equity Resiliency budget, but we also observe some projects securing incentives below that value. The average incentive in the Large-Scale storage and Small Residential categories are lower in PY 2020-2021 compared to PY 2017-2019, which indicates higher incentive steps fully subscribing in earlier program years and stepping down as applications are submitted. This is also reflected by less variability in inter-project incentives for those program years within those budget categories in PY 2020-2021 because projects applying in 2020 and 2021 were securing incentives in later incentive steps.

FIGURE 3-8: BOXPLOT OF INCENTIVE/WH BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING



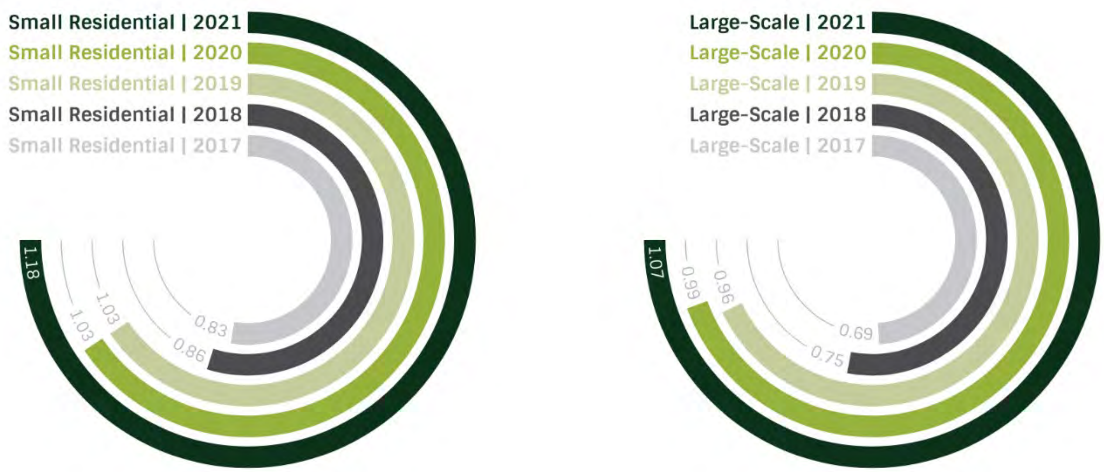
3.1.3 SGIP Storage Total Eligible Costs

Verdant also reviewed the eligible costs reported by host customers, applicants, and system owners. Customers are required to disclose this information as part of the application process, along with all other incentives they have received, plan to receive or have applied for. The sum of the SGIP incentive and any other incentive received for the project may not exceed the total eligible project costs. If the total exceeds the eligible costs, the SGIP incentive is reduced until the sum of the SGIP incentive, combined with any others, equals the total eligible costs.

While the storage capacity is tied to the configuration of the system and incentives are tied to specific reductions based on subscription step downs, total eligible costs are self-reported data provided by host customers, applicants, and system owners and generally consider a variety of costs – capital equipment costs, labor and installation costs, permitting and interconnection costs, etc. Verdant summarized the self-reported eligible cost data to help frame how costs differ based on budget category and the program year of application. We also interacted these data with the size of the system and the average incentive paid to better understand if there were any evident trends or changes in total costs over time.

Figure 3-9 presents the average self-reported eligible costs for Small Residential and Large-Scale storage projects by program year. We observe an increase in total cost per watt hour of capacity for each program year across both budget categories. On average, self-reported costs were roughly $0.83/Wh in PY 2017 and climbed to $1.18/Wh by the end of PY 2021. A similar pattern is evident within the Large-Scale storage category – roughly $0.69/Wh in PY 2017 to $1.07 by the end of 2021. We observe a more significant increase in both budget categories from 2018 to 2019 and again from 2020 to 2021. While not presented below, the average costs for Equity Resiliency projects were $1.06/Wh for both PY 2020 and 2021.

FIGURE 3-9: AVERAGE TOTAL ELIGIBLE COST/WH BY BUDGET CATEGORY AND PROGRAM YEAR



We further disaggregated the cost data by budget category, program administrator and grouped program year. Figure 3-10 conveys those averages with PY 2017-2019 on the left and PY 2020-2021 on the right. As evident above, we observe an increase in self-reported eligible costs over time and variability across program administrator as well. Projects administered by CSE have the lowest project costs by each program year grouping for both Small Residential and Large-Scale storage projects. PG&E had the highest self-reported average costs within those two budget categories in PY 2020-2021. Furthermore, SGIP applicants were self-reporting similar total eligible costs for systems installed within the Equity Resiliency and Small Residential budget category for PY 2020 and 2021.

FIGURE 3-10: AVERAGE TOTAL ELIGIBLE COST/WH BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING

We observe an average increase in total eligible costs in subsequent program year groupings, but not in the distribution of individual project costs, for the Small Residential and Large-Scale storage categories (Figure 3-11). The variation in individual self-reported project costs is less in PY 2020-2021 than in PY 2017 -2019 for large scale storage projects and similar across Small Residential program groupings. The Equity Resiliency budget has the least variability in individual project costs, as a percentage of capacity, with an average of $1.09/Wh and median cost of $1.01/Wh.

Later in this chapter, we review how the distribution of installations by project developer and battery manufacturer impact the variability in project costs. Some manufacturers of energy storage within the SGIP also develop and install systems, while other developers are downstream channel partners to a manufacturer. Battery costs will differ if a manufacturer installs their own product compared to a developer first purchasing the equipment from a manufacturer and then installing it. Furthermore, energy storage systems are built and configured in a variety of ways, which has an impact on the capital cost of the system. Finally, installation costs – which are built into the total eligible costs – may vary based on a developer's market share or geographic region of sales and installation.

FIGURE 3-11: BOXPLOTS OF TOTAL ELIGIBLE COST/WH BY BUDGET CATEGORY AND PROGRAM GROUPING

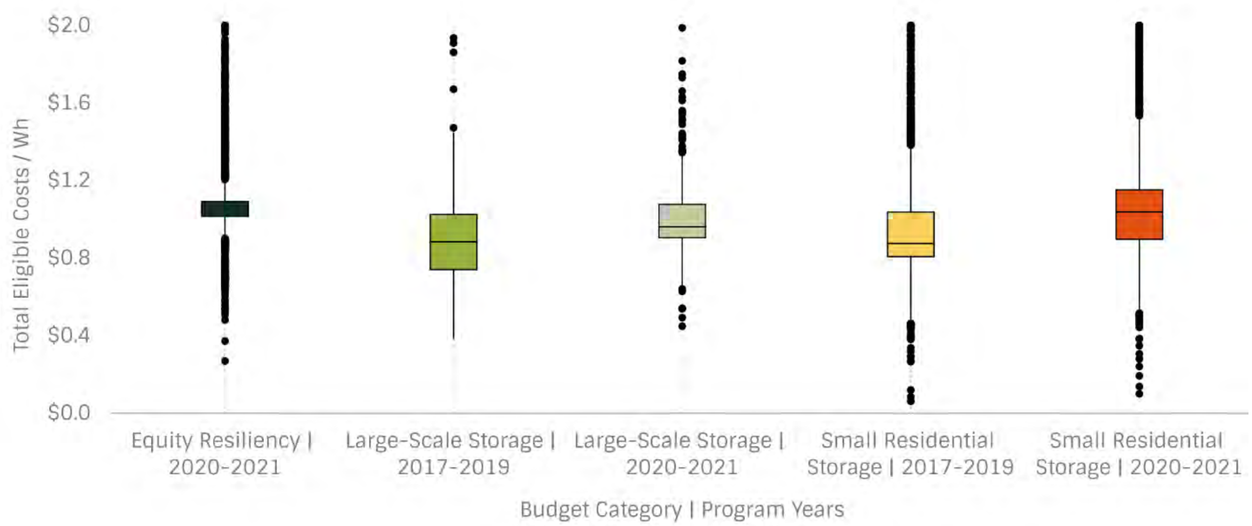
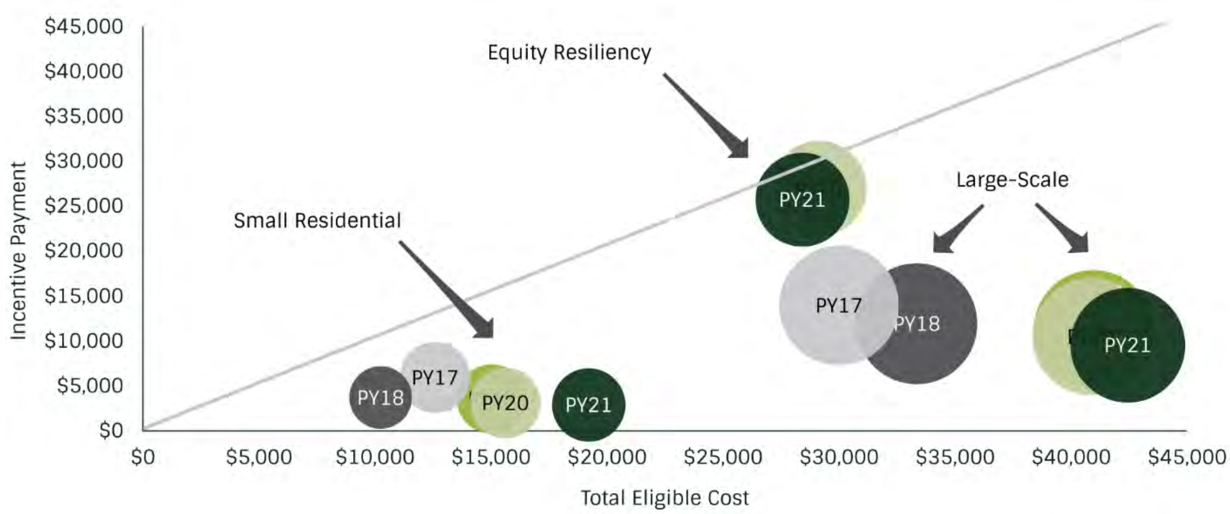


Figure 3-12 combines the information above and presents the average total eligible costs (horizontal axis) and incentive payment (vertical axis) for each budget category and program year. The size of the bubble represents the relative size of the storage systems within that budget category-program year and, for reference, if the SGIP incentive equals the total eligible project cost, the budget category-program year value would fall on the gray line. As expected, we observe differences in sizing across budget category, but far less variability within. Furthermore, we observe differences in incentive payments and total eligible costs across budget. We also observe a slight decrease in incentive payment over time, but a more prominent increase in total costs within the Small Residential and Large-Scale storage categories across program years.

FIGURE 3-12: AVERAGE INCENTIVE AND COSTS BY BUDGET CATEGORY AND PROGRAM YEAR



3.1.4 SGIP Storage Out-of-Pocket Costs

One important metric, which considers both the total eligible project cost and the SGIP incentive payment, is total out-of-pocket expense. An incentive of $1.00/Wh would require an SGIP participant to pay a small percentage of the total cost of the system, as many energy storage product offerings are priced near that estimate. Figure 3-13 conveys that, on average, customers in the Equity Resiliency budget category paid four percent to nine percent across program administrator. On the other hand, Small Residential and Large-Scale storage customers were paying 61 percent to 72 percent across PY 2017-2019. The out-of-pocket expenses for customers in the Large-Scale budget category increased marginally in PY 2020-2021 with modest decreases in overall incentives and increases in total eligible costs. For Small Residential customers, the increases were more prominent. Small Residential PG&E customers, for example, were paying 67 percent, on average, throughout PY 2017-2019. In PY 2020-2021, lower incentives and increasing self-reported costs lead to PG&E customers paying 83 percent of total project cost, on average.

FIGURE 3-13: OUT-OF-POCKET EXPENSE/WH BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING

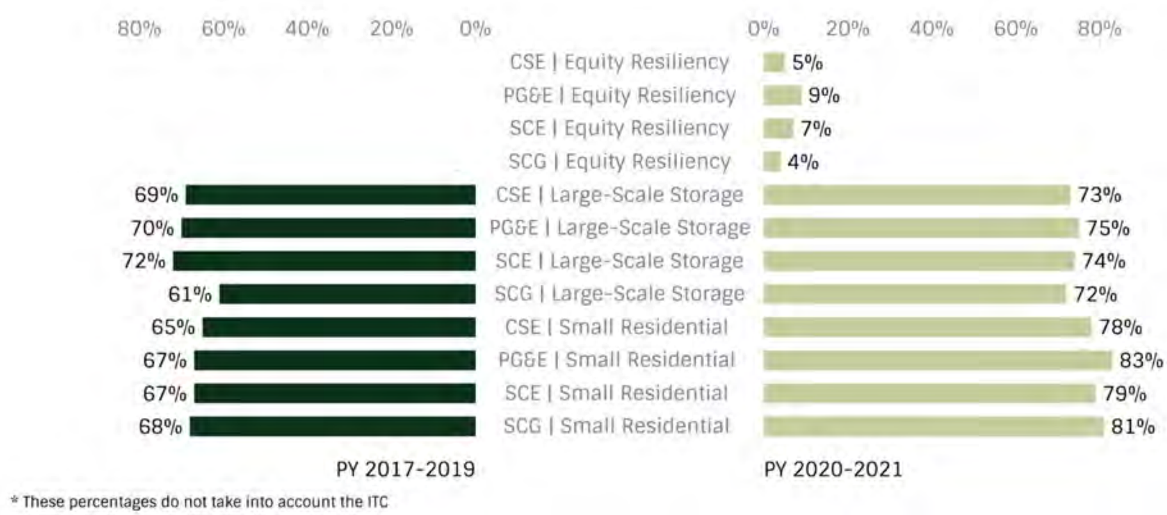
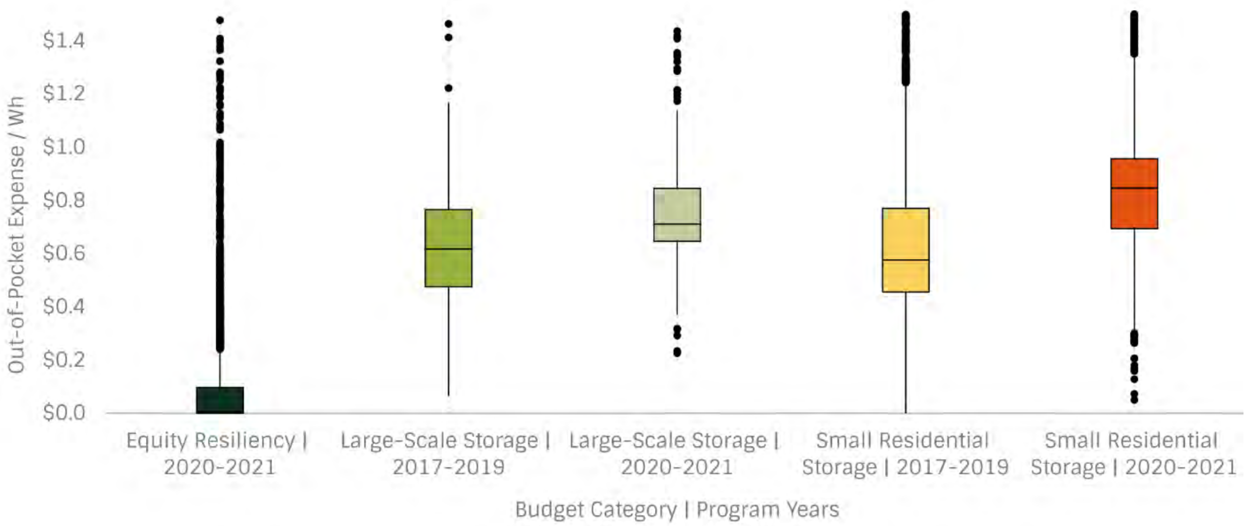


Figure 3-14 presents box plots of those out-of-pocket expenses for each of the budget category-program year groupings. Given the interaction of eligible costs and incentives, there is more inter-project variability in overall out-of-pocket expenses for each of the budget category program year groupings. Out-of-pocket expenditures in the Equity Resiliency budget, as discussed, were much lower than the other categories given the relative size of the incentive payment. Both the Large-Scale storage and Small Residential costs were increasing from PY 2017-2019 to PY 2020-2021 as higher incentive steps fully subscribed and lower incentive steps opened and total reported eligible costs continued to increase.

FIGURE 3-14: BOXPLOTS OF OUT-OF-POCKET EXPENSE/WH BY BUDGET CATEGORY AND PROGRAM GROUPING

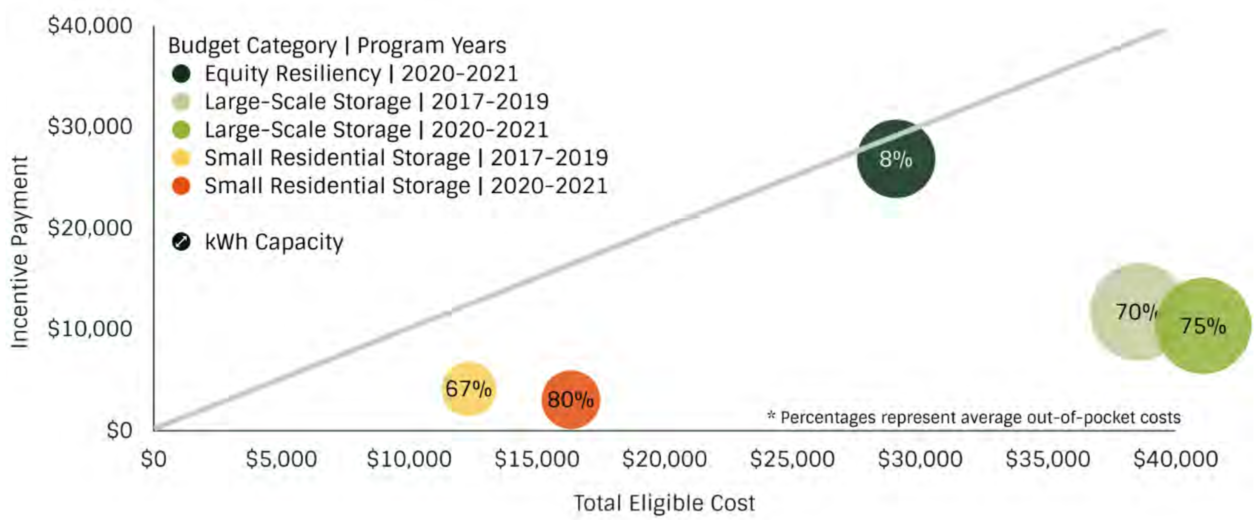


One potential justification for an increase in project costs and, by extension, out-of-pocket expenditures is that customers in 2021 were installing larger energy storage systems than in 2017 or 2018 within the Small Residential budget category. We observe a modest increase in capacity from PY 2017-2019 to PY 2020-2021. The more substantial increases in costs, however, don't necessarily correlate with this.

Figure 3-15 presents the five categories discussed above: 1) Budget category and program year grouping, 2) total incentive payment (vertical axis), 3) total eligible costs (horizontal axis), 4) the average capacity kWh (relative size of each bubble), and 5) the average out-of-pocket cost (percentage within each bubble). Again, for reference, if the SGIP incentive equals the total project cost, then the budget category-program year grouping would fall on the gray line.

As expected, Large-Scale storage projects (green bubbles) are much larger than Small Residential (orange bubbles) and Equity Resiliency (dark green bubble) projects, and the average self-reported costs are greater as well. Equity Resiliency projects, although smaller than Large-Scale storage projects, are larger than those in the Small Residential budget category. They sit close to the gray line because the total eligible costs are well aligned with the total incentive payment. The Small Residential projects have lower costs and lower incentive payments than each of the other categories. The incentive payments and eligible costs in the Small Residential and Large-Scale storage budgets increase from PY 2017-2019 to PY 2020-2021, with a more significant increase in total costs across program year grouping for Small Residential projects. The increases in self-reported costs, combined with reductions in incentive payments increase the average out-of-pocket expense in PY 2017-2019 from 67 percent of total costs (minus incentive) to 80% in PY 2020-2021. Large-Scale storage out-of-pocket expenses increased from 70 percent to 75 percent of total project cost.

FIGURE 3-15: AVERAGE INCENTIVE AND COSTS BY BUDGET CATEGORY AND PROGRAM YEAR GROUPING



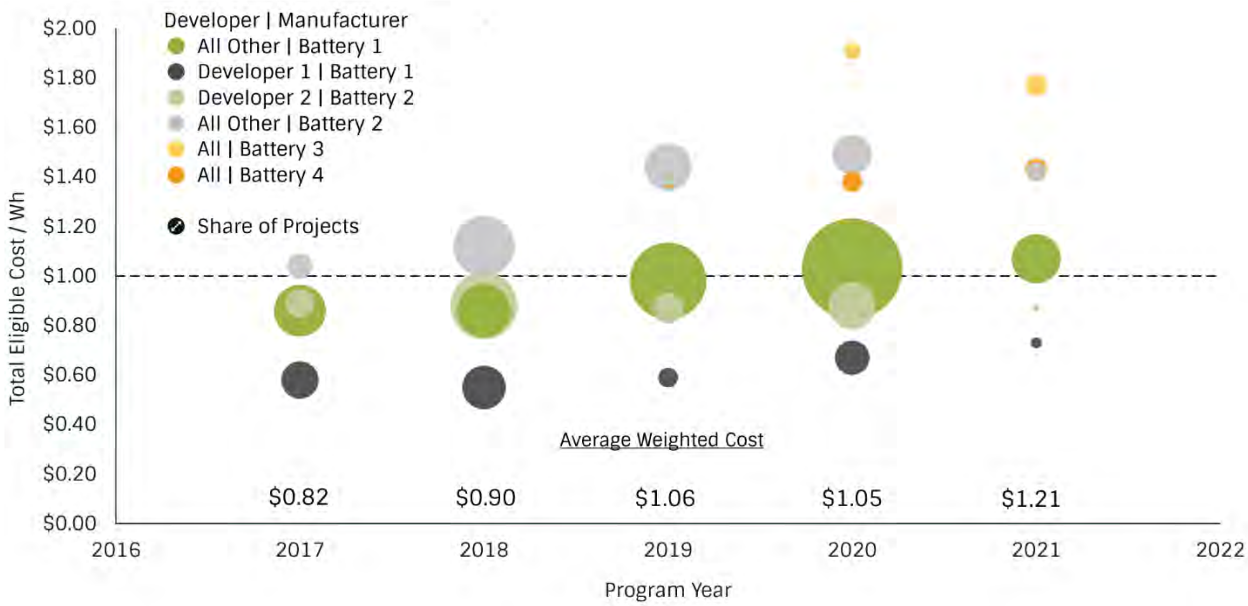
3.1.5 SGIP Storage Developer and Manufacturer

Verdant also reviewed the program tracking data to characterize project developers and energy storage manufacturers to examine their role in the distribution of storage sizing and total eligible costs within a specific budget category over time. Within a given program year, there are well over 100 individual project developers applying to the program and these developers install over a dozen unique storage products throughout California.

Figure 3-16 through Figure 3-18 present the average eligible costs for specific developer-manufacturer groupings for Small Residential, Equity Resiliency and Large-Scale storage, respectively. For each of the figures the categorical program year is presented on the horizontal axis and the total eligible costs per watt-hour of capacity are presented on the vertical axis. Each colored bubble corresponds to a developer-manufacturer grouping that represents at least one percent of total project applications within that program year. Furthermore, the size of the bubble represents the total share of projects that developer-manufacturer represents within that budget category across program years. The dashed line at $1.00/Wh is provided for reference. Finally, the weighted average of total eligible costs is presented at the bottom of the figure for each program year.

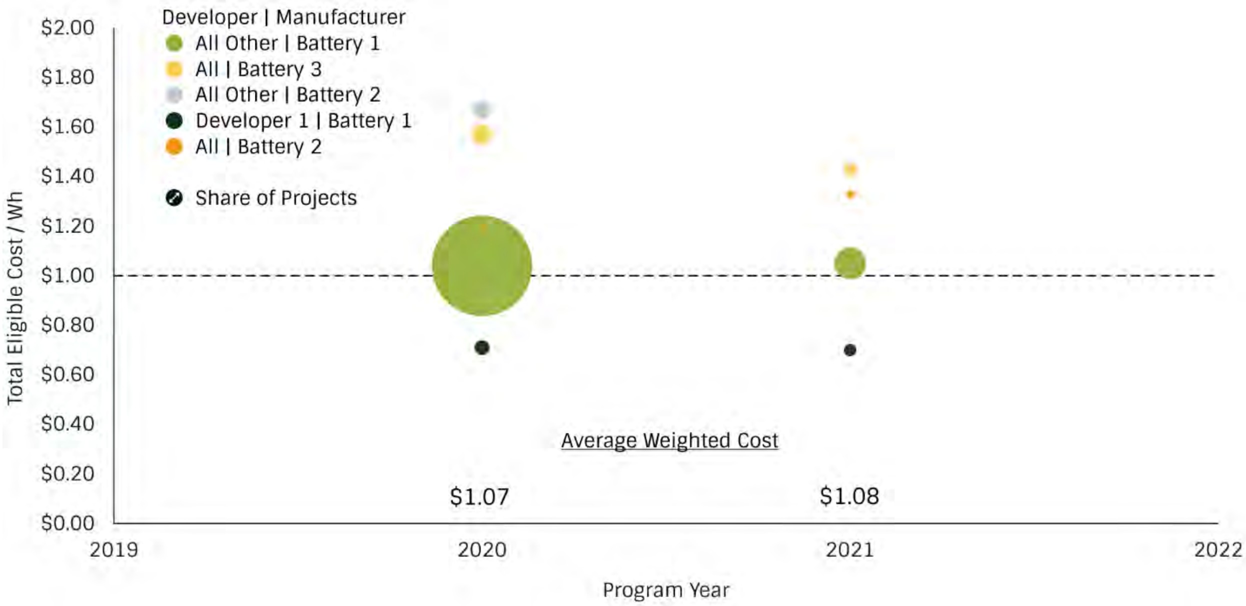
For the Small Residential budget category, we observe an overall increase in total program year eligible costs – from $0.82/Wh in 2017 to $1.21/Wh in 2021 (Figure 3-16 below). This is driven primarily by an increase in costs over time across all developer-manufacturers, along with the distribution of developer-manufacturers within each program year. Developer 1-Manufacturer 1 has the lowest reported costs, and their contribution to project applications is much greater in PY 2017 than PY 2021, for example. Furthermore, there are newer product offerings (Battery 3 and 4) in PY 2020-2021 that self-report higher costs than the others.

FIGURE 3-16: SMALL RESIDENTIAL ELIGIBLE COSTS BY DEVELOPER-MANUFACTURER AND PROGRAM YEAR



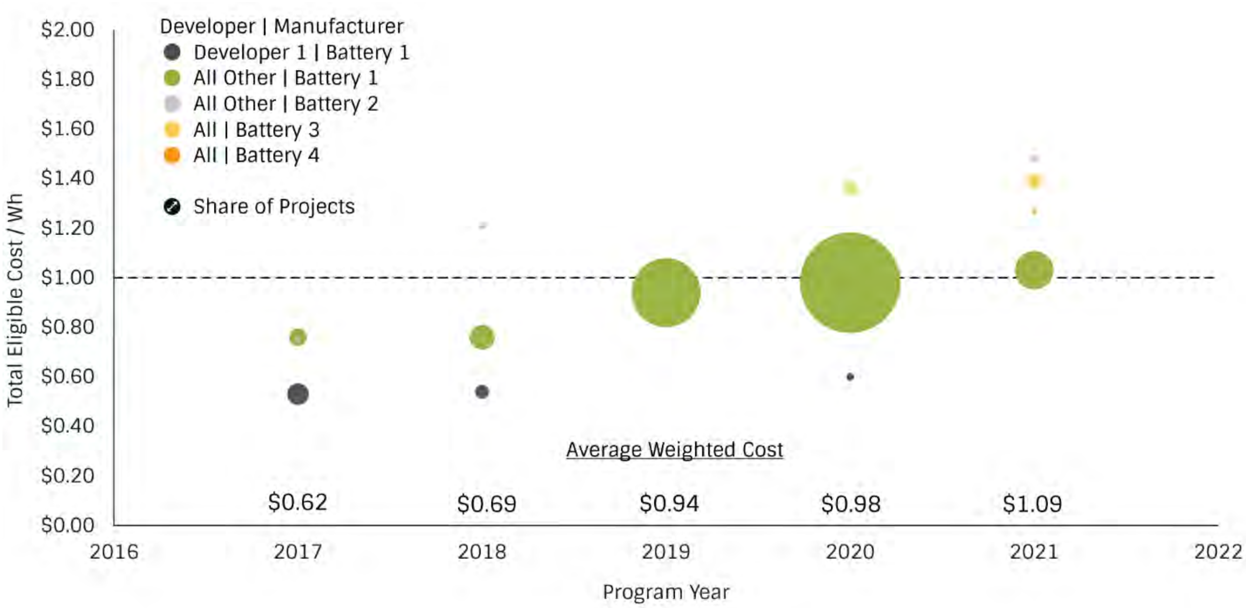
The self-reported costs in the Equity Resiliency budget are similar across program year, but the total projects applying to the program and the distribution of applications are different (Figure 3-17 below). Channel partners installing Battery 1 (green bubbles) comprise a significant majority of program applications, and their average reported costs are slightly over $1.00/Wh. Other developer-manufacturer combinations represent a much smaller percentage of total applications for both years.

FIGURE 3-17: EQUITY RESILIENCY ELIGIBLE COSTS BY DEVELOPER-MANUFACTURER AND PROGRAM YEAR



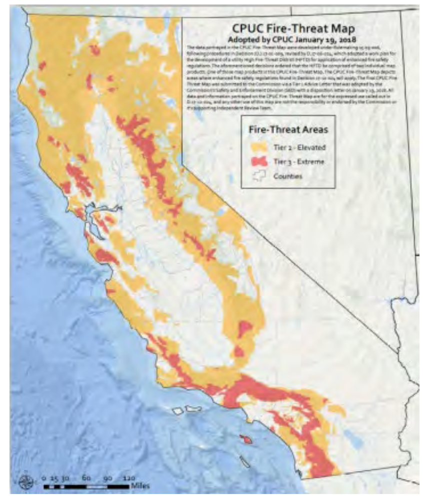
Trends in the Large-Scale storage budget are consistent with those in each of the other two categories (Figure 3-18 below). We observe an overall increase in self-reported costs – from $0.62/Wh in 2017 to $1.09/Wh in 2021 – across program year and within each developer-manufacturer across time. Again, channel partners installing Battery 1 represent the most significant share of applications, especially in PY 2019 and PY 2020.

FIGURE 3-18: LARGE-SCALE STORAGE ELIGIBLE COSTS BY DEVELOPER-MANUFACTURER AND PROGRAM YEAR



3.1.6 SGIP Within High Fire Threat Districts (HFTD)

Wildfire risk poses a unique challenge in California, especially during periods of high temperature, low humidity and gusting winds in the late summer and fall. These severe weather events can threaten the electricity transmission and distribution system and, more importantly, vulnerable individuals and communities. In 2018, the CPUC, working alongside CAL FIRE and other public safety officials, developed a High Fire-Threat map which identified areas that are at extreme risk or elevated risk for wildfires. Furthermore, the CPUC built upon earlier rules providing authority to electric utility companies to shut down portions of the electric grid in response to these threats. Decision 19-09-027 followed, establishing the Equity Resiliency budget for the SGIP to help deal with critical needs resulting from electric grid power shutoffs and public safety power shutoff (PSPS) events.

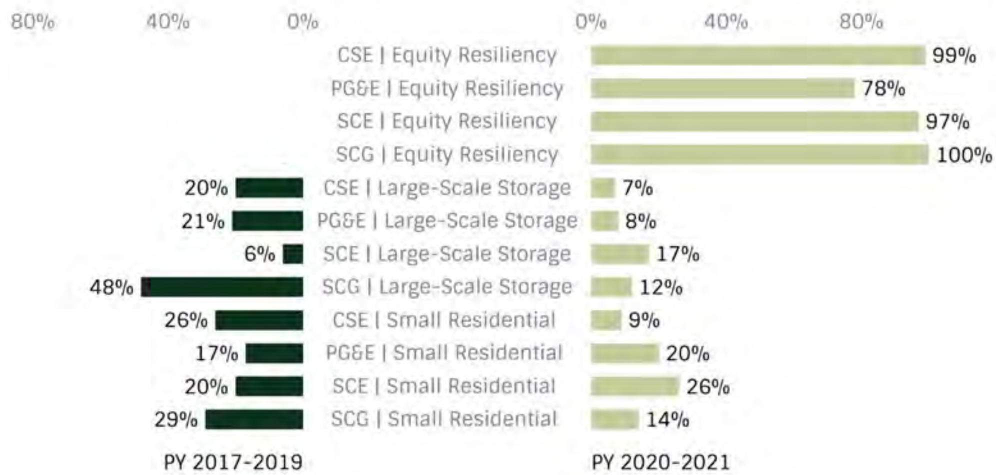


California State Parks, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS | Esri, USGS | CAL FIRE

The SGIP began tracking customers living in HFTDs and those experiencing more than two PSPS events in PY 2020 as these were eligibility criteria for the Equity Resiliency budget category. Verdant also geocoded participant customer addresses from the Small Residential and Large-Scale storage budgets and overlayed those coordinates onto a map of the HFTDs to determine which customers applying to the program prior to 2020 resided in a HFTD as well.

Figure 3-19 presents the percentage of projects located within HFTDs by PA, budget category and program year grouping. Equity Resiliency projects, as expected, have a much greater share of incented projects installed within Tier 2 and Tier 3 HFTDs. – areas that are at elevated or extreme wildfire risk. We do observe, however, a lower percentage of PG&E projects (78 percent) located within these high-fire threat districts in PY 2020-2021. There were 22 percent of projects within the PG&E Equity Resiliency budget that applied and received incentives through alternative eligibility pathways. These pathways are discussed in more detail below. Furthermore, we observe projects receiving incentives within the Small Residential and Large-Scale storage categories located in HFTDs as well – 20 percent of SCE projects applying in 2017-2019 and 26 percent in PY 2020-2021, for example. The Equity Resiliency budget (ERB) did not exist in PY 2017 – 2019 so it is likely that customers were concerned about resiliency, grid de-energization and wildfire threat before the SGIP created and allocated budget to the ERB.

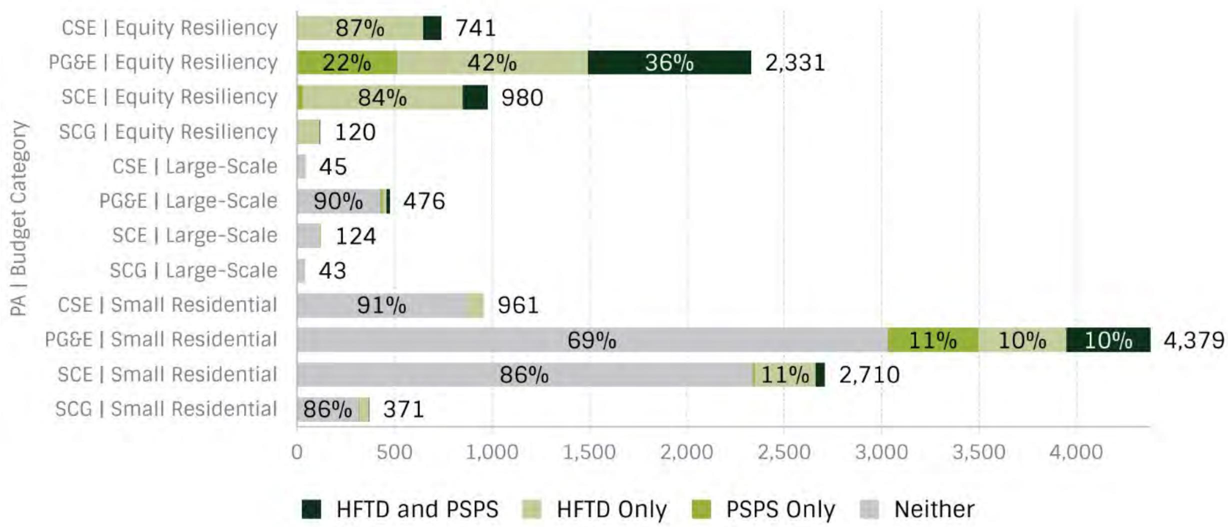
FIGURE 3-19: HFTD BY PA, BUDGET CATEGORY AND PROGRAM YEAR GROUPING



The SGIP began tracking host customer HFTD designation in PY 2020, along with whether a customer experienced two or more PSPS events. These are two program eligibility requirements within the ERB. We examined the program tracking data to assess the pathways by which customers were incented through that program category – especially when we observe 22 percent of PG&E projects receiving incentives and not residing in a HFTD.

Figure 3-20 presents whether: 1) a host customer lives in a HFTD and experienced two or more PSPS related outages, 2) a host customer lives in a HFTD only, 3) a host customer experienced two or more PSPS events, and if 4) a host customer does not live in an HFTD and did not experience PSPS events. Equity Resiliency projects administered by CSE, SCE and SCG are located almost exclusively within HFTD only areas with a small percentage located both in a HFTD and having experienced more than two PSPS events. PG&E projects are more evenly distributed throughout eligibility pathways. Large-Scale and Small Residential projects are primarily located outside of HFTDs, but again, we observe a significant percentage of PG&E projects – 31 percent of all Small Residential projects in PY 2020-2021 – located either in a HFTD only, a HFTD and they experienced at least two PSPS events, or they experienced two or more PSPS events, but live outside of a HFTD. These participants may not be eligible for ERB incentives for other reasons (i.e., they are not eligible under the Equity Budget or are not a medical baseline customer), but they may experience some of the resiliency benefits afforded to ERB participants.

FIGURE 3-20: HFTD DESIGNATION AND PSPS EVENTS BY PA AND BUDGET CATEGORY (PY 2020-2021 ONLY)



3.2 NON-SGIP STORAGE POPULATION AND HOW IT COMPARES TO SGIP

This study also includes an analysis of IOU customers who installed behind-the-meter energy storage systems without receiving an SGIP incentive for the technology. Verdant collected SGIP non-participant energy storage host customer data for this evaluation from the three electric IOUs, utilizing their interconnection data for storage systems. The purpose of these data was to inform the Storage non-SGIP participant market surveys. These surveys have been designed to better understand the barriers and drivers these different customers encounter within and outside the program and identify how the decision-making process for an SGIP non-participant may differ from a customer who installs the system within the program.

Verdant compared the interconnection data received from the IOUs for SGIP participants and non-participants to help identify any nuances or differences in the sizing or the timing of storage installations. Below we present the distribution of SGIP participant and non-participant energy storage installations by permission-to-operate (PTO) year. These data present an increasing percentage of non-SGIP projects being interconnected throughout the three IOU service territories. In 2017 and 2018, SGIP installations represented a slight majority of total installations, but by 2021, non-SGIP installation represented 76 percent of the total. Overall, at the time this Market Assessment was fielded, SGIP residential incented energy storage systems represented roughly 22,000 (40 percent) of all BTM residential energy storage installed in California from 2017 into 2021. Non-SGIP installations represented the remaining 32,000 installations (60 percent).

FIGURE 3-21: SGIP AND NON-SGIP PROJECTS BY PTO YEAR

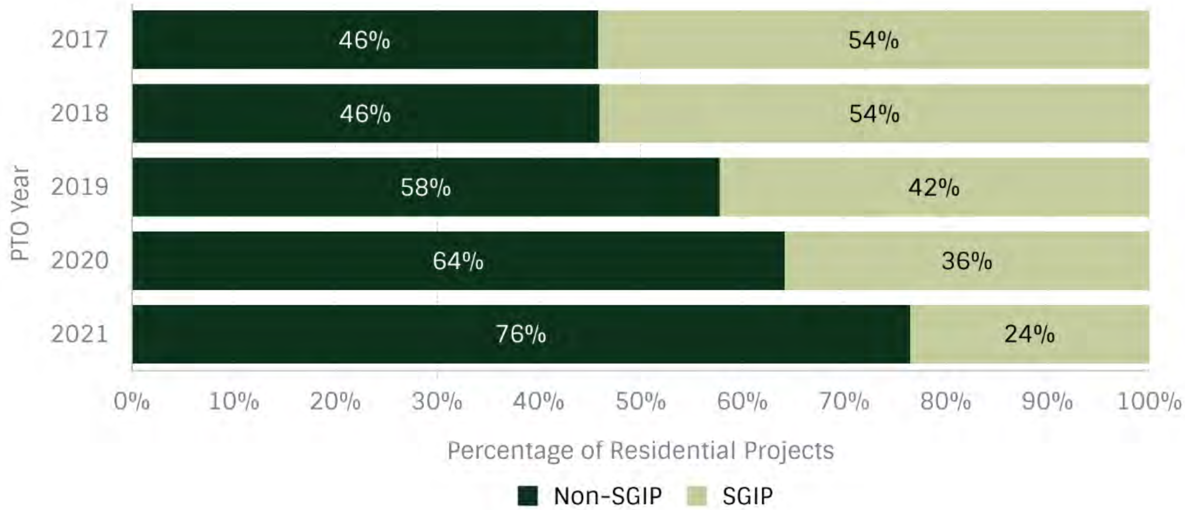
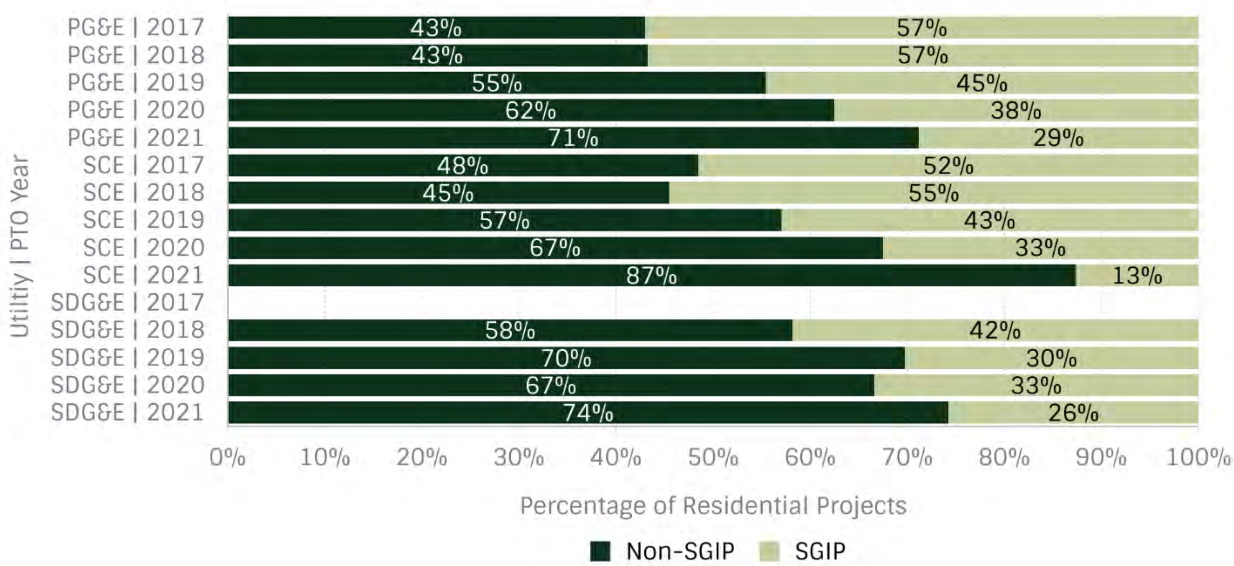


Figure 3-22 presents the distribution by utility and PTO year. A similar pattern is evident across IOU, with SGIP installations representing most installations in 2017 and 2018 for PG&E and SCE. By 2021, however, most interconnections were program non-participants, with 71 percent in PG&E, 87 percent in SCE and 74 percent in SDG&E service territory. The shift from SGIP installations to non-SGIP installations is a multi-faceted one which will be explored more throughout this report.

FIGURE 3-22: SGIP AND NON-SGIP PROJECTS BY IOU AND PTO YEAR



We also compared the average storage system capacities being installed through the SGIP compared to outside of the program. Figure 3-23 and Figure 3-24 present those distributions across time by PTO year and by IOU and PTO, respectively. Across IOU, there are minimal differences in average system sizing when comparing against PTO year, however, SGIP installations are generally higher, on average, in 2021. SGIP capacities are predicated on the distribution of installations across budget category, whereas the general market is not. We do observe within both groups an overall increase in average system sizing over time. This is evident from some of the newer longer duration storage product offerings on the market and a transition in marketing and customer demand for increased resiliency and grid independence.

FIGURE 3-23: SGIP AND NON-SGIP AVERAGE STORAGE CAPACITY KWH BY PTO YEAR

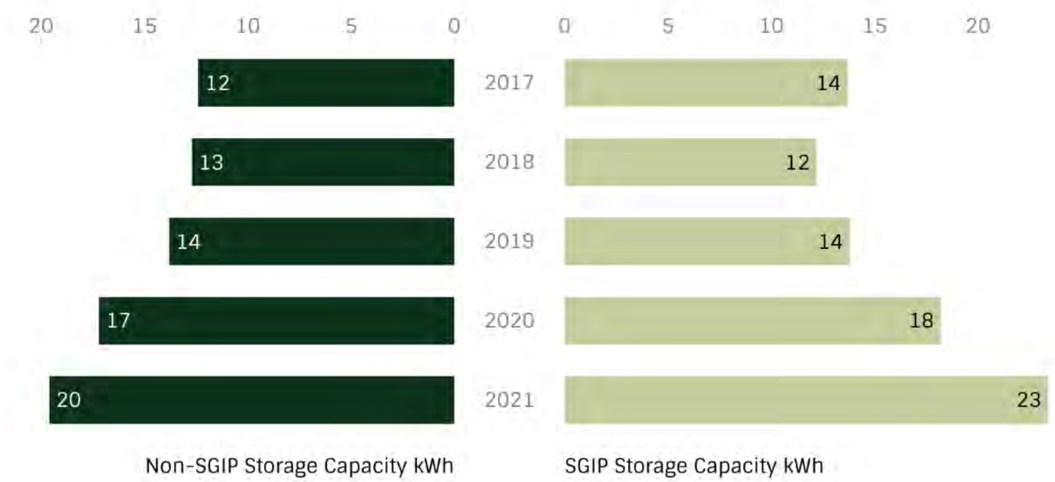
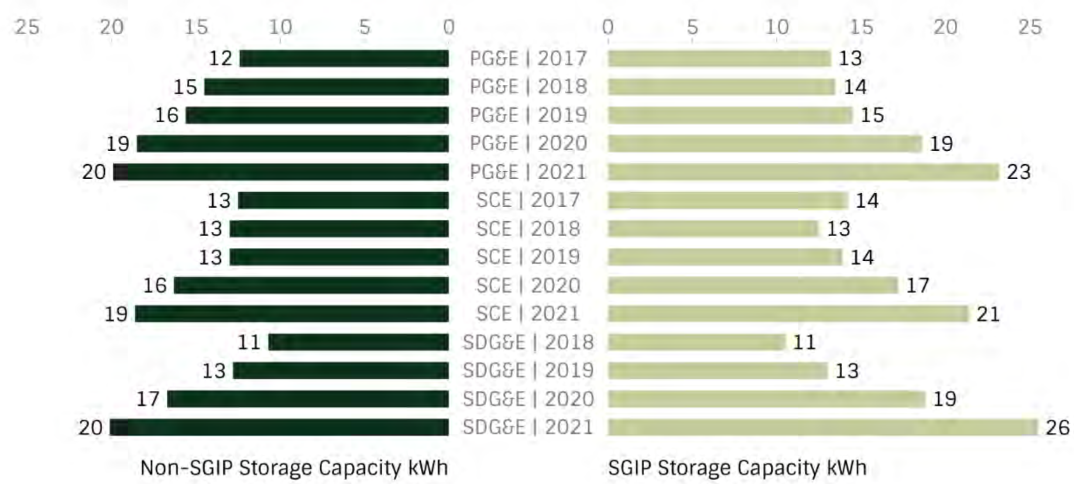
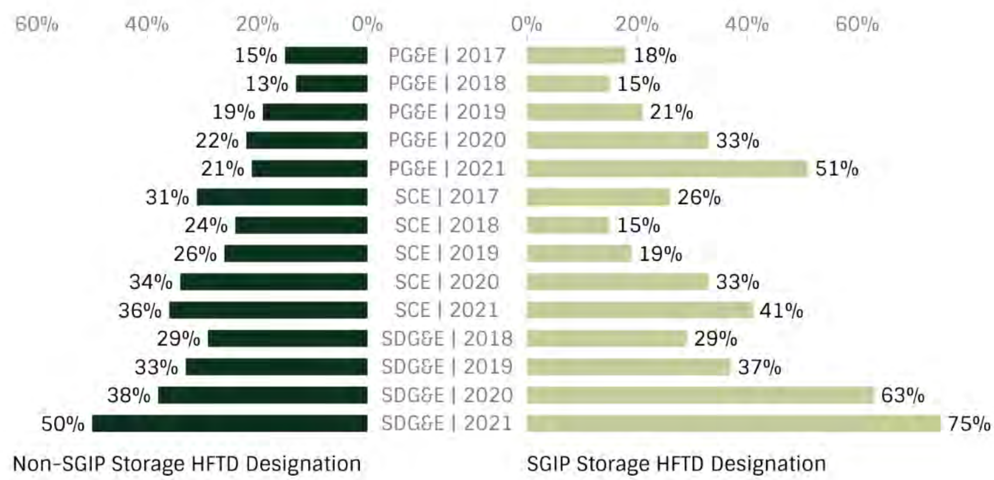


FIGURE 3-24: SGIP AND NON-SGIP AVERAGE STORAGE CAPACITY KWH BY IOU AND PTO YEAR



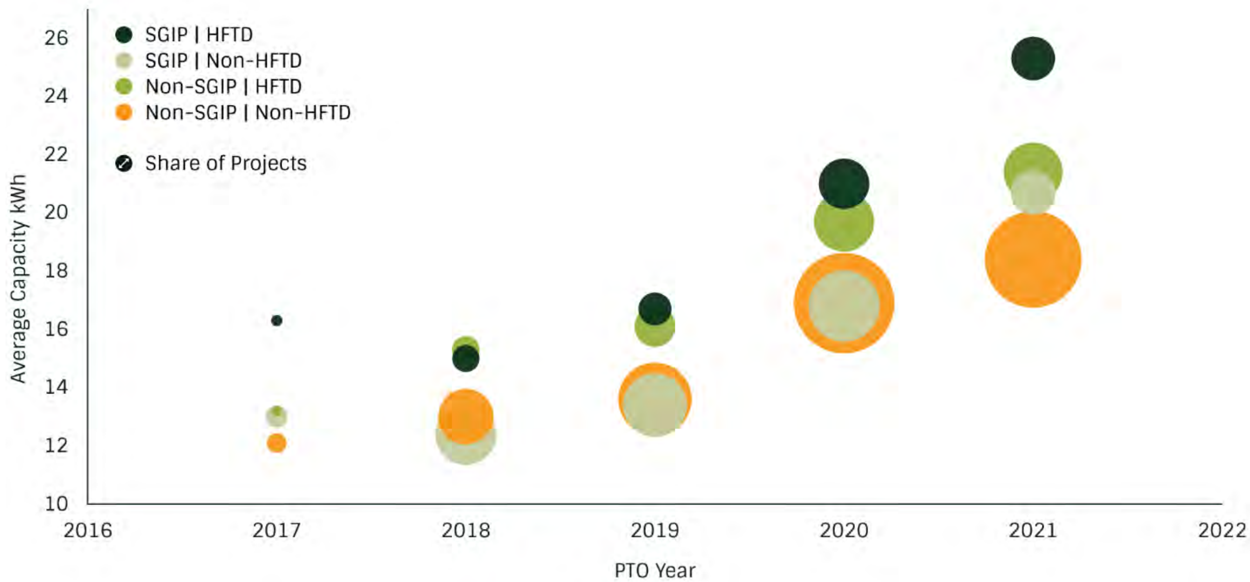
We also reviewed interconnection data provided by the IOUs to gauge the percentage of annual interconnections completed within and outside of high-fire threat areas and compared those to SGIP interconnections. Figure 3-25 conveys those results. In 2017 and 2018, we observe a similar composition of energy storage systems being interconnected in HFTDs across utility, especially in PG&E and SDG&E service territories. This was before CAL FIRE developed the Tier 2 and Tier 3 high-fire threat maps and before Decision 19-09-027 created the Equity Resiliency budget and eligibility requirements. HFTD designated areas existed well before a map was created to characterize them, so it's likely there were more early adopters both within SGIP and outside of SGIP who were marketed to and/or who pursued resiliency and grid independence without the benefit of a $1.00/Wh incentive. The composition of HFTD designation began shifting quite dramatically beginning in 2020 toward SGIP program participation. This coincides with the creation of the ERB. While SGIP participant and non-SGIP interconnections in SCE territory are similar across time, by 2021, PG&E and SDG&E SGIP participants increased to 51 percent and 75 percent of total interconnections, respectively.

FIGURE 3-25: SGIP AND NON-SGIP HFTD INTERCONNECTIONS BY IOU AND PTO YEAR



We also collapsed interconnections across utility and reviewed the average system size by PTO year differentiated by SGIP program participation and HFTD designation. Figure 3-26 presents those results and trends over time. Overall, SGIP installations within HFTDs represent the largest storage capacities across years, followed by non-SGIP HFTD installations. SGIP participant and non-participant installations outside of HFTDs are similar across years and, as signified by the bubble size, non-participant non-HFTD represent the most significant share of project interconnections, especially in 2020 and 2021. The most significant pattern the data reveal is the general trend in capacity increases over time for both SGIP projects and non-participant ones, independent of HFTD designation. The most substantial increases begin in 2019 and continue throughout 2021, with SGIP HFTD projects averaging 25.3 kWh and non-SGIP HFTD projects averaging 21.4 kWh by 2021.

FIGURE 3-26: SGIP AND NON-SGIP CAPACITIES BY PTO YEAR AND HFTD DESIGNATION



3.3 SUMMARY OF SGIP AND NON-SGIP MARKET CHARACTERISTICS

Below we present a summary of key SGIP and non-SGIP energy storage characteristics across program administrator/IOU, budget category, project developer/manufacturer grouping and location of installation over time. These summaries are informed by the analyses conducted above in Section 3.1 and 3.2 and represent inputs into the SGIP host customer and non-SGIP customer market surveys. These data will also be referenced throughout this study to better gauge how customer and developer survey responses align with or deviate from trends in SGIP participation and general market energy storage installations throughout California. These data also represent a baseline by which customer and developer perspectives on the future of energy storage adoption can be tracked and compared against.

VERDANT

FIGURE 3-27: SUMMARY OF SGIP AND NON-SGIP MARKET CHARACTERISTICS

Summary of SGIP and Non-SGIP Market Characteristics

SGIP Storage Population

- Pre-2017 -> residential projects represented 2% of program capacity and 42% of total projects
- By 2021 -> residential projects represent 47% of program capacity and 96% of total projects
  - -78% in Small Residential budget category
  - -16% in Equity Resiliency
  - -6% in Large-Scale storage
- 27,000 total projects issued incentives by the end of 2021. 950 MWh of energy capacity

SGIP Storage Sizing

- Minor increases in storage sizing over time within the residential sector.
- Significant differences in storage sizing across residential budget categories.
  - -Small Residential -> 15 kWh
  - -Equity Resiliency -> 27 kWh
  - -Large-Scale Storage -> 41 kWh

SGIP Incentives

- Incentives tied to budget category and incentive step
  - -Small Residential begins at $0.50/Wh. Currently in Step 6-7 with incentive stepdown
    - -Decrease in average incentive across PY -> Currently $0.20/Wh
  - -Equity Resiliency set to $1.00/Wh. Budget is fully subscribed across PAs
  - -Large-Scale Storage begins at $0.50/Wh. Currently in Step 4-5 with incentive stepdown
    - -Decrease in average incentive across PY -> Currently $0.25/Wh

SGIP Storage Eligible Costs

- Predicated on program year, storage sizing, developer and manufacturer
  - -Small Residential: $0.83/Wh in 2017 -> $1.18/Wh in 2021
  - -Equity Resiliency: $1.06/Wh in 2020 and 2021
  - -Large-Scale Storage: $0.69/Wh in 2017 -> $1.07/Wh in 2021
- Cost increases not associated with general storage capacity sizing increases

SGIP Storage Out-of-Pocket Expenses

- Accounts for interaction between project costs and incentive payments
  - -Small Residential: 67% of total cost in PY 2017-2019 -> 80% of total cost in PY 2020-2021
  - -Equity Resiliency: 8% of total cost in PY 2020-2021
  - -Large-Scale Storage: 70% of total cost in PY 2017-2019 -> 75% of total cost in PY 2020-2021

SGIP Storage Developer and Manufacturer Participation

- Well over 150 project developers installing over a dozen manufacturer batteries
- Observe an increase in total costs across project developer/manufacturer, especially since 2019
- Higher costs w/ newer storage products in PY2020-2021 relative to those with higher market share in the SGIP

SGIP Storage HFTD and PSPS

- Almost all ERB customers reside in a HFTD.
  - -22% of PG&E ERB participants don't reside in a HFTD, but have experienced 2+ PSPS events
- Small Residential and Large-Scale storage participants also reside in HFTDs
  - -31% of PG&E general market participants live in HFTD and/or experienced 2+ PSPS events

SGIP versus Non-SGIP Installations

- Across utility, increasing share of non-SGIP installations over time
  - -Non-SGIP represented 46% of total installations by PTO in 2017 -> 76% in 2021
- SGIP installed capacities slightly higher than non-participant storage installations
  - -2017 SGIP -> 14 kWh and 2017 non-SGIP -> 12 kWh
  - -2021 SGIP -> 23 kWh and 2021 non-SGIP -> 20 kWh
- Increase in share of HFTD installations for SGIP and non-SGIP customers from 2017-2021
- Measured increase in storage capacities over time, especially for projects located in HFTDs
  - -2021 SGIP HFTD -> 25 kWh and 2021 SGIP non-HFTD -> 20 kWh
  - -2021 non-SGIP HFTD -> 21 kWh and 2021 non-SGIP non-HFTD -> 18 kWh

3.4 OTHER STORAGE INCENTIVE PROGRAMS – NATIONAL PERSPECTIVE

The SGIP remains the largest and longest-lived energy storage incentive program nationwide and possibly in the world. Since the SGIP revised eligibility rules for battery storage technologies in 2009 and wholeheartedly in 2011, other jurisdictions throughout the country have tested and implemented programs to deploy battery storage technologies. In this section we provide a list of current or recently closed energy storage programs as an indicator of market activity in other states. Table 3-1 provides a summary of the eleven programs reviewed and notable highlights that may be relevant to California decisionmakers and program administrators. The following subsections include additional details on the program designs.

TABLE 3-1: SUMMARY OF NON-SGIP ENERGY STORAGE PROGRAMS

Program Name	Notable Characteristic
California Self-Generation Incentive Program	Provides incentives for residential and non-residential energy storage systems. Higher incentives for systems that provide resiliency benefits. Dedicated equity budgets. Upfront incentives for smaller systems, performance-based incentives for larger systems. Optional greenhouse gas signal to ensure environmental benefits.
Connecticut Energy Storage Solutions	Both residential and non-residential customers are eligible for upfront and performance-based incentives. Additional incentives are available for those who benefit from increased resilience.
Vermont Green Mountain Power Bring Your Own Device	Up to $10,500 in upfront incentives to customers purchasing their own batteries through local installers.
Vermont Green Mountain Power Powerwall Energy Storage	Customers pay $55 per month for two Powerwall batteries in a 10-year period, with the option of five more years at no additional cost. Customers can alternatively pay $5,500 up front if they choose. Customers also agree to share their stored energy with GMP during peak energy use times.
NV Energy Storage Incentives	There are two incentive levels – customers that are on a TOU rate plan receive a higher energy storage incentive amount. As a consideration for the receipt of the incentive, large commercial customers grant NV Energy the right to remotely control the storage system pursuant to the terms of a demand response or equivalent program.
NYSERDA Retail Storage Incentives	Incentives are provided through a network of pre-approved contractors who contract directly with the customer. NYSERDA assigns a certain amount of incentives by region. Each region is then broken into blocks that are designated an allocation of MWh eligible for incentives. Incentives remain available until all blocks within a region are fully subscribed.
ConEd Brooklyn and Queens Energy Storage Incentive	In exchange for incentives, participants agree to provide Con Edison with full dispatch rights to the energy storage systems on "NWS Event" days with day-ahead notification during 10 consecutive Summer Capability Periods (May 1 – September 30).

Program Name	Notable Characteristic
Massachusetts SMART Battery Adder	If customers pair their solar panel system with a battery, they are eligible for an extra "adder" to their solar incentive rate.
Massachusetts ConnectedSolutions	A demand response program that pays an annual incentive in exchange for allowing the utility company to access and use electricity in your battery during times of peak energy demand. Customers can receive $225 per kW during summer events and $50 per kW during winter events.
Oregon Solar + Storage Rebate Program	Rebates are issued to approved contractors, who pass the savings on to their customers. In the case of a paired solar and storage system, they must be purchased together by the same approved contractor. Stand-alone storage systems, or systems added to existing solar, are not eligible.
Salt River Project Battery Storage Incentive	Salt River Project (SRP) offers up to $3,600 ($300 per kWh-DC) for residential customers who purchase and install qualifying battery storage systems and agree to participate in SRP's battery research study.
JEA Battery Incentive Program	JEA Provides $2,000 incentive per home/business on the purchase of a qualified battery storage system. Only JEA customers with approved renewable generation systems will qualify to receive the incentive.

Connecticut Energy Storage Solutions

On January 1, 2022, Connecticut's Public Utilities Regulatory Authority (PURA) launched Energy Storage Solutions, a statewide electric storage program for all Eversource and United Illuminating (UI) residential, commercial, and industrial customers in an effort to foster a more reliable and resilient electric distribution system, especially for vulnerable communities.[21] Energy Storage Solutions is administered by the Connecticut Green Bank, along with Eversource and UI. The nine-year program will continue through at least December 31, 2030.

Average upfront incentives for residential customers are initially around $200 per kWh, with a maximum per project incentive of $7,500. Commercial and industrial customers are also eligible for upfront incentives, with a maximum incentive of 50 percent of the project cost. Residential, commercial, and industrial customers are all eligible for performance incentive payments based on the average power an electric storage project contributes to the grid during critical periods. Additional incentives are available for those who would most benefit from increased resilience measures, such as low-income customers, customers in underserved communities, small businesses, and customers who historically experience the most frequent and longest duration storm-related outages.

[21] https://portal.ct.gov/PURA/Press-Releases/2022/Connecticut-Launches-Statewide-Battery-Storage-Program

Development of Energy Storage Solutions was informed by objectives outlined in Public Act (PA) 21-53, which establishes a statewide goal of deploying 1,000 megawatts (MW) of energy storage by year- end 2030.

Vermont Green Mountain Power Bring Your Own Device and Powerwall Energy Storage Programs

Green Mountain Power (GMP) serves approximately 266,000 residential and business customers in Vermont. As of June 5, 2020, GMP customers have two home battery programs they can enroll in, the Tesla Powerwall and Bring Your Own Device (BYOD) programs.[22]

GMP's BYOD tariff, developed in partnership with solar companies and Renewable Energy Vermont (REV), offers up to $10,500 in upfront incentives to customers purchasing their own batteries through local installers. At least 500 customers can enroll each year, up to five MW of stored energy annually. Customers can choose from several battery brands, and the amount of stored power they enroll determines the amount of their upfront savings. Customers enrolled in this program also help to lower costs for all GMP customers by providing access to stored energy during peak demand times.[23]

GMP's Powerwall tariff allows up to 500 customers to enroll each year in the program. They pay $55 per month for two Powerwall batteries in a 10-year lease which covers standard installation, with the option of five more years at no additional cost. Customers can alternatively pay $5,500 up front if they choose. Customers also agree to share their stored energy with GMP during peak energy use times, which helps to lower costs for all GMP customers.[24]

On September 29, 2020, GMP announced that its network of stored energy reduced about $3 million in costs for all GMP customers by cutting power demand during energy peaks, especially during the hot, dry summer.[25] Batteries in GMP's programs provided more than 16,000 hours of backup power to customers. On May 12, 2021, GMP announced a new Frequency Regulation Pilot program, which allows customers to share stored energy with regional grid operator ISO-New England (ISO-NE) to keep a steady, regulated flow of energy on the grid at all times.[26] ISO-NE is continually calling on qualified regional energy producers to increase or decrease output to help maintain a balanced flow of power on the grid at all times. This

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22 https://greenmountainpower.com/news/vermont-regulators-approve-pioneering-gmp-energy-storage-programs/

23 https://greenmountainpower.com/rebates-programs/home-energy-storage/powerwall/

24 https://greenmountainpower.com/rebates-programs/home-energy-storage/bring-your-own-device/

25 https://greenmountainpower.com/news/gmps-energy-storage-programs-deliver-3-million-in-savings/

26 https://greenmountainpower.com/news/network-of-powerwall-batteries-delivers-first-in-new-england-benefit-for-customers/

cycling on and off of energy is performed through the Regulation Market, a wholesale energy market that also pays participants for their consistent, quick, and accurate responses to grid needs, which can shift minute-to-minute. Using their network of Powerwall batteries and Tesla Autobidder software, GMP is able to perform this grid service in the wholesale power market with stored energy distributed from customers' homes.

GMP entered the Regulation Market with this network of residential power sources after three months of testing with ISO-NE, and partnerships with ISO-NE, Tesla and Customized Energy Solutions (CES), a software solutions company. Tesla coordinates the distributed batteries to respond to signals from ISO-NE and aggregates critical data about the response. CES provides the key integrations between Tesla and ISO-NE. Two-hundred GMP customers are enrolled in the program as of May 2021, and a prerequisite is that they already have two Powerwall batteries through a GMP program.

GMP plans to expand this pilot program in the future. Customers sharing energy through the program are paid $13.50 per month on their energy statements. This includes a share for their program participation and for the increased use of their batteries, which can charge and discharge rapidly for periods of time each month. GMP takes steps to ensure that customers have backup power available if weather is predicted to cause outages.

NV Energy Storage Incentives

NV Energy Storage Incentives were created by the Nevada State Legislature and are regulated by the Public Utilities Commission of Nevada.[27] They are funded by NV Energy customers and administered by NV Energy. All program participants must qualify for, participate in and comply with all of the rules of Net Metering. The goal of the program is to promote market adoption of energy storage systems by providing monetary incentives. These systems are to benefit utility customers by reducing peak demand, by improving the reliability of the operation of the transmission and distribution grid, and by helping to defer utility investments in new generation, transmission, and distribution assets. NV Energy pays incentives as available as long as there is available funding.

The Residential Storage program is for customers who plan to install solar-integrated energy storage units from 4 kW up to 100 kW capacity and either already have or will install a renewable energy system, like rooftop solar. There are two incentive levels – customers that are on a TOU rate plan receive a higher energy storage incentive amount. The residential incentive rate is $0.19 per watt-hour (Wh) for customers on a TOU rate and $0.095 per watt-hour (Wh) for customers that are not on a TOU rate. The incentive payment is capped at $3,000 per premise for customers on a TOU rate and $1,500 per premise for customers that are not on a TOU rate, or 50 percent of the equipment cost, whichever is less. The energy

[27] https://www.nvenergy.com/cleanenergy/energy-storage

storage device must be capable of being charged by at least 75 percent by a renewable energy source (i.e., solar PV system).

The Commercial Energy Storage Incentives program is for small and large commercial and industrial customers who are going to install an energy storage system. Except for the standalone small energy storage incentive program, to qualify for a storage incentive, a renewable energy system, like rooftop solar, must already be installed or will be installed on the property. There are two programs for commercial energy storage incentives:

- Small Energy Storage Incentives program for systems with 4 kW up to less than 100 kW nameplate capacity.
- Large Energy Storage Incentives program for systems with 100 kW to 1,000 kW nameplate capacity.

The incentive is classified based on three conditions, 1) the customer eligibility for the Federal investment tax credit (ITC); and 2) under the large energy storage program, whether the customer facility qualifies for a critical infrastructure designation; or 3) under the standalone small energy storage program, whether the customer entity is deemed for profit or non-profit/government.

In the commercial market, non-profits and governments are unable to benefit from the investment tax credit (ITC) or accelerated depreciation. Therefore, a higher incentive structure is available for non-profit and government customers. If the project is financed through a third-party ownership model, then the third party can claim the ITC credit. NV Energy determines the incentive amount by the actual transaction and ownership model, not the customer type. The following customers may qualify for the critical infrastructure incentive; 1) Hospitals, 2) Medical facilities, 3) Airports, 4) Public safety facilities, 5) Public infrastructure facilities, and 6) Dams.

Applicants for critical infrastructure must provide evidence that the project supports emergency services always available for public benefit. Applicants categorized as non-eligible for ITC must provide evidence that the company or entity is an agency of a federal, state or local government; or a public school district, an institute of higher education that is part of the Nevada System of Higher Education; an Indian tribe or tribal organization; or a corporation for public benefit as defined in NRS 82.021; or a company who is recognized as exempt from taxation pursuant to section 501(c)(3) of the Internal Revenue Code, 26 U.S.C. § 501(c)(3), as amended.

As a consideration for the receipt of the incentive, the applicant grants NV Energy the right to remotely control the ESD system pursuant to the terms of a demand response or equivalent program approved by the Public Utilities Commission of Nevada. By receiving the incentive, the applicant agrees to participate in such a demand response or equivalent program and enter into any agreement with NV Energy contemplated by the program. This applies only to the Large Energy Storage Program. The energy storage system must be compliant with the OpenADR2.0b standard communications protocol.

NYSERDA Retail Storage Incentives

NYSERDA's Retail Energy Storage Incentive provides commercial customers funding for standalone, grid-connected energy storage or systems paired with a new or existing clean on-site generation like solar, fuel cells, or combined heat and power.[28] Energy storage systems must:

- Be sized up to 5 megawatts (MW) of alternating current (AC) power
- Be new, permanent, and stationary
- Be located in New York State
- Use thermal, chemical, or mechanical commercially-available technology primarily operated for electric load management or shifting on-site renewable generation to more beneficial time periods
- Provide value to a customer under an investor-owned utility rate, including delivery charges or New York State's value of distributed energy resources (VDER)
- Interconnect either behind a customer's electric meter or directly into the distribution system

Incentives for all retail storage projects are provided through a network of participating contractors approved under the Retail Energy Storage Incentive program who contract directly with the customer. Incentive rates are available on the Retail Energy Storage Incentive Dashboards.

NYSERDA assigns a certain amount of incentives by region. Each region is then broken into blocks that are designated an allocation of MWh eligible for incentives. Incentives remain available until all blocks within a region are fully subscribed. NYSERDA intends to phase out incentives within a reasonable timeframe as storage costs decline and the market for energy storage systems becomes self-sustaining. The MWh block structure also supports energy storage markets in the areas where system benefits are the greatest and support is needed most.[29] As each block is fully subscribed, the incentive level will step down in subsequent blocks.

28 https://www.nyserda.ny.gov/retailstorage

29 https://www.nyserda.ny.gov/All-Programs/Energy-Storage/Developers-Contractors-and-Vendors/Retail-Incentive-Offer/Incentive-Dashboard

ConEd Brooklyn and Queens Energy Storage Incentive

The Con Edison Non-Wires Solutions (NWS) team offers incentives for distributed energy resources that help reduce electric demand, in Brooklyn Queens Demand Management (BQDM) eligible neighborhoods within Brooklyn and Queens.[30] The program offers incentives for installing qualified measures that reduce grid peak load, which typically occurs on the hottest weekday evenings. Con Edison offered incentives to customers or developers who installed energy storage systems in eligible neighborhoods of Brooklyn and Queens, which are operational by June 1, 2020.

In exchange for BQDM incentives, participants agree to provide Con Edison with full dispatch rights to the energy storage systems on "NWS Event" days with day-ahead notification during 10 consecutive Summer Capability Periods (May 1 – September 30). There is no minimum Peak Demand Reduction requirement for individual energy storage projects, however projects are limited to a maximum 5,000 kW of rated output. A proposed project or portfolio must be available to provide demand reduction for a minimum of four consecutive hours when called upon via day-ahead notification. Failure to meet operational deadline or contracted Demand Reduction during NWS Event days may result in liquidated damages. A "NWS Event" is called by Con Edison when a determination is made by Con Edison that Demand Reduction is needed to help provide load relief capacity during peak times of demand on the grid, and which results in a request by Con Edison of a participant to meet its Demand Reduction obligation by providing dispatchable energy capacity from the energy storage system.

Massachusetts SMART Battery Adder and ConnectedSolutions Program

The Solar Massachusetts Renewable Target (SMART) program pays Eversource, National Grid, and Unitil customers a bonus for each kilowatt-hour (kWh) of electricity produced by their solar panel system.[31] If customers pair their solar panel system with a battery, they are eligible for an extra "adder" to their incentive rate. The value of the adder depends on the type of battery installed and the size of the solar panel system – for the average 8 kW system in Massachusetts, the battery can earn an additional $237 to $732 a year, or $2,370 to $7,320 over the 10-year duration of the SMART program.

The ConnectedSolutions Program, available to Eversource customers, is a demand response program that pays an annual incentive in exchange for allowing the utility company to access and use electricity you store in your battery during times of peak energy demand.[32] Customers can receive $225 per kW during the summer events and $50 per kW during winter events. Program participants experience a maximum of 60 events during the summer, and five events during the winter. A single event can last no longer than

30 https://www.coned.com/en/save-money/rebates-incentives-tax-credits/rebates-incentives-tax-credits-for-commercial-industrial-buildings-customers/brooklyn-and-queens-energy-storage-incentive

31 https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program

32 https://www.masssave.com/saving/residential-rebates/connectedsolutions-batteries

three hours. The overall incentive benefit will depend on the number of events per year and how much power the battery can provide.

Oregon Solar + Storage Rebate Program

The Oregon Solar + Storage Rebate Program issues rebates for solar electric systems and paired solar and storage systems for residential customers and low-income service providers in Oregon.[33] Rebates are issued to approved contractors, who pass the savings on to their customers. In the case of a paired solar and storage system, they must be purchased together by the same approved contractor. Stand-alone storage systems, or systems added to existing solar, are not eligible.

Organizations eligible as "low-income service providers" include:

- Developers/owners of affordable multifamily housing that are eligible for public assistance administered by Oregon Housing & Community Services.
- A community service organization (public, tribal, or a 501(c) nonprofit) whose primary purpose is to offer health, dental, social, financial, energy conservation, or other assistive services to households below 100 percent of the state median income by household size.
- A tribal or local government entity, such as a city, county, or school district that uses public buildings to provide services to low- or moderate-income individuals, or to provide emergency shelter and/or communications in disaster situations.

Rebates may cover up to 40 percent of the net cost (ODOE defines the net cost of a system as the total of all eligible costs minus any incentive provided by an electric utility or by Energy Trust of Oregon) for a residential system installed for a customer that is not considered low- or moderate-income, up to 60 percent of net cost for a low- or moderate-income customer, and up to 50 percent for a low-income service provider.

For residential projects, the maximum rebate is $5,000 for a solar electric system and $2,500 for an energy storage system. For low-income service providers, the caps are $30,000 for solar electric and $15,000 for an energy storage system.

33 https://www.oregon.gov/energy/Incentives/Pages/Solar-Storage-Rebate-Program.aspx

Salt River Project Battery Storage Incentive

Salt River Project (SRP) offers up to $3,600 ($300 per kWh-DC) for residential customers who purchase and install qualifying battery storage systems and agree to participate in SRP's battery research study.[34] The incentive was offered since May 1, 2018, through April 30, 2021. Batteries are not considered on-site generation, and customers with battery-only installations are not eligible for SRP's solar price plans.

This program works with all SRP residential electric price plans, except M-Power (SRP’s pay-as-you-go program). Eligible customers on M-Power will need to switch to a different price plan to participate, due to current meter technology associated with M-Power. Only customers on one of SRP's solar price plans, or grandfathered solar customers with a net metering rider, qualify to receive SRP bill credits if their battery sends energy back to the grid.

Program participants agree to be available for relevant research studies with SRP to evaluate the battery system and its impact on the grid and customer satisfaction. Research will generally focus on two uses of battery storage systems: 1) as backup power, and 2) for peak reduction. Additional focus areas, such as system configuration comparisons, may also be added as the research unfolds. This research could last up to two years, within the first three years after the battery system is installed.

JEA Battery Incentive Program

Jacksonville Electric Authority (JEA) offers an incentive to help rooftop solar customers install battery storage.[35] The Battery Incentive Program aims to encourage renewable energy adoption by making this technology more affordable for customers. JEA Provides $2,000 incentive per home/business on the purchase of a qualified battery storage system. Only JEA customers with approved renewable generation systems will qualify to receive the incentive.

34 https://www.srpnet.com/electric/home/batterystorage/default.aspx

35 https://www.jea.com/residential_customers/residential_rebates/solar_battery_incentive_program/

4 MARKET ASSESSMENT SURVEY METHODS

This section summarizes the research activities and sources of data used in the market research component of this study. The primary data sources used in this evaluation included:

Pre-existing data sources:

- The SGIP Statewide Project Database[36] managed by the PAs – this dataset was used to create the sample frame for the manufacturer and developer interviews and host customer web surveys.

Requested data source:

- Information on all customers who had installed and interconnected storage was requested from PG&E, SCE, and SDG&E. These data were used to identify customers and create the sample frame for the Storage Non-SGIP cohort who had installed storage without receiving an SGIP incentive.
- Information on a sample of customers who had installed and interconnected solar but not storage was requested from PG&E, SCE, and SDG&E. These data were used to identify customers and create the sample frame for the Solar Non-Storage cohort who had installed solar but not storage.
- Information on a sample of customers who had not interconnected solar or storage was requested from PG&E, SCE, and SDG&E. These data were used to identify customers and create the sample frame for the non-interconnected (non-DER) cohort.

Data Collected from research activities:

- In-depth interviews (IDIs) and web surveys with BTM storage project developers and manufacturers, where applicable
- Web surveys completed by SGIP storage participants (SGIP cohort)
- Web surveys completed by customers who have installed storage that had not received an incentive from the SGIP (Storage Non-SGIP cohort)
- Web surveys completed by solar non-storage participants (Solar Non-SGIP cohort)
- Web surveys completed by non-DER customers (non-interconnected cohort)

36 Accessed October 22, 2021.

The six data collection activities outlined above enabled the evaluation team to better understand individual knowledge and perceptions of energy storage technologies within California. In particular, the IDIs with project developers provided their perspectives on the key drivers, barriers, and trends in the storage market. The web surveys with residential and non-residential customers were used to obtain feedback on their knowledge of storage and the factors influencing their decision to install, or not install, storage. The customer web surveys collected information on the role of SGIP, resiliency, the environment, and other factors in customers' decision to purchase battery storage. The web surveys with residential customers also collected information on customer willingness to pay for battery storage for resiliency. These data were used to calculate an estimate of residential willingness to pay for battery storage systems ($/system) and for the resiliency provided by battery storage systems ($/kWh) by domains of interest.

4.1 SGIP STATEWIDE PROJECT DATABASE

A copy of the SGIP statewide project database was downloaded from www.selfgenca.com on October 22nd, 2021.[37] All completed SGIP BTM residential and nonresidential electrochemical storage projects from program years 2017 through 2021 are included in this evaluation.[38] The breakout of completed projects, developers, and host customers included in this study, by PA, is shown in Table 4-1 below. Some developers and host customers have applications in multiple PA territories and so the SGIP developer and host customer totals do not equal the sum of each PA's subtotals. A total of 22,824 residential and 545 nonresidential completed storage projects were included across all PA service territories.

[37] The total projects subject to evaluation are different than those presented in Section 2. Research planning and sample designs were developed in Q3 of 2021 to allow time to conduct to market research. Those data were pulled on October 22nd, 2021. Whereas the population summaries in Section 2 were pulled in early January.

[38] As of October 2021, there were only three completed thermal storage projects in the SGIP. Consequently, this report considers only electrochemical storage.

TABLE 4-1: SGIP COMPLETED PROJECTS, APPLICANT, AND HOST CUSTOMER COUNT BY MARKET SECTOR AND PROGRAM ADMINISTRATOR

Market Sector	PA	# Completed Projects	# Unique Host Customers	# Developers	Total Capacity MWh
Residential	CSE	3,621	3,581	77	55
	PG&E	10,407	10,283	197	192
	SCG	1,335	1,327	56	24
	SCE	6,916	6,823	160	110
Residential Total		**22,279**	**21,870**	**368**	**381**
Nonresidential	CSE	96	46	22	42
	PG&E	129	82	29	63
	SCG	46	23	8	34
	SCE	274	117	26	136
Nonresidential Total		**545**	**250**	**60**	**275**
SGIP Total		***22,824***	***22,110***	***405***	***656***

4.2 BTM STORAGE MARKET ACTOR IN-DEPTH INTERVIEWS AND WEB SURVEYS

Verdant conducted in-depth interviews (IDI) and web surveys with project developers of BTM storage systems who participate in the SGIP. The sample of SGIP project developers was divided into two segments that were either interviewed by phone by Verdant professional staff or emailed a link to a web survey. The survey instruments used for the IDIs and web surveys were the same and included topics relating to developers' methods for marketing and selling energy storage systems, their projections of current market trends, and their descriptions of the effect the SGIP program has had on the sales of energy storage systems. These interviews included several open-ended questions that allowed detailed descriptions of each developer's experiences and enabled follow-up questioning depending on the answers provided. Appendix B of this report presents the interview guide used for the developer interviews and web surveys.

4.2.1 Sample Design

The sample for the developer interviews and web surveys was designed so that results could be reported with high confidence across the wide variety of developers that worked with host customers to complete projects through the SGIP program. Verdant reviewed the unique developers installing BTM storage in SGIP across PA service territory, application program year and budget category to better understand how specific developers were targeting potential SGIP customers. Ultimately, we identified clusters of developers with varying degrees of market share within the program.

As such, the overall sample was subdivided into four groups based on how many SGIP projects each developer had completed. Developers who had completed 1,000 or more projects were classified as "High Volume" developers, those completing 100 to 999 projects were classified as "Mid Volume", those completing between 5 and 100 projects were "Low-Mid Volume" developers, and those completing fewer than five projects were classified as "Low Volume" developers. While the "High Volume" developers accounted for only 6 of the 405 developers in the sample (2 percent), they accounted for 54 percent of the 22,824 completed projects. Conversely, the "Low Volume" developers accounted for 243 of the 405 developers in the sample (60 percent), but only 2 percent of the completed projects. The "Mid Volume" developers accounted for 25 of the 405 developers in the sample (6 percent) and 32 percent of the completed projects. The "Low-Mid Volume" developers make up the difference – 32 percent of all developers and 13 percent of total completed projects.

A census was attempted with the group of "High Volume" developers, with our goal being to complete 5 interviews out of the sample of 6 developers, since we knew one of these developers had previously filed for bankruptcy and would be unavailable to speak with our team. The second tier or "Mid Volume" cohort had more unique developers to pull from, so we attempted to interview nine of the 25 developers. Each successive strata had more developers to sample from, but far fewer completed projects. Ultimately, we planned to conduct interviews and web surveys with 9 developers in the "Low-Mid Volume" tier and 20 web surveys within the lowest tier.

Table 4-2 below summarizes the manufacturer and developer population, the targeted completes, and the achieved completes for each of the manufacturer and developer strata. As this table shows, we did not meet sample quotes for any of the developer strata. Our team was only able to secure an IDI with one of the five high volume developers, despite multiple attempts to connect with SGIP contacts and schedule interviews. We completed eight of nine surveys with the mid volume developers, but again, had difficulty scheduling interviews with the appropriate individuals within their respective organizations. The web survey reached and was completed by four of the nine targeted completes in the low-medium volume developer strata. Finally, we were able to complete nine of the expected 20 in the low volume developer strata. Contact information was far less robust and complete within this group, so connecting with the appropriate individual through email proved more burdensome than initially anticipated.

TABLE 4-2: TARGET AND ACHIEVED DEVELOPER SAMPLE DESIGN

Developer Strata	Population Definition	Population		Completes		% Complete	
		N	Projects	n	n Projects	% of N	% of Projects
High Volume	Projects >=1,000	6	12,261	1	3,564	17%	29%
Mid Volume	Projects >=100 and < 1,000	25	7,246	8	2,726	32%	38%
Low-Mid Volume	Projects > 5 and < 100	131	2,898	5	298	4%	10%
Low Volume	Projects <= 5	243	419	14	38	6%	9%
Total		**405**	**22,824**	**28***	**6,460**	**7%**	**28%**

* Six of these completes were only partial completes as the respondent did not finish the entire survey. The data that was provided was included in the analysis.

4.3 SGIP AND STORAGE NON-SGIP WEB SURVEYS

Residential and non-residential SGIP participants and Storage Non-SGIP customers were contacted through a web survey. Survey questions covered topics relating to the customer's reasons for installing battery storage, the messaging they received from the vendor who sold/leased them the system, their experience and satisfaction with or knowledge of the SGIP, and the key decision influences that led to their purchase of a battery storage system. The residential surveys also collected information on the customer's willingness to pay for battery storage systems. A survey invitation with a web link was emailed to all storage customers in the population to encourage them to participate in the survey. Additional follow up emails were sent to strata that had not reached their desired number of responses.

4.3.1 Sample Design

For the SGIP participant surveys, Verdant pulled the program participant data to develop the study SGIP population in mid-2021. The SGIP population included all residential and non-residential battery storage systems installed from 2017 to mid-2021 who had received an incentive or were in the process of receiving a performance-based incentive. The Market Assessment focused on customers who had installed their systems in 2017 and more recently because customers with earlier SGIP installations are likely to have more difficulty recalling some of the answers to survey questions (e.g., How did you learn about battery storage, Why did you install your battery storage system), reducing the value of their responses and more recent installations better represent the current and future battery storage market.

To develop a population of non-SGIP storage customers, Verdant requested the electric utilities to provide a data set with customer information for all battery storage systems interconnected between 2017 and mid-2021. The IOUs were asked to include SGIP application numbers where available. Verdant combined the SGIP paid participant data with the storage customer data provided by the IOUs to identify storage customers who had not received an SGIP incentive. Given the process of developing the Storage Non-SGIP cohort, some of these customers will transition to SGIP participants, but they were included in the Storage Non-SGIP cohort as this described their status at the time the data were pulled.

For the Storage Non-SGIP cohort, each IOU provided slightly different sets of information to Verdant which was used to describe the Storage Non-SGIP population and to create weights for the survey analysis. PG&E provided the population of their storage installations over the period requested. SCE provided data on storage customers who were paired with solar. SDG&E provided data on a sample of 3,000 customers who had installed storage since 2018 and population counts to use during the development of survey weights.

For the study, all unique SGIP participants and unique Storage Non-SGIP customers were sent emails encouraging them to participate in the web surveys.[39] If a customer had installed storage both in SGIP and outside of SGIP, they were included in the SGIP sample and deleted from the Storage Non-SGIP sample.

Table 4-3 lists the residential unique storage population counts and the number of surveys completed.[40] The survey dramatically exceeded the number of targeted completes for the residential SGIP surveys for all utilities. No quota had been established for the Storage Non-SGIP surveys.

39 Given that SDG&E provided a sample of their storage installations, the SDG&E storage surveys were only sent to a sample of their customers and were restricted to customers installing storage after 2018.

40 The number of SGIP customers differs slightly from those listed in Table 4-1 due to the need for unique emails for the survey implementation.

TABLE 4-3: RESIDENTIAL SGIP AND STORAGE NON-SGIP POPULATION AND COMPLETED SURVEYS

Program Administrator	Storage Populations	Population N	% of Storage Population	% of SGIP/Non-SGIP Storage Population	Targeted Number of Completes*	Survey Completes	Achieved Sample Distribution Relative to SGIP/Non-SGIP
PG&E	SGIP	10,120	19%	47%	470	1,551	52%
	Non-SGIP	15,610	29%	48%	-	1,487	68%
SCE	SGIP	6,684	12%	31%	310	787	26%
	Non-SGIP	10,073	19%	31%	-	545	25%
SCG	SGIP	1,283	2%	6%	60	167	6%
CSE/SDG&E	SGIP	3,450	6%	16%	160	479	16%
	Non-SGIP	6,660	12%	21%	-	151	7%
Total	SGIP	**21,537**	**40%**		**1,000**	**2,984**	
	Non-SGIP	**32,343**	**60%**			**2,183**	
		53,880	**100%**			**5,167**	

*The Research Plan did not develop a targeted number of completes for the Non-SGIP storage population due to a lack of knowledge on the size of this population and the study plan to census the population.

The achieved distribution of SGIP storage surveys by IOU is similar to the distribution of residential SGIP customers in the population. Table 4-4 presents the distribution of the residential SGIP sample frame and survey completes by SGIP budget category and program year groups. Given the interest in understanding customer characteristics, knowledge of and satisfaction of battery storage and need for resiliency by budget category and program participation timing, it is important that the distribution of SGIP residential survey responses closely reflect the distribution of the SGIP population. Therefore, the SGIP residential storage site-based weights were developed by program budget category and two program year ranges (2017-2019 and 2020-2021) to ensure the survey analysis presents an unbiased representation of this population.

TABLE 4-4: RESIDENTIAL SGIP POPULATION AND COMPLETED SURVEYS BY BUDGET CATEGORY AND YEARS

SGIP Residential Storage Populations	Sample Frame	% of SGIP Residential Storage Population	Survey n	% of SGIP Residential Surveys
Small Residential SGIP 2017-2019	11,387	53%	1,298	43%
Large Residential Storage 2017-2019	314	1%	51	2%
Small Residential SGIP 2020-2021	6,667	31%	977	33%
Large Residential Storage 2020-2021	464	2%	85	3%
Equity Resiliency 2020-2021	2,697	13%	573	19%

The residential Storage Non-SGIP distribution of survey responses differs from the distribution of residential Storage Non-SGIP customers in the population, at least in part due to SDG&E providing a random sample of their customers for their sample frame, instead of their population. Verdant developed site-based weights designed to ensure that the surveyed sites represent the utility specific populations of residential Storage Non-SGIP customers.

Table 4-5 lists the non-residential storage populations and the number of surveys completed.[41] The populations within the non-residential sample are dramatically lower than in the residential sample and the response rate is also lower. The quota for the non-residential SGIP survey was 25. It was difficult to get to this number of completes; The survey effort emailed three requests for response to achieve 27 completes. No quota had been established for the Storage Non-SGIP surveys and very few responses were achieved. It is likely that the response rate was higher for the SGIP sample than the non-SGIP sample due to the SGIP sample receiving a rebate.

TABLE 4-5: NONRESIDENTIAL SGIP AND STORAGE CUSTOMER SAMPLE DESIGN AND COMPLETED SURVEYS

Program Administrator	Storage Populations	Population N	% of Storage Population	% of SGIP/Non-SGIP Storage Population	Targeted Number of Completes*	Survey Completes	Achieved Sample Distribution Relative to SGIP/Non-SGIP
PG&E	SGIP	81	15%	35%	9	8	32%
	Non-SGIP	168	32%	56%	-	5	83%
SCE	SGIP	97	18%	42%	10	14	56%
	Non-SGIP	68	13%	23%	-	1	17%
SCG	SGIP	18	3%	8%	2	0	
CSE/SDG&E	SGIP	35	7%	15%	4	5	20%
	Non-SGIP	62	12%	21%	-	0	
Total	SGIP	**231**			**25**	**27**	
	Non-SGIP	**298**				**6**	
		529			**25**	**33**	

*The Research Plan did not develop a targeted number of completes for the Non-SGIP storage population due to a lack of knowledge on the size of this population and the study plan to census the population.

41 The number of SGIP installations differ from what is listed in Table 4-1 due to the need for unique emails for the survey implementation.

The SGIP sample was weighted by program year buckets, 2017-2019 and 2020 to 2021. Twenty-one of the responses were from the earlier time period and six from the later period. The distribution of responses, however, implies a higher response rate for the later time period and this was corrected with weighting. The non-SGIP survey was not weighted given the low number of responses. The non-residential non-SGIP survey responses are not reported in the study due to the low number of completes.

4.4 SOLAR NON-STORAGE SURVEY

Residential and non-residential solar non-storage customers were contacted through a web survey. Survey questions were similar to those fielded to battery storage owners with additional questions covering topics relating to solar non-storage customers' awareness and familiarity with battery storage technologies and the SGIP, their perceptions about the barriers and benefits of installing battery storage, and their likelihood of installing a battery storage system in the future. Like the host customer survey, the solar non-storage survey focused primarily on quantitative questions, with an opportunity to enter open-ended responses if the respondent did not feel that any of the pre-defined responses were appropriate. The residential Solar Non-Storage survey also included questions on the customer's willingness to pay for battery storage systems.

A survey invitation with a web link was emailed to all unique contacts in the sample. Following the initial round of completed surveys, a reminder email was sent if the strata's quota had not been reached.

4.4.1 Sample Design

Surveying the solar non-storage population allowed the evaluation to collect data from customers who had not installed storage but were experienced with distributed energy resources. These customers were believed to be more likely than the general population to be at least somewhat familiar with battery storage and thus able to provide insights into their potential motivations and barriers to battery storage adoption.

The sample frame for the Solar Non-Storage survey was constructed from data provided by PG&E, SCE, and SDG&E for customers who had installed solar on their homes or businesses since 2017 and had not installed storage. Each utility provided slightly different data for their solar customers. The analysis required a sample of solar customers pulled by HFTD and Non-HFTD and a count of the number of residential solar customer for each utility by HFTD and Non-HFTD. PG&E and SDG&E provided both the sample and the population of solar customers as requested. SCE provided the sample of solar customers by HFTD and Non-HFTD but did not provide a count of the number of solar customers. Verdant developed an estimate of the number of SCE solar customers, that is needed to develop site-weights, using information on SCE solar installation from California's DG Stats web site. The SCE solar installations were allocated to HFTD and Non-HFTD using a ZIP code mapping process.[42]

The sample design of the solar data requested from the utilities over sampled solar customers in HFTD. The focus on these populations was due to the high level of resiliency concerns for customers in HFTD and therefore the design was developed to ensure that sufficient customers in these areas responded to the survey. The site-based weights were based on utility and HFTD such that the survey responses are representative of the utility's solar population installed since 2017.

Table 4-6 lists the solar population, the sample of site requested, the survey targets and the number of surveys completed by solar non-storage customers. These data show that the study met the sample quotas.

TABLE 4-6: TARGET RESIDENTIAL SOLAR NON-STORAGE SAMPLE SIZE BY CUSTOMER TYPE

IOU	Solar Populations	Population N	% of Solar Population	Sample Requested	Targeted Number of Completes	Survey Completes
PG&E	HFTD	18,712	4%	1,550	40	87
	Non-HFTD	176,286	34%	950	30	31
SCE	HFTD	72,415	14%	1,600	40	48
	Non-HFTD	128,945	25%	900	30	83
SDG&E	HFTD	31,143	6%	1,725	40	77
	Non-HFTD	87,098	17%	775	30	42
Total	**HFTD**	**122,270**	**24%**	**4,875**	**120**	**212**
	Non-HFTD	**392,329**	**76%**	**2,625**	**90**	**156**
	Total	***514,599***	***100%***	***7,500***	***210***	***368***

The non-residential population was developed in an approach similar to what was described above for the residential solar non-storage population. The study requested information on 7,000 non-residential solar customers from each IOU, but the IOUs did not have that many non-residential solar sites that met the sample criteria. Table 4-7 lists the number of solar non-storage sites received from the IOUs with unique email addresses. Unique emails included removing emails from the sample that had designated to received surveys in the SGIP and non-SGIP storage populations and duplicate emails from the solar population. The information presented in Table 4-7 indicate that the non-residential solar non-storage survey completed over four times the pre-survey quota. For survey data analysis, the study developed

42 Given the timing of when each utility provided population level solar counts, or the counts were pulled from publicly available information, it is likely that the numbers represented in the table below do not reflect a single point in time.

site-based weights by IOU and HFTD to weight the responses back to the population of solar non-storage customers.

TABLE 4-7: TARGET NON-RESIDENTIAL SOLAR NON-STORAGE SAMPLE SIZE BY CUSTOMER TYPE

IOU	Solar Populations	Population N	% of Solar Population	Unique Email Sample	Targeted Number of Completes	Survey Completes
PG&E	HFTD	401	4%	3,805	18	21
	Non-HFTD	5,008	46%			126
SCE	HFTD	1,583	15%	997	17	4
	Non-HFTD	1,760	16%			18
SDG&E	HFTD	527	5%	1,118	17	21
	Non-HFTD	1,493	14%			41
Total	**HFTD**	**2,511**	**23%**	**5,920**	**50**	**46**
	Non-HFTD	**8,261**	**77%**			**185**
	Total	**10,772**	**100%**			**231**

4.5 NON-INTERCONNECTED (NON-DER) CUSTOMER SURVEY

Residential and non-residential customers without solar or storage were contacted through a web survey. Survey questions were similar to those fielded to solar non-storage customers with additional questions about customer knowledge and familiarity with solar PV and their likelihood of installing a solar PV and/or battery storage system in the future. Like the surveys that were previously described, the non-interconnected (non-DER) customer survey focused primarily on quantitative questions, with an opportunity to enter open-ended responses if the respondent did not feel that any of the pre-defined responses were appropriate. The residential survey included questions on the customer’s willingness to pay for battery storage systems.

4.5.1 Sample Design

Surveying customers without interconnected technologies allowed the evaluation to collect data from customers who most closely represent the general population. These customers likely represent households and businesses with the least experience with, or knowledge of, distributed energy resources.

The sample frame for the non-interconnected survey was constructed from data provided by PG&E, SCE, and SDG&E for customers who had not previously installed solar or battery storage systems on their homes or businesses. The samples were designed to over sample customers in HFTD, similar to the surveys described above. The sample frames for the residential population requested sample from each IOU by

HFTD and Disadvantaged Communities (DAC). Unfortunately, not all of the utilities were able to provide sample by DAC. Given the limitations, the samples for the surveys, and the respondent weighting, were developed by IOU and HFTD for the residential non-interconnected surveys. Table 4-8 presents the information on the non-interconnected population, sample, and survey completes. The survey achieved approximately twice as many completes as the study's initial target. The site-based weights, developed at the IOU and HFTD level allow the survey responses to better reflect the non-interconnected cohort while maintaining sufficient responses across multiple domains of interest.[43]

TABLE 4-8: TARGET RESIDENTIAL NON-INTERCONNECTED (NON-DER) SAMPLE SIZE BY CUSTOMER TYPE

IOU	Populations	Population N	% of Population	Sample Requested	Targeted Number of Completes	Survey Completes
PG&E	HFTD	300,203	4%	22,000	285	799
	Non-HFTD	2,893,270	34%	25,500	190	266
SCE	HFTD	639,069	7%	18,000	198	218
	Non-HFTD	3,871,495	45%	17,000	132	143
SDG&E	HFTD	115,526	1%	14,500	135	242
	Non-HFTD	757,060	9%	8,000	90	236
Total	**HFTD**	**1,054,798**	**12%**	**54,500**	**618**	**1,259**
	Non-HFTD	**7,521,825**	**88%**	**50,500**	**412**	**645**
	Total	**8,576,623**	**100%**	**105,000**	**1,030**	**1,904**

For the non-residential samples, the sample frame was requested by NAICS code, oversampling NAICS that are the most common in the SGIP. This approach hoped to provide the study with more non-interconnected sample completes with businesses with a higher likelihood of future adoption. PG&E and SDG&E provided sample and counts of the population by NAICS code. SCE provided sample by NAICS code but did not provide population counts by NAICS code. SCE only provided population counts for their non-residential population in total. The study chose to move forward with the sample development by NAICS code for PG&E and SDG&E weighting these segments back to their population total. For SCE, however, non-residential survey completes were weighted back to their total non-residential population without controlling for the NAICS oversampling. While this is not ideal, it is the best choice given the data available to the study.

Table 4-9 presents the population, sample, and completed survey information for the non-residential non-interconnected (non-DER) customers. As the table shows, the survey completes exceeded the targeted number of completes by IOU. The sample weights were developed at the NAICs and IOU level for PG&E

43 The response rate within the PG&E HFTD was substantially higher than for the other sample strata. The weight developed for the analysis will account for the higher response rate within this strata.

and at the IOU level for SCE responses. Given the small number of completes for the PG&E public administration strata and the large population count, the weights for these sites were very large and the team chose to combine the Public Admin and Other strata for weighting purposes. This approach allows the PG&E survey completes to weight up to the population for statewide calculations, without given the PG&E public Admin sites weights that could impact the interruption of findings.

TABLE 4-9: TARGET NON-RESIDENTIAL NON-INTERCONNECTED (NON-DER) SAMPLE SIZE BY CUSTOMER TYPE

IOU	Populations	Population N	% of Population by IOU	Sample Requested	Targeted Number of Completes	Survey Completes
PG&E	PG&E Industrial NAICS 31-33	16,198	1%	5,250	210	88
	PG&E Public Admin NAICS 92	803,558	65%	5,250		6
	PG&E Education NAICS 61	8,511	1%	5,250		50
	PG&E Healthcare NAICS 62	23,662	2%	5,250		62
	PG&E Other	392,557	32%	14,000		154
SDG&E	SDG&E Industrial NAICS 31-33	3,034	5%	3,034	150	15
	SDG&E Public Admin NAICS 92	259	0%	259		2
	SDG&E Education NAICS 61	1,089	2%	1089		5
	SDG&E Healthcare NAICS 62	4,609	7%	3,750		15
	SDG&E Other	55,380	86%	10,000		184
SCE	All	718,949	100%	40,000	240	291
Total	**All**	**2,027,806**	**12%**			**872**

5 MARKET RESEARCH RESULTS

This section presents findings from the primary data collection activities completed for this study. These data collection activities included online surveys of residential and non-residential customers who have installed battery storage systems (both inside and outside of the SGIP), customers with solar but no storage installed, and a representative sample of customers who have not installed solar or storage (non-interconnected or non-DER). A hybrid of IDIs and online surveys were also conducted with battery storage project developers. The results presented below are organized thematically as follows:

- *Key Characteristics of Storage Customers, Market Actors, and Installed Systems,* i.e., who is buying storage, who is selling it, and what is being purchased.
- *Storage Awareness and Marketing*, i.e., how are customers becoming aware of battery storage, and what marketing measures are being used to persuade them to buy.
- *Storage System Costs as Perceived by Developers*, i.e., what is the typical distribution of costs across cost categories reported by developers, and the percentage of customers who require panel upgrades or subpanel installations.
- *Primary Motivations for Installing Battery Storage*, i.e., what factors motivate customers to purchase storage.
- *Perceived Barriers to Storage System Adoption*, i.e., what factors impede storage system purchases.
- *Battery Storage and Resiliency, i*.e., what are customers' recent experiences with electricity outages, what resiliency needs do they perceive, and what alternatives to battery storage have they considered to meet these needs.
- *Storage System Performance*, i.e., to what extent are customers realizing the benefits they expected based on perceived performance.
- *Willingness to Pay for Battery Storage,* i.e., what are customers willing to pay for a whole house and a partial house battery storage system to provide resiliency during outages.
- *Effect of SGIP on the Storage Market*, i.e., how has the SGIP influenced the market for storage to date and how important is it for near term adoption and potential future market transformation?

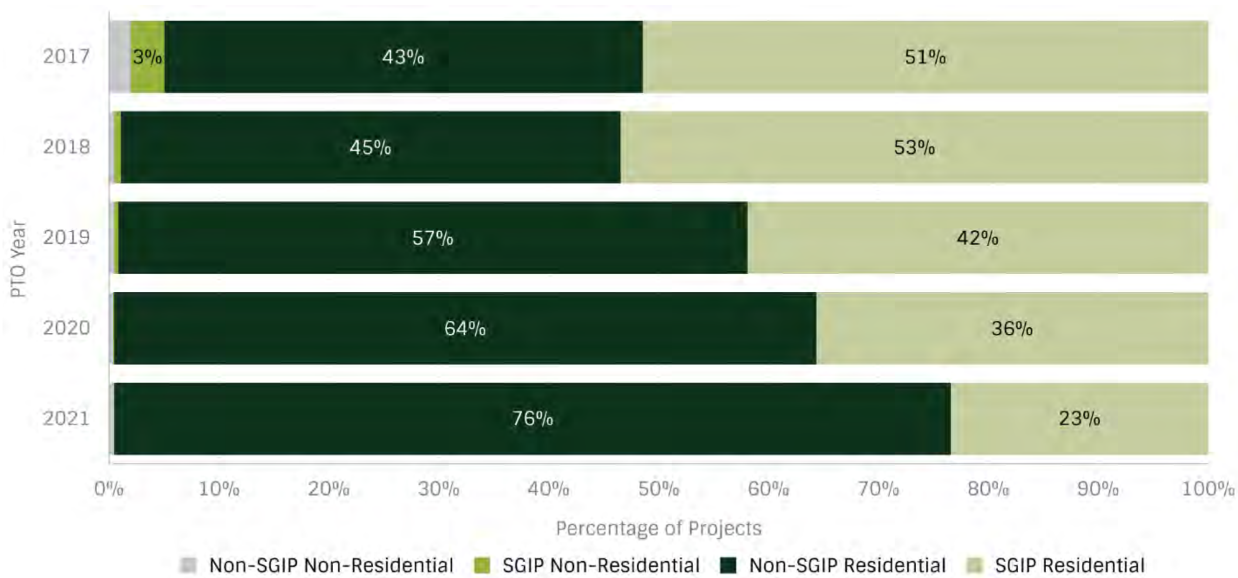
Data and analysis from the IDIs and online surveys are presented below as they pertain to each section.

5.1 END-USER CHARACTERISTICS

This section compares the key demographic and firmographic characteristics of SGIP program participants (Host Customers and Project Developers), customers with solar and/or storage installed outside of SGIP, and customers who have not installed solar or storage.

As discussed in Section 3 above, the growth in installed storage capacity and project count throughout the past five years has been primarily from the residential market. As shown in the figure below, since 2017 the annual share of battery storage projects installed has shifted from the majority being residential SGIP projects to residential projects installed without an SGIP incentive. It should be noted it is likely that the share of Non-SGIP residential installations in 2021 will decrease as some of these residential non-SGIP projects may have applied for an SGIP incentive but had not yet received it as of the time of reporting.

FIGURE 5-1: RESIDENTIAL AND NON-RESIDENTIAL BATTERY STORAGE INSTALLATIONS, 2017 TO 2021



While this market assessment study addresses both residential and non-residential storage markets, more attention is paid to the residential market as it accounts for the majority of recent, and likely future, SGIP participation and market focus.

5.1.1 Residential Characteristics

This section presents an assessment of the residential demographic characteristics gathered as part of the

Storage Participants, Storage Non-SGIP, Solar Non-Storage, and Non-Interconnected surveys.[44] For ease of description, these survey respondents will be referred to as the SGIP Participant, Storage Non-SGIP, Solar Non-Storage, and Non-Interconnected survey respondents. Note that the Storage Non-SGIP population was identified based on a comparison of the storage interconnection database and the SGIP participant tracking database. Customers who were found in the interconnection database and had not received an SGIP incentive within the participant data were placed into the Storage Non-SGIP sample population. Some of these customers may have applied for an SGIP incentive and been declined and others may still be waiting for the SGIP application to be processed.

In the subsections that follow, we present comparisons of residential customer demographics across various characteristics to illustrate the differences and similarities that exist between those who have installed storage (both inside and outside of SGIP), those who have installed solar, and those who have not installed storage or solar. SGIP residential battery storage currently has four budget categories: Equity Resiliency, Residential Equity, Large-Scale Storage, and Small Residential Storage. Three of these budget categories have respondents represented in this study.[45] As one might expect, SGIP participant characteristics vary in interesting and significant ways across these budget categories. As a result, the tables that follow disaggregate the SGIP residential participants findings by the respondent's budget category.

Household Income and Education Levels

Households who have installed storage tend to be high income and highly educated. The Equity Resiliency budget category, however, has effectively increased the percentage of lower income households who have adopted storage. Figure 5-2 below presents the distribution of self-reported annual household income across the customers who responded to each of the surveys. The proportion of customers in each of the income categories varies substantially across the three SGIP budget categories. While the development of the Equity Resiliency budget category in 2020 increased the percentage of customers with lower incomes that are purchasing battery storage (six percent reported making less than $50,000 and 28 percent reported making between $50,000 and $100,000), the majority of all SGIP participants surveyed in 2022 reported household income levels greater than $100,000 (78 percent). In 2021, the total eligible project cost for Large-Scale Storage systems was nearly $45,000 (see Figure 3-15). These systems were purchased primarily by those who could afford them, notably those with household

44 In key select areas we compare the results of the 2021 SGIP MA study to the previous 2019 MA study, however in many cases this comparison is not necessary as this study included customers who installed solar between 2017 and 2021 which encompasses the period when the majority of the residential storage installations occurred.

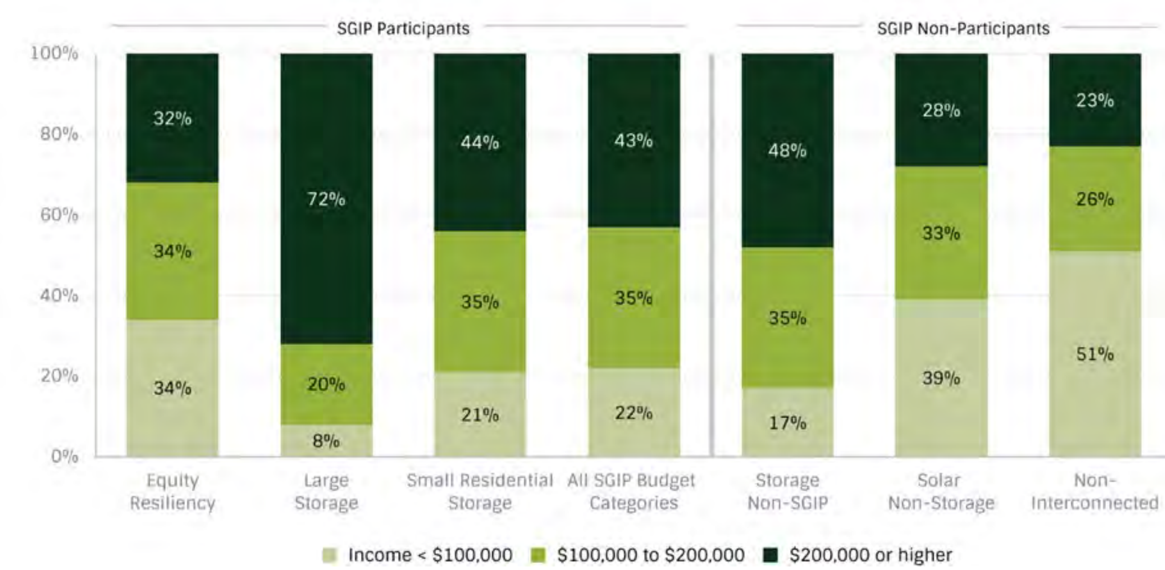
45 The Residential Equity participants were represented in the Study's sample but the small population of customers in the budget category led to no respondents.

incomes greater than $200,000.

Figure 5-2 illustrates that the income distribution of residential storage non-SGIP participants is similar to that of participants in the small residential budget category (83 percent of storage non-SGIP respondents reported annual household incomes over $100,000 compared to 79 percent of Small Residential Storage participants). Eligibility criteria for the Small Residential and Large-Scale Storage SGIP budget categories are not based on customer income. One of the two eligibility criteria for the Equity Resiliency budget category, however, can be met by the participants living in deed-restricted housing or their having received an incentive from a low-income solar program (SASH, DAC-SASH, MASH, or SOMAH). The needs-based eligibility criteria of the Equity Resiliency category helps to explain the higher share of respondents with incomes less than $100,000.

Solar and Non-Interconnected survey respondents have substantially lower household incomes than those who have battery storage (51 percent of Non-Interconnected respondents and 39 percent of solar respondents reported household incomes less than $100,000). Nineteen percent of Non-Interconnected respondents reported annual household incomes less than $50,000, compared to only eight percent of solar respondents, six percent of Equity Resiliency respondents, three percent of Small Residential Storage respondents, two percent of Storage Non-SGIP respondents, and no Large-Scale Storage respondents.

FIGURE 5-2: HOUSEHOLD INCOME DISTRIBUTIONS



The majority of residential storage owners (85 percent of SGIP and 87 percent of Storage Non-SGIP) reported their head of household had attained a college or post-graduate degree. Similar to the income distributions reported above, SGIP Equity Resiliency household heads are slightly less likely to have a college or post-graduate degree (82 percent) while Large-Scale Storage respondents are more likely (91 percent). The share of respondents reporting similar educational attainment levels (college or post-graduate degrees) was 75 percent for Solar Non-Storage respondents and 72 percent Non-Interconnected respondents.

Household Resident Composition

Table 5-1 below presents the share of households that reported having youth (< 18 years old) or senior (> 65 years old) residents in their household. Equity Resiliency SGIP participants were the most likely to have a household resident that was 65 years of age or older. Older residents are more likely to have essential electrical medical needs that qualify them for the Equity Resiliency budget category.

TABLE 5-1: HOUSEHOLDS WITH OLDER AND YOUNGER RESIDENTS

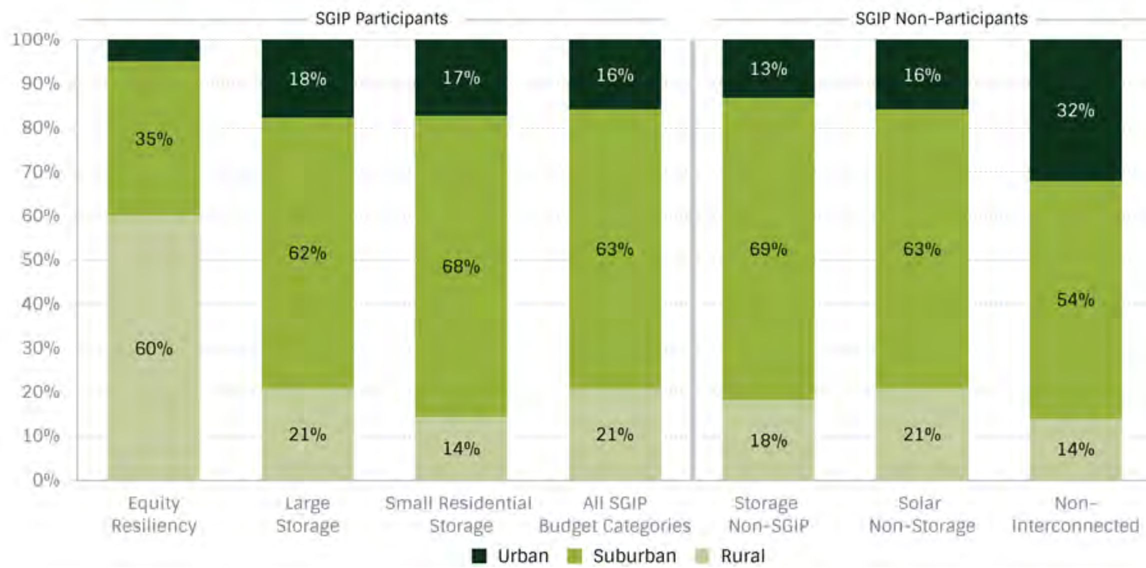
Households with Residents	SGIP Respondents				Non-SGIP Respondents		
	All	Equity Resiliency	Large Storage	Small Res Storage	Storage Non-SGIP	Solar Non-Storage	Non-Interconnected
<18 years old	25%	27%	31%	24%	29%	32%	23%
>= 65 years	52%	57%	49%	52%	46%	48%	37%

Urban/Rural/Suburban

Storage Households are more likely live in suburban locations and less likely to be in urban or rural locations; however, the Equity Resiliancy budget category has significantly increased the share of rural customers installing storage. The Urban/Suburban/Rural distribution of residential SGIP respondents also differs significantly by budget category. Figure 5-3 illustrates that participants in the Equity Resiliency budget category are substantially more likely to reside in a rural location, while those in the small residential program are more likely to report residing in a suburban location. The location of residential participants in the Large-Scale Storage budget category is very similar to that for the Small Residential Storage category with 18 percent self-describing living in an urban location, 62 percent suburban, and 21 percent rural. The HFTD and PSPS requirements of the Equity Resiliency budget category likely contribute to its higher share of rural participants.

The Urban/Suburban/Rural distribution of Storage non-SGIP and Solar Non-Storage respondents are fairly similar to the overall SGIP distribution and Non-Interconnected (non-DER) survey respondents were more likely to report living in an urban location than other survey respondents.

FIGURE 5-3: URBAN, SUBURBAN, AND RURAL DISTRIBUTIONS RESPONDENT DISTRIBUTIONS

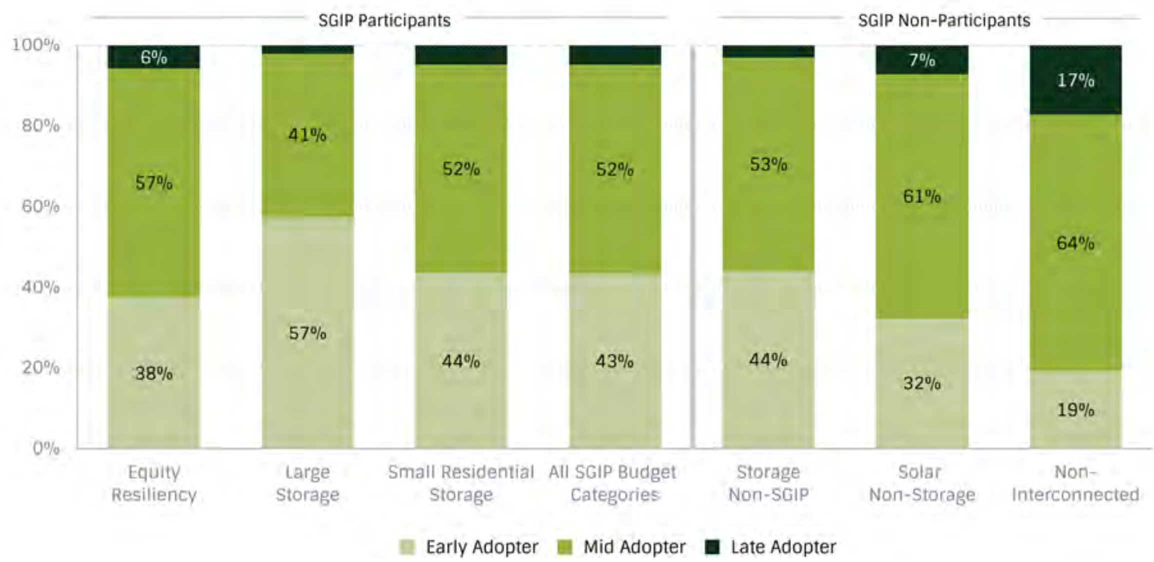


Early Adopters

Storage Households are more likely to consider themselves "early adopters", however Large-Scale Storage participants are much more likely to describe themselves this way than Equity Resiliency participants. Residential survey respondents were asked to self-describe their household's typical adoption behaviors for new products and technologies. Figure 5-4 shows that Equity Resiliency SGIP participants were less likely to describe themselves as early adopters (38 percent) than the Small Residential Storage (44 percent) or the Large-Scale Storage participants (57 percent). We also analyzed adoption behavior by year of SGIP participation and found recent SGIP participants (2020 and 2021) were less likely to describe themselves as early adopters (37 percent) than those who participated in SGIP in 2017-2019 (49 percent).

Reported adoption behavior of storage non-SGIP respondents is very similar to the average across all SGIP participants, with 44 percent reporting that they are always or usually one of the first to try new products and 53 percent stating that they are usually in the middle. In comparison, 32 percent of Solar Non-Storage respondents and 19 percent of Non-Interconnected respondents described themselves as early adopters. A substantially higher share of Non-Interconnected respondents self-report that they are either usually one of the last or the last to try new products.

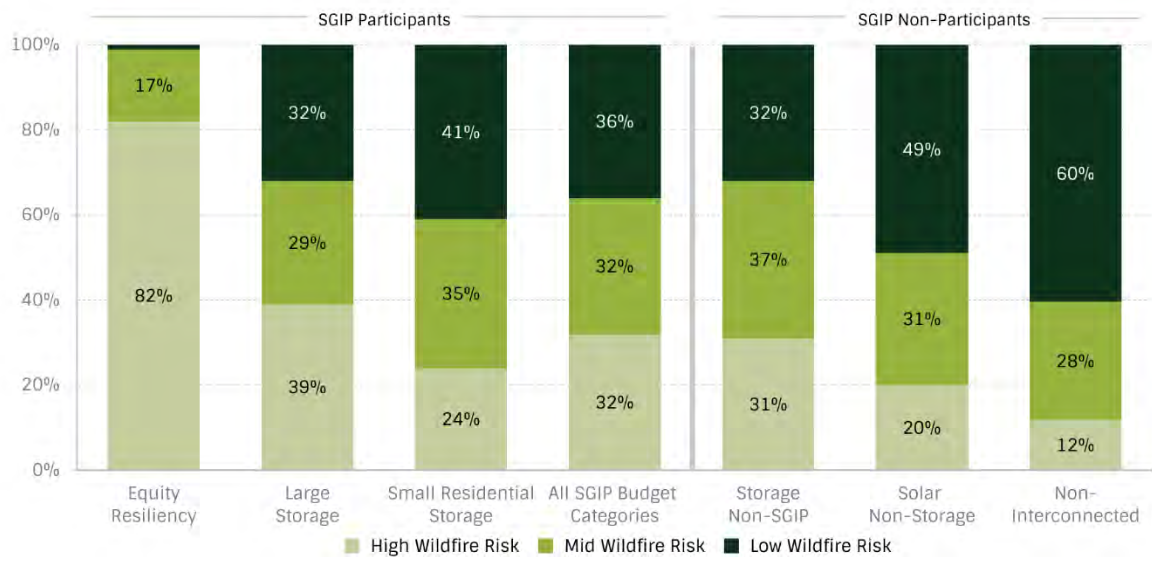
FIGURE 5-4: SELF-DESCRIBED ADOPTION BEHAVIOR



Threat of Wildfire

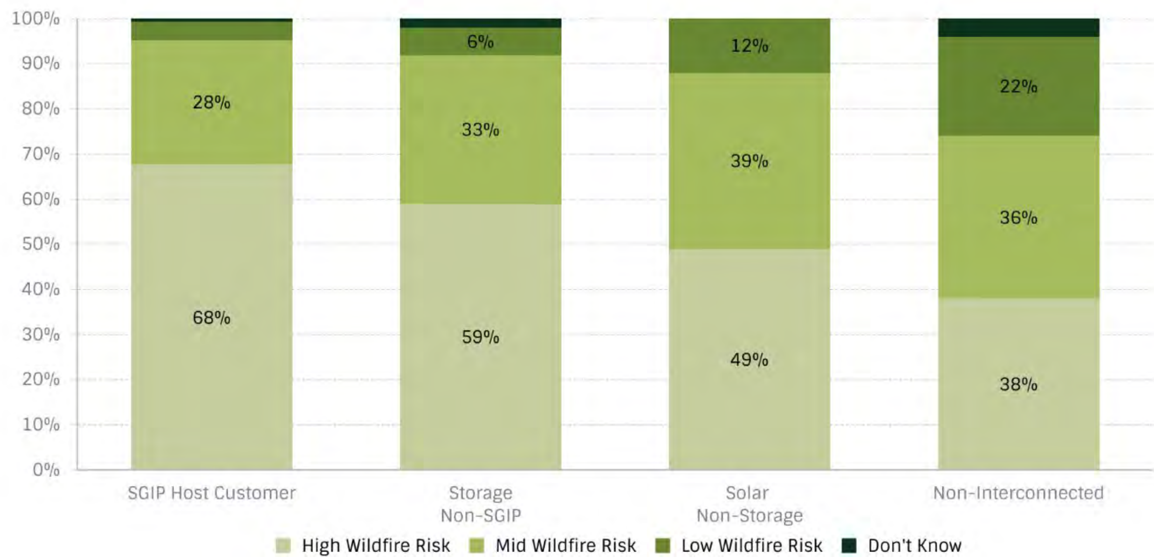
SGIP Equity Resiliency participants are substantially more likely to reside in a high wildfire area than any of the other segments of survey respondents (Figure 5-5). The high share of Equity Resiliency participants in high wildfire risk areas is consistent with the Equity Resiliency program's eligibility requirement that participants live in either a Level 2 or 3 High Fire Threat District (HFTD) or an area that has experienced multiple Public Safety Power Shutoff (PSPS) events. Sixty percent of the Non-Interconnected respondents report that they reside in a low wildfire risk area, a substantially higher share than respondents with storage and/or solar installed at their residence. As a reminder, an analysis of SGIP participants between 2017 and 2021 by program administrator and budget category is provided in Section 3.

FIGURE 5-5: SELF-DESCRIBED WILDFIRE RISK LEVEL



Self-described high wildfire shares line up well with tier 2 and tier 3 HFTD, but individual end-users' perception of their wildfire risk and their HFTD designation do not always align correctly. The survey respondents' self-reported wildfire risk level was compared to the wildfire risk assessed by the HFTD. The figure below presents this comparison for respondents living in a HFTD. SGIP Participants are the most likely to correctly self-describe where they live as a high or moderate wildfire risk area. Non-interconnected respondents who live in HFTD are much less likely to be unaware of their risk level. People who are unaware they live in a HFTD may be less interested in purchasing storage due to their lack of recognition of their future potential resiliency needs.

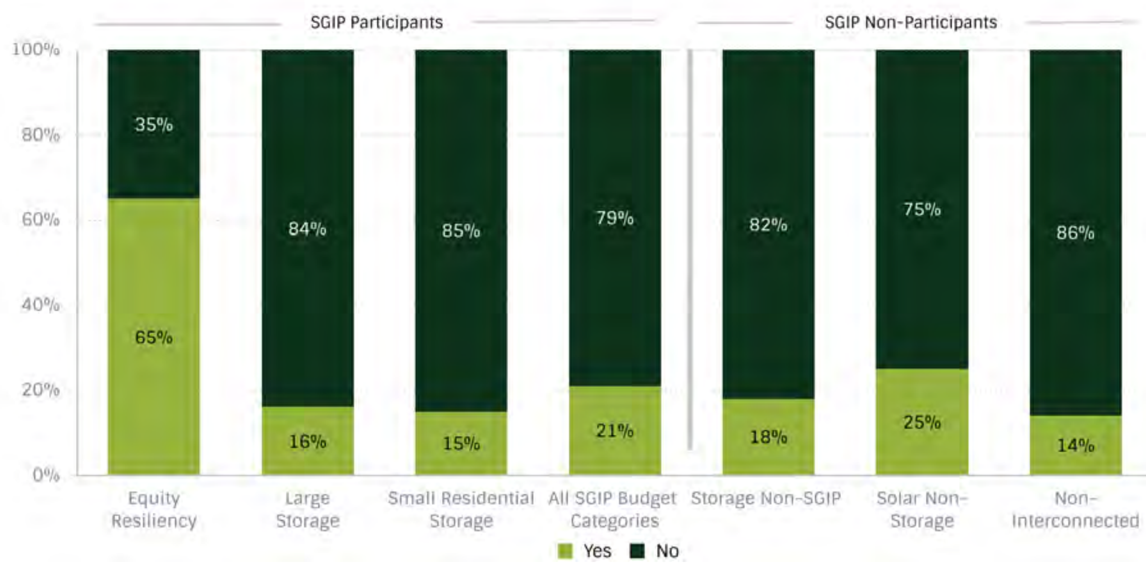
FIGURE 5-6: RESIDENTIAL SELF-DESCRIBED WILDFIRE RISK LEVEL OF THOSE LOCATED IN HFTD



Resiliency Needs

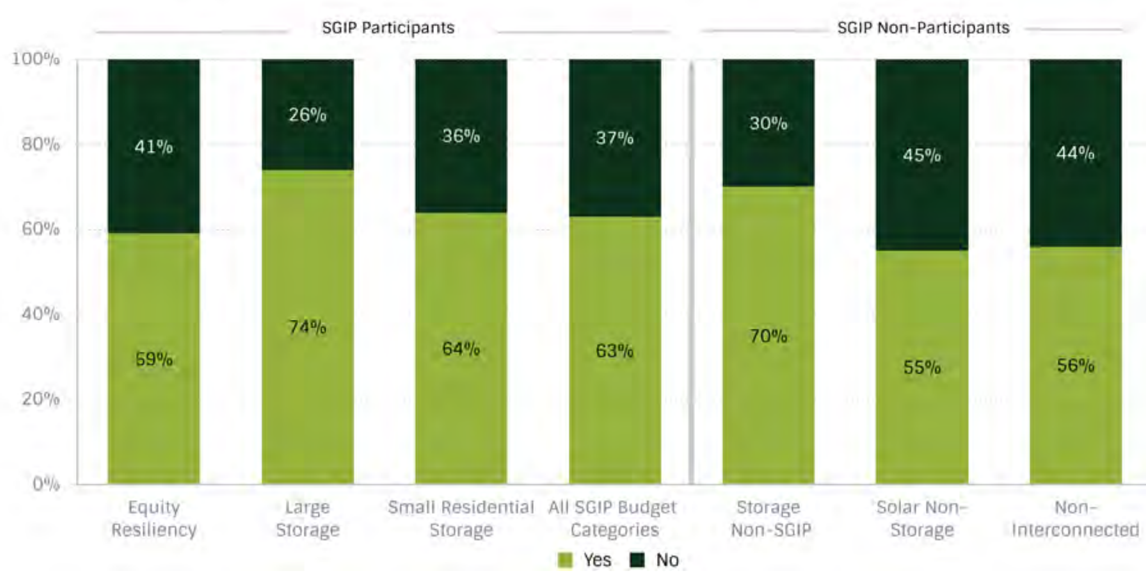
Surveyed customers were asked a number of questions about their essential medical and home office resiliency needs. **Equity Resiliency participants are much more likely to report having a household member with medical needs requiring electricity** (see Figure 5-7). This high share with reported medical needs is consistent with the Equity Resiliency's program design which has an eligibility path for medical baseline households and households where a member has a condition that could be life-threatening if their electricity is disconnected. The share of Storage Non-SGIP respondents reporting a medical need is similar to what was observed for SGIP Large-Scale Storage and Small Residential Storage participants. The data collected from non-storage households shows that 25 percent of solar households report a medical need and 14 percent of Non-Interconnected respondents.

FIGURE 5-7: RESILIENCY NEEDS: NECESSARY MEDICAL EQUIPMENT



The COVID-19 pandemic has increased the need for electric resiliency for individuals who work from home. As shown in Figure 5-8, between 59 and 74 percent of residential SGIP and Non-SGIP storage customers work from home compared with approximately 55 percent of those that do not have storage. **Large-Scale Storage (74 percent) and Storage Non-SGIP (70 percent) respondents are slightly more likely to work from home than Small Residential Storage (64 percent) or Equity Resiliency (59 percent) participants.** Nearly all of the households with a household member that worked from home reported this work included the need for electric powered equipment.

FIGURE 5-8: RESILIENCY NEEDS: WORK FROM HOME



Other Household Characteristics

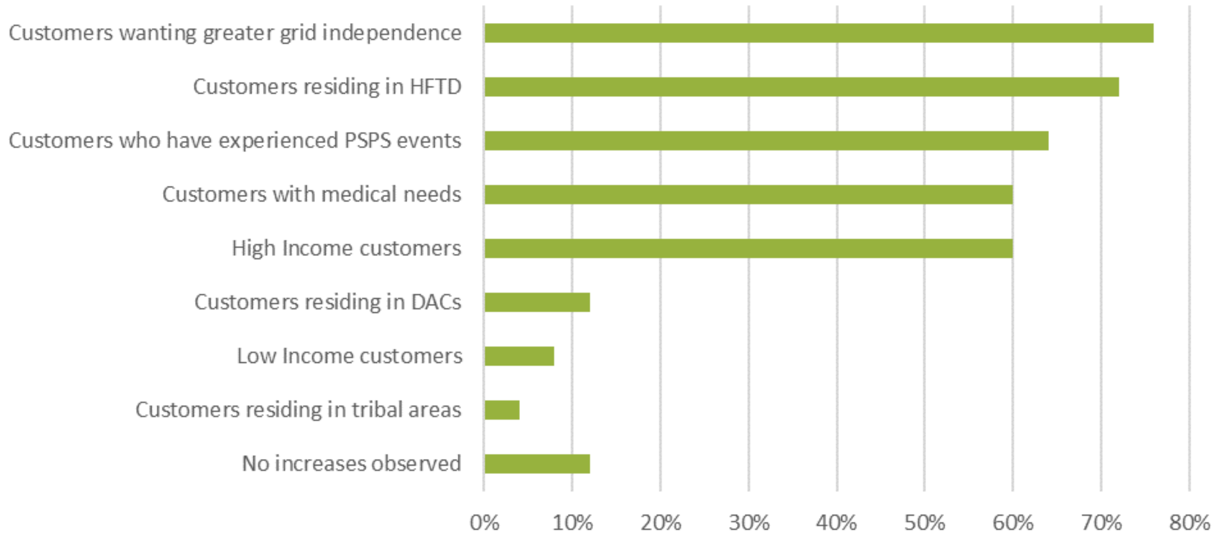
Ownership of a single-family home appears to be a defining characteristic of residential customers who have battery storage and/or solar PV (100 percent of households with storage and 98 percent of households with solar) and most of these homes are single family residences (97 percent of SGIP storage participants, 97 percent of non-SGIP storage owners, 94 percent solar). The respondents to the Non-Interconnected (non-DER) survey were significantly less likely to report that they owned their homes (64 percent) or that they resided in a single-family residence (62 percent).

Developer Perspectives on Changes to Storage Customers

Developers were asked whether they had seen increases in the share of battery storage projects completed by various customer groups in the past two years. Figure 5-9 provides the share of developers surveyed who reported experiencing increases in various customer groups (note the various customer groups was provided as a list and developers could select all customer groups where they had observed increases). As this figure shows, most developers reported increases in the types of customers interested in storage (only 12 percent reported they had not observed any increases). Developers were more likely to report increases in customers wanting greater grid independence, in HFTD or who have experienced PSPS events, and those with medical needs. Customers residing in HFTD or regions where PSPS have occurred, as well as those with medical needs, have been a central focus of the Equity Resiliency budget category and the repercussions of this new budget category have been observed by storage project developers.

Few developers reported increases in low-income customers or those residing in DACs. While the Equity and Equity Resiliency budget categories also aim to increase the share of low-income customers installing storage, they have been less successful making observable differences in this market. Additionally, low-income customers are less likely to reside in owner-occupied single-family residences, which is where most residential storage projects are currently being installed. One Developer interviewed discussed the difficulties that currently exist to get low-income multi-family storage projects incentivized by the SGIP, they reported "*We hoped SGIP would finally unlock the storage market for low-income or DAC multi-family residents as they want to install solar and storage… we hoped SGIP would be the SOMAH (Solar on Multifamily Affordable Housing) Program for batteries, but it hasn't been… All parties interested in supporting this market (Low income and DAC) should spend the time required to fix the program to enable it*".

FIGURE 5-9: SHARE OF DEVELOPERS REPORTING INCREASES IN CUSTOMER GROUPS INSTALLING STORAGE



Developers were also asked if the new SGIP budget categories (Residential Equity, Non-residential Equity, and Equity Resiliency) impacted the markets where their organization installs battery storage. More than two-thirds reported that they had. However, very few of these respondents provided any specifics regarding how the new budget categories had done so. Insightful comments from a few who did share details on the impact of these new categories included:

- *"Due to higher Equity incentives, the developers that we work with have focused more on serving customers that qualify for the Non-Residential Equity incentive."*
- *"Equity Resiliency (budget category) allowed customers with lower income who live further outside of the city of San Diego to purchase battery systems."*
- *"Increased outreach out to customers who already have solar in those HFTDs."*

Developers also expressed their disappointment with the impact these new budget categories have had:

- *"They have not helped us provide solar paired storage to the clients in DACs or low-income homeowners."*
- *"The Equity rebates were introduced prematurely and benefited the high-income customers much more than the low-income customers that they were created for. Additionally, the rebate level was too high. When the whole system is covered by the rebate customers that don't even need it are going to try and get the system for free thus taking the rebate money out of the hands of those that truly need it."*

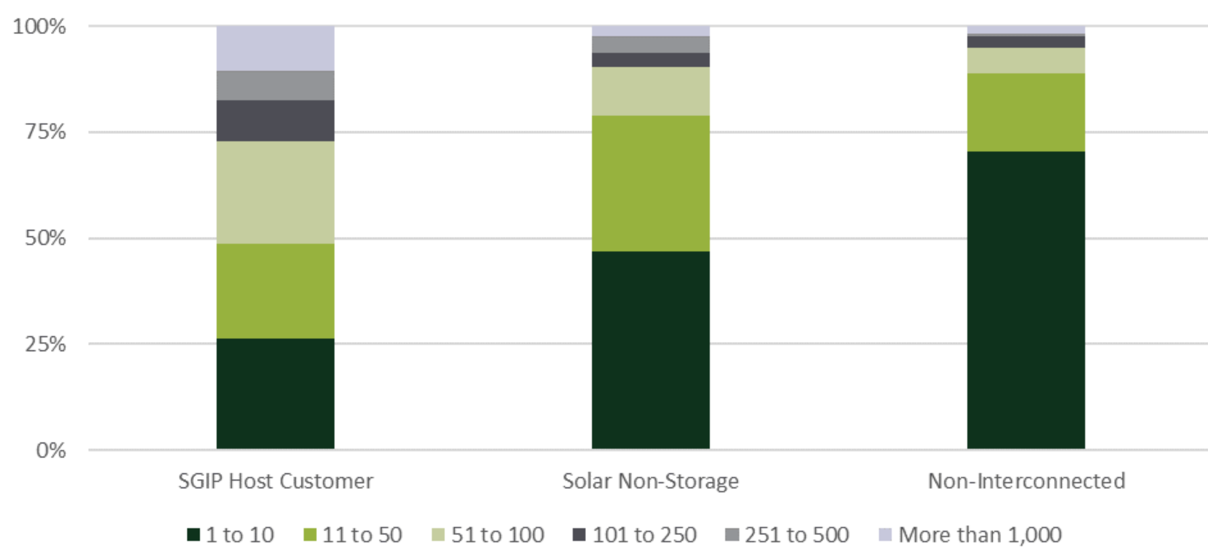
5.1.2 Non-Residential Characteristics

This section presents an assessment of demographic non-residential organization characteristics gathered as part of the SGIP Participant, Storage Non-SGIP, Solar Non-Storage, and Non-Interconnected surveys.[46]

Company Size

Non-residential organizations who have installed storage tend to be large organizations with more than 50 full-time equivalent employees. Non-residential organizations were asked about their number of full-time equivalent employees as a proxy for the company's size. The results (Figure 5-10) tended to vary significantly by respondent type. Non-residential SGIP Participants had the largest share of businesses with more than 500 employees (17 percent of respondents) and less than 50 percent had 50 of fewer employees. Comparatively, most Solar Non-Storage and Non-Interconnected respondents reported having 50 or fewer employees (75 percent and 85 percent, respectively). Nearly 75 percent of Non-Interconnected respondents reported they had fewer than 10 employees. This suggests that larger non-residential organizations are more likely to invest in battery storage than smaller organizations.

FIGURE 5-10: NON-RESIDENTIAL NUMBER OF EMPLOYEES

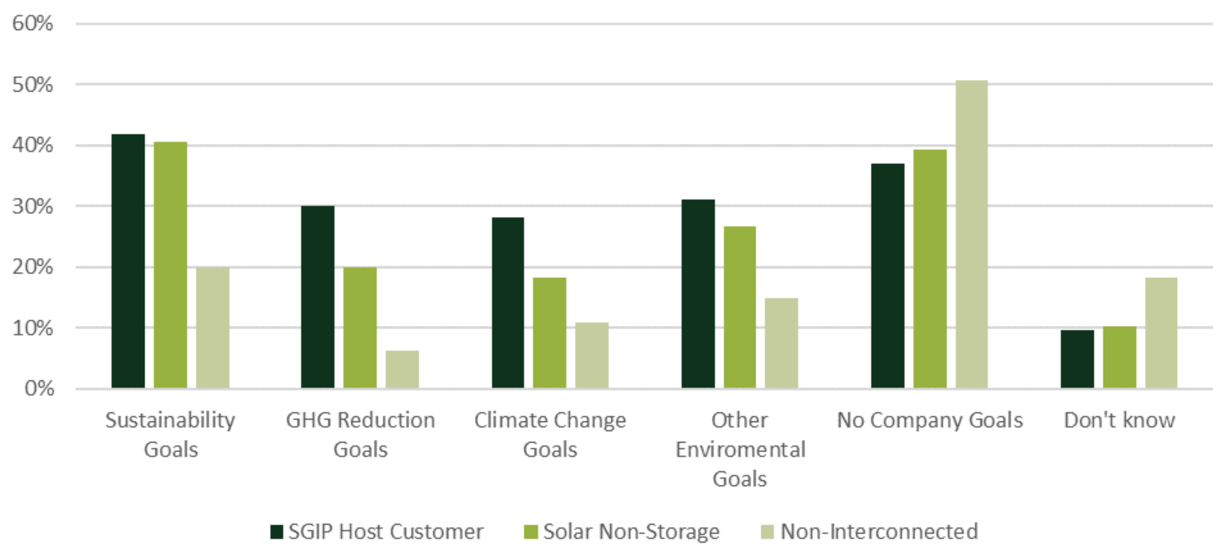


46 The evaluation team attempted to conduct non-residential Storage Non-SGIP surveys, but the population was quite small and only seven customers who had installed storage outside of the SGIP responded and thus their results are not presented throughout this report.

Environmental Goals and Policies

Non-residential organizations with storage are more likely to have some type of company environmental goals or policies than non-Interconnected organizations. Just over 50 percent of both SGIP participants and Solar Non-Storage respondents reported having one or more of the following environmental goals; corporate sustainability, GHG reduction, climate change, or other environmental goals. Only 31 percent of the non-residential non-Interconnected respondents reported having some type of environmental goals.

FIGURE 5-11: NON-RESIDENTIAL ENVIRONMENTAL GOALS



5.1.3 Battery Storage System Characteristics

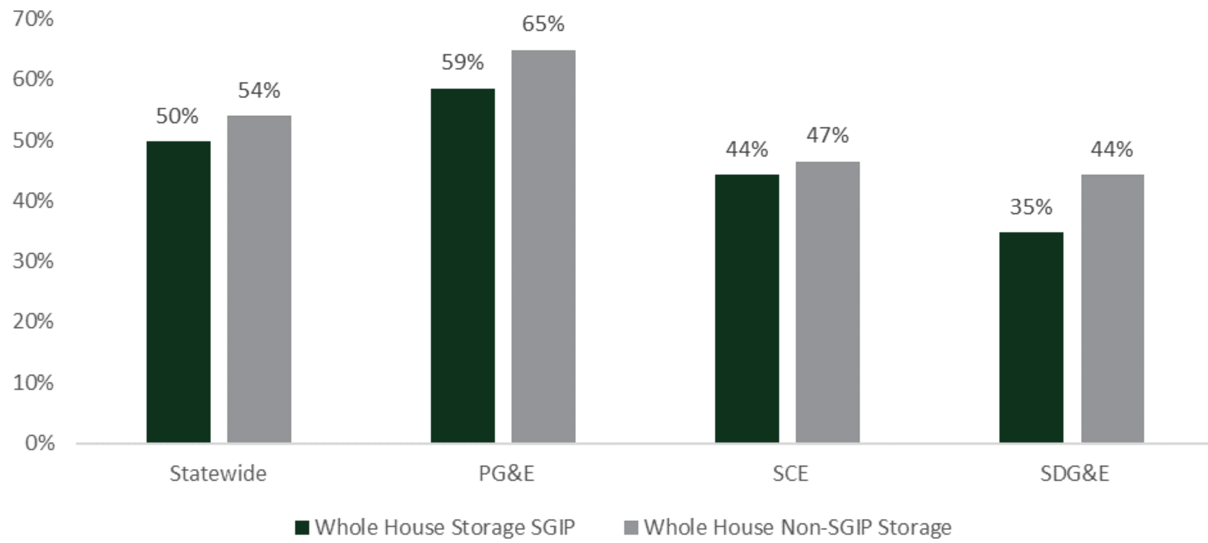
This section presents key findings on battery storage system characteristics based on data gathered during the 2022 SGIP Storage MA surveys with residential and non-residential battery storage owners. Characteristics analyzed include the proportion of systems sized for whole home versus partial home backup, storage paired with solar PV, the timing and influence of solar and storage paired systems and paired solar and storage system sizes. Analysis of California battery storage system characteristics based on SGIP, and storage interconnection data is included in Section 3.

Residential Battery Storage Sized for Whole or Partial House

Residential battery storage systems were nearly equally likely to be sized to provide energy to the whole home as they were to provide energy to only a portion of the home. Figure 5-12 presents the share of SGIP and non-SGIP storage owners who stated that their battery system was designed to provide energy to their whole house. Over half of those with non-SGIP storage (54 percent) have systems designed to provide energy to the whole house compared to 50 percent of those with storage incented by the SGIP program. These data provide further evidence that the average SGIP and non-SGIP battery storage customers, and their systems, are remarkably similar.

The findings presented in Figure 5-12 also show that battery storage systems installed in PG&E's territory are more likely to be designed to provide energy for the whole house than those installed in SCE or SDG&E's territories. Figure 3-20 in Section 3 illustrates that far more customers were rebated through the Equity Resiliency budget in PG&E than in SCE or SDG&E. The figure also details how SGIP PG&E projects within the Equity Resiliency budget are installed within HFTDs, but 22 percent were also installed in homes that were not located in HFTDs but had experienced two or more PSPS events. Furthermore, 33 percent of projects installed through the Small Residential budget category in PG&E – which has no HFTD or PSPS eligibility requirements and offers a much lower incentive than the Equity Resiliency budget – reside in HFTDs and/or experienced two or more PSPS events. The frequency of PSPS events in PG&E territory, dating back to 2019, and the severity of recent wildfires in those areas could correlate to developers' marketing whole home storage to customers in PG&E. Or, perhaps, customers in PG&E may be more sensitive to long duration outages stemming from PSPS events because of more frequent and recent experiences.

FIGURE 5-12: SHARE OF SGIP AND NON-SGIP RESIDENTIAL STORAGE THAT PROVIDES ELECTRICITY TO THE WHOLE HOUSE

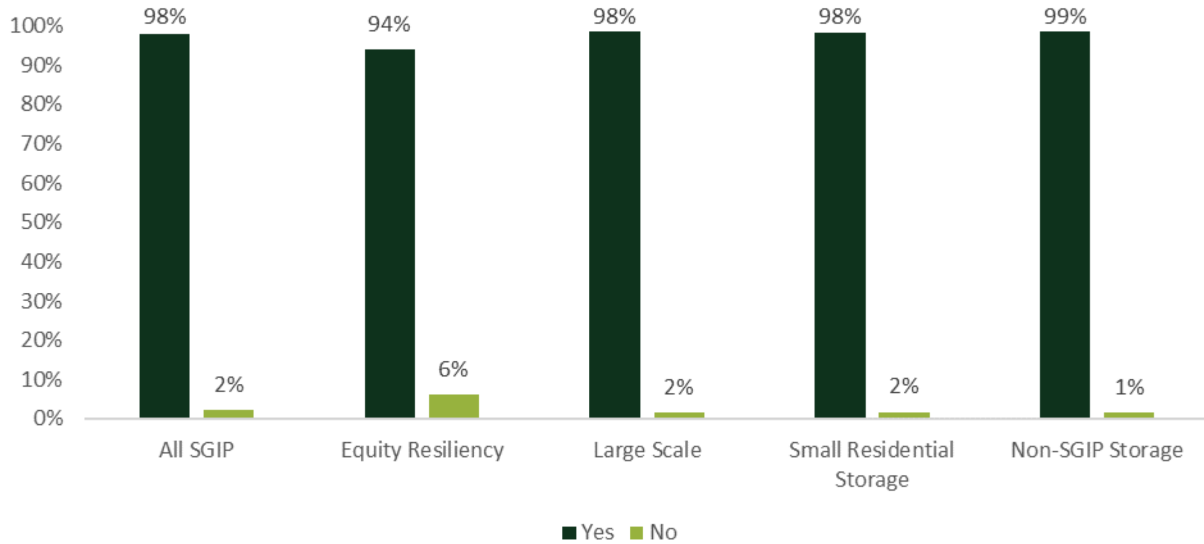


Solar and Storage Pairing

The SGIP program tracking data reveal that residential SGIP participants either install an energy storage system in conjunction with solar PV or retrofit a battery onto an existing PV system. This is true across utility, program administrator, program year and budget category. These program tracking data summaries were compared against actual responses from SGIP participants and non-SGIP storage customers and findings are consistent throughout.

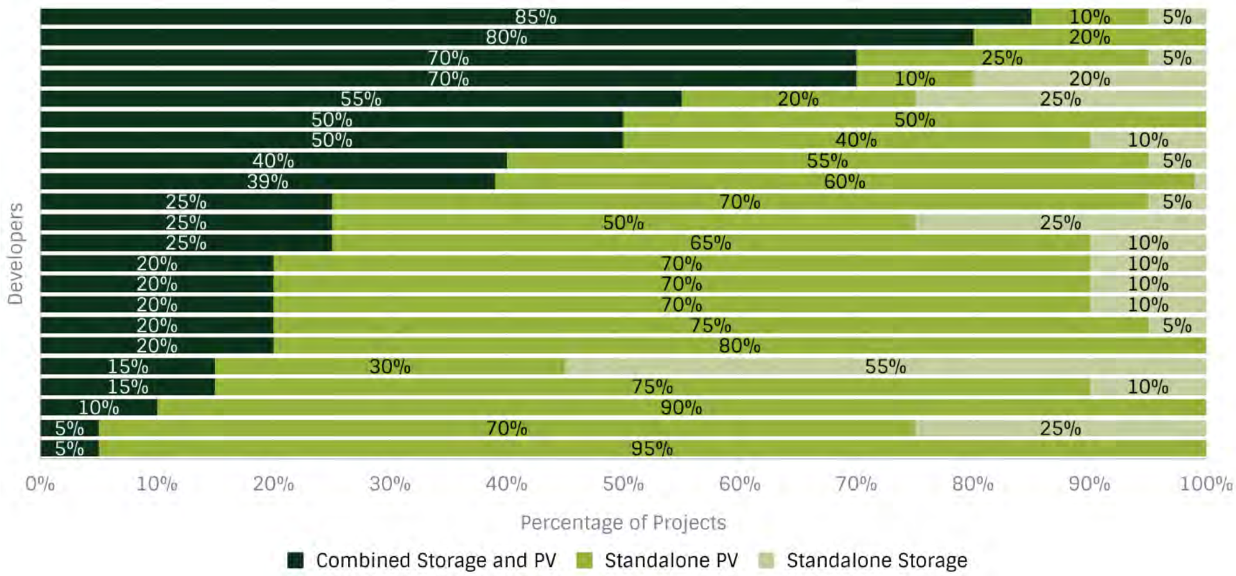
Nearly all residential storage customers also have solar systems installed, enabling them to extend the resiliency the battery provides beyond the system's capacity. Non-residential organizations that have installed storage are considerably less likely than residential storage owners to have paired their storage with solar. Figure 5-13 below shows that most residential storage customers have installed solar. Equity Resiliency customers have a slightly smaller likelihood of owning a solar system that is necessary for their battery storage to provide resiliency or backup during a long power outage. Fifty-two percent of non-residential SGIP Participants reported they have a solar PV generation system.

FIGURE 5-13: SHARE OF RESIDENTIAL CUSTOMERS WITH BATTERY STORAGE THAT HAVE SOLAR



The project developers interviewed as part of this market assessment mostly confirm the above information. As expected, project developers and installers may have different market shares for several reasons related to firmographics and economics. Figure 5-14 summarizes developers' responses regarding the percentage of their organization's residential projects that were paired solar and storage systems, PV only, or storage only installations. There is significant variability in developer responses, but very few are installing standalone energy storage systems. The developers interviewed for this study were more likely installing paired systems or solar PV only. The dark green bars are likely indicative of their SGIP business, and from the percentage of solar PV only installations, there would appear to be significant future potential to retrofit more existing PV with energy storage.

FIGURE 5-14: PERCENTAGE OF DEVELOPER PROJECTS WHICH ARE PAIRED VERSUS STANDALONE SYSTEMS

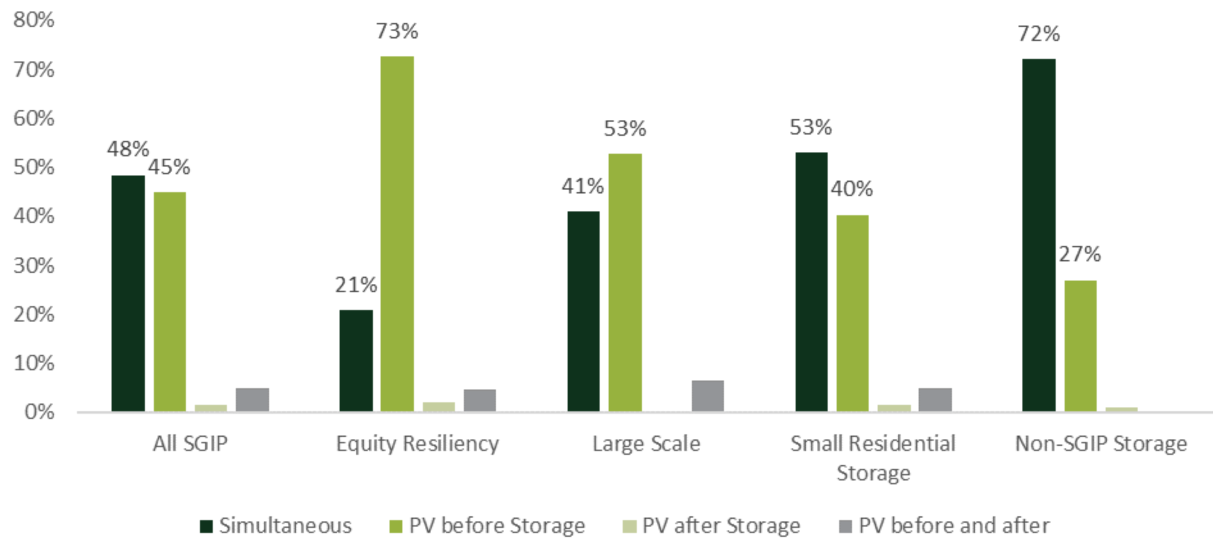


Solar and Storage Purchase Timing and Influence

Approximately half of residential storage is installed simultaneously with solar and the other half is installed on homes with pre-existing solar. Equity Resiliency budget category systems are more likely to be installed after the solar system. Storage survey respondents who have solar installed on their homes and businesses were asked when they purchased their solar system. Figure 5-15 illustrates that the average SGIP participant purchased their solar either concurrently with their storage (48 percent) or before their storage (45 percent). Disaggregating the responses by budget category, however, reveals that Equity Resiliency respondents are far more likely to have installed their battery storage system after their PV solar system (73 percent) than concurrently with it (21 percent). The increased share of Equity Resiliency participants that installed storage after solar may be due to developers focusing their sales efforts on existing solar customers who qualified for the Equity Resiliency budget category incentives prior to the incentives being exhausted. Additionally, the Equity Resiliency budget category requires that customers live in a Level 2 or 3 high fire threat district or have experienced at least two Public Safety Power Shutoff (PSPS) events. Those living in areas of high fire threat or with frequent PSPS events may be more likely to adopt technologies that will enable them to become grid independent prior to other populations.

The results presented in Figure 5-15 also show that a higher share of residential Storage Non-SGIP respondents purchase their battery and solar system simultaneously than SGIP storage customers. Vendors selling batteries to customers outside of the SGIP program may be more likely to sell battery and solar systems together rather than separately, since there is no incentive for either of the technologies. The developer survey results confirm that few customers are installing energy storage before solar PV. Most are either installing paired systems or are installing PV only, which opens up the opportunity to retrofit with storage sometime in the future.

FIGURE 5-15: TIMING OF RESIDENTIAL SOLAR PV PURCHASE RELATIVE TO STORAGE BY BUDGET CATEGORY

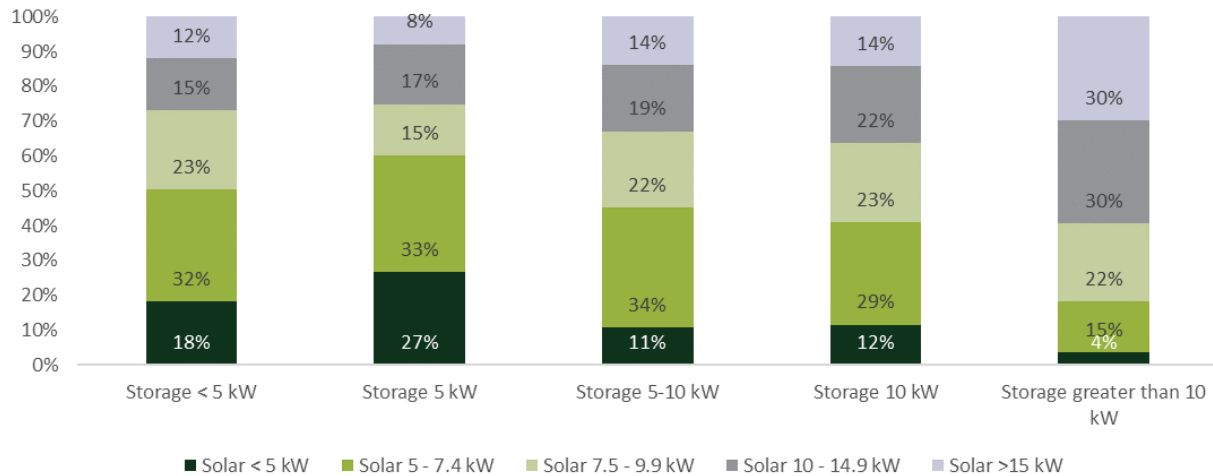


Non-residential SGIP participants with storage and solar are more likely than residential participants to install their storage system at the same time they installed solar PV (61 percent). Less than one-third of participants (30 percent) installed their solar PV system before installing their battery storage system and the remaining 9 percent installed the solar PV after the storage system was installed.

Solar and Storage Sizing

As stated above, nearly all residential storage owners have paired their battery storage systems with solar. The joint sizing of these systems significantly affects the ability of these systems to provide resiliency and the ability of customers to use more of the solar energy they produce, to take advantage of time-of-use arbitrage, and to respond to demand response events. Figure 5-16 illustrates the self-reported joint sizing of storage and solar systems within the SGIP residential population. The figure shows that 60 percent of large battery storage systems (> 10kW) are paired with solar systems that are equally large (10 kW or larger), while 50 to 60 percent of smaller battery storage system (5 kW or less) are paired with smaller solar systems (7.4 kW or smaller).

FIGURE 5-16: SGIP RESIDENTIAL CUSTOMER STORAGE AND SOLAR SIZING



The solar system sizes for non-residential SGIP participants have a much larger range, with 31 percent of respondents reporting systems of less than 100 kW, while the remainder reported sizes ranging from 100 kW to over 1,000 kW.

5.1.4 Storage Developer Characteristics

A significant increase in the number of unique energy storage developers completing projects that had received a SGIP incentive has occurred since the previous Market Assessment was completed in 2019. With the re-authorization of the SGIP, increased funding allocations across multiple budget categories and newer, more sophisticated product offerings, more developers have gained access into the program. There has been a 400 percent increase in the total number of developers operating within the SGIP and the total number of completed projects has increased by well over 900 percent in that time as well.

TABLE 5-2: SGIP STORAGE DEVELOPER POPULATION – 2019 VS. 2022

	2019 Developer Population		2022 Developer Population	
	N	%	N	%
High Volume Developer (> 99 Projects)	15	15%	31	8%
Mid Volume Developer (5 - 99 Projects)	15	15%	131	32%
Low Volume Developer (< 5 Projects)	68	69%	243	60%
Total	**103**		**405**	

Storage developers who responded to the 2022 Developer survey were asked a variety of questions regarding their organization and targeted markets. Key characteristics of the developers who responded to the survey are provided below.

- **Size of Organization**
  - The number of full-time (FT) staff employed by the developers surveyed ranged from a low of 1 to a high of 45,000. The average number of FT staff (excluding the largest) was just under 300 employees. One-third had less than 10 FT staff and roughly one-quarter had more than 100 FT staff.
- **Tenure selling storage and solar**
  - Most developers surveyed have been selling storage for more than 5 years (60 percent). About one-third (36 percent) have been selling storage for 2 to 5 years. Only one respondent said they had been selling storage for less than two years.
  - In general, developers have been selling solar for many more years than storage. than storage. The vast majority (86 percent) have been selling solar for more than 5 years, while a small fraction (14 percent) have been selling it more than 20 years. Only two respondents have been selling solar for less than 2 years. Both of these developers reported they had been selling storage for 5 or more years indicating they have sold storage longer than solar.
- **Target customer segment:** Residential vs. Non-Residential
  - Just over half of the developers surveyed (54 percent) reported their organization focused exclusively on residential or non-residential markets (39 percent residential and 14 percent non-residential). Across organizations that developed both residential and non-residential projects, the primary target was residential customers (89 percent of projects were residential vs. 11 percent that were non-residential).
  - Developers whose organizations focused primarily on the residential sector were asked why that was their target market. They explained it is because the residential market has higher demand, it is easier to install and sell to residential customers (shorter sales cycles and simpler financing), and residential customers have greater resiliency needs due to wildfires and powering critical loads. A few mentioned that obtaining commercial energy storage equipment is hard.
- **Location of targeted customers:** Inside vs. Outside of California
  - The majority of developers surveyed complete storage projects exclusively within California (89 percent). Three firms complete storage projects outside of California, of which two of have one-quarter of their business was outside of California and the remaining firm has 70 percent of their sales outside of California.
  - No developers reported selling storage outside of the U.S.

- **Battery storage systems sold inside and outside of SGIP**
  - Storage project developers were asked what share of their residential and non-residential storage projects received SGIP incentives. The responses varied widely by respondent ranging from those with 100 percent of their storage projects receiveing SGIP incentives to those with no SGIP projects. On average, the developers surveyed reported that 74 percent of residential projects received an SGIP incentive and 66 percent of non-residential projects received an SGIP incentive.
  - Developers who reported selling battery storage without an SGIP incentive reported they chose to do so since participation in the program was often difficult and time consuming due to program rules, waitlists, and the uncertainty of receiving incentives.

5.2 STORAGE AWARENESS AND MARKETING

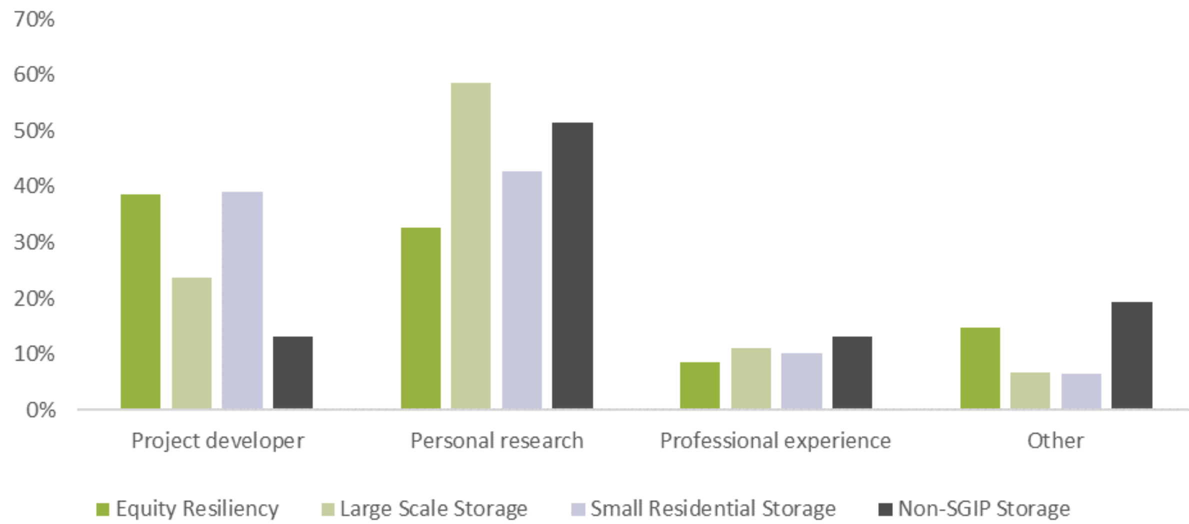
This section highlights customers awareness of battery storage and the messaging used by project developers and recalled by storage adopters.

5.2.1 Sources of Battery Storage Awareness

Most residential and non-residential storage customers learn about storage through personal research or a project developer, and few learn about it through the SGIP or their utility. Those who installed storage systems were asked how they first learned about battery storage. Besides standard response categories (i.e., project developers or contractors, their utility, the SGIP, personal research/social media, and professional experience or knowledge), respondents could also describe other ways they learned about batteries. Figure 5-17 summarizes the responses by SGIP budget category and for storage customers who had not received an SGIP incentive. A small fraction of each group (three percent or less) learned about battery storage from SGIP or their utility. Since these shares are so small, they have not been included in Figure 5-17.

Figure 5-17 clearly illustrates that a higher share of SGIP participants learn about battery storage from their project developer than Storage Non-SGIP survey respondents. The high SGIP developer share may reflect developers marketing or up-selling to previous or potential solar customers when SGIP incentives are available. Storage Non-SGIP respondents rely more on personal research, professional experience, or family and friends. Large-Scale Storage participants also learn about battery storage more frequently on their own rather than through a project developer.

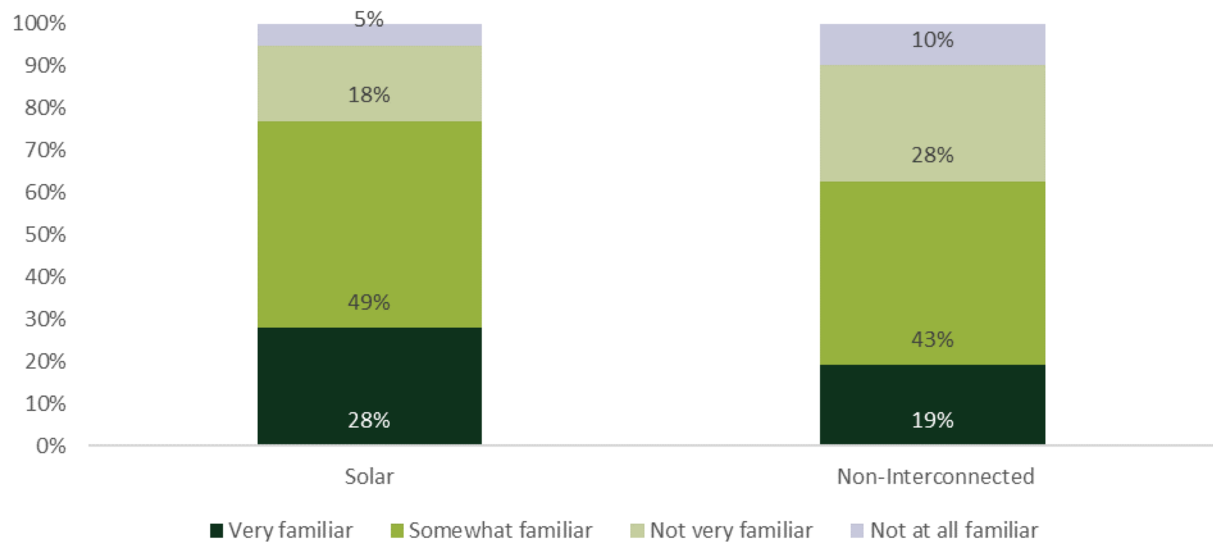
FIGURE 5-17: HOW RESIDENTIAL BATTERY STORAGE CUSTOMERS FIRST LEARNED ABOUT BATTERIES



The majority of non-residential battery storage organizations (56 percent) learn about batteries through a project developer, while another 15 percent learn about storage through their personal research.

Those without storage systems (Solar Non-Storage and Non-Interconnected survey respondents) were also asked whether they had heard about battery storage systems that could be installed in homes or businesses. Nearly all Solar Non-Storage respondents (90 percent) and 64 percent of Non-Interconnected respondents are aware of battery storage systems. Respondents who are knowledgeable about storage were asked to describe their level of familiarity. Figure 5-18 shows that residential Solar Non-Storage respondents who are aware of storage are more likely to report higher levels of familiarity with it than Non-Interconnected respondents. Non-Interconnected customers were also asked about their level of familiarity with solar PV technology. Overall, respondents are only slightly more familiar with solar PV than with storage (19 percent are very familiar, 51 percent are somewhat familiar, and 22 percent are not very familiar with solar PV).

FIGURE 5-18: RESIDENTIAL NON-STORAGE CUSTOMER FAMILIARITY LEVEL WITH BATTERY STORAGE, FOR CUSTOMERS WITH KNOWLEDGE OF STORAGE



Non-Storage respondents who are aware of battery storage were asked how they first became aware of battery storage technology.

- The most frequently reported source was online research (39 percent and 28 percent, respectively).
- Other frequently reported sources of awareness were word of mouth (19 percent Solar Non-Storage and 28 percent Non-Interconnected respondents) and through a solar or storage company (24 percent Solar Non-Storage and only six percent for Non-Interconnected respondents).
- Rarely reported sources were the SGIP and the customer's utility (less than three percent for all respondent groups).
- Most Non-Storage respondents first heard about battery storage within the last five years and Non-Interconnected respondents more often first heard about it in the last year than customers with solar installed (17 percent versus six percent, respectively).

5.2.2 Storage Marketing Messages

Respondents who installed battery storage systems were asked if they recalled the benefits of storage described to them by their vendor prior to purchase. Table 5-3 shows the primary benefits reported by residential and non-residential storage customers as part of the 2022 and 2019 MA studies. Notable findings include:

- **The most widely reported benefits emphasized by vendors, according to residential storage respondents are the ability to improve energy reliability and to save on energy bills.** Improving energy reliability increased by nearly 20 percentage points from the 2019 MA study to the 2022 MA study. Energy reliability was the top reported benefit described across all budget categories.

- The percentage of residential respondents reporting energy bill savings as a benefit also increased substantially between the 2019 MA study and the 2022 MA study, likely due to the increase in rates and the transition to time-of-use rates that many residential customers have experienced over the last few years.

- Twice as many SGIP participants recalled their vendor describing the SGIP Incentive as a benefit than non-SGIP survey respondents.

- The share of residential SGIP participants who recalled their battery storage vendor describing DR Program participation as a benefit of installing battery storage doubled between the 2019 and 2022 market assessment surveys.

- There was a 16 percent increase between the 2019 and 2022 surveys in the share of residential SGIP participants reporting environmental benefits as one of the storage benefits described by vendors. Over half of residential Non-SGIP Storage households (57 percent) report vendors describing environmental benefits.

- **The most widely reported benefits described by vendors according to non-residential SGIP respondents were reduced demand charges and energy bill savings.** Improving energy reliability was recalled less frequently by non-residential storage organizations than by residential storage entities.

TABLE 5-3: PRIMARY BENEFITS OF STORAGE DESCRIBED BY STORAGE EQUIPMENT VENDOR

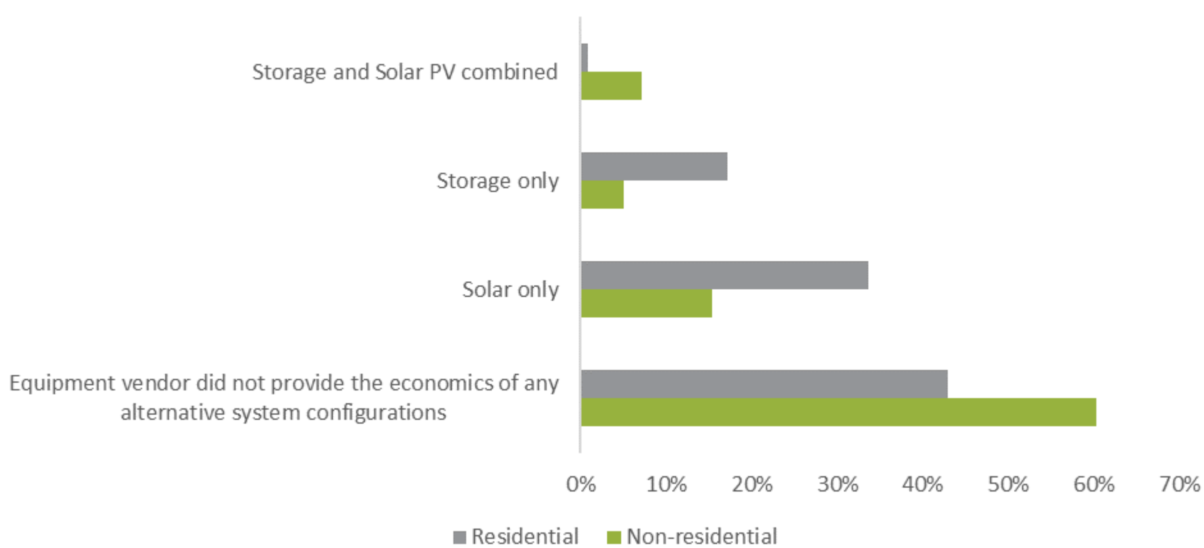
	2022 MA Study			2019 MA Study	
	Residential SGIP	Storage Non-SGIP	Non-Res SGIP	Residential SGIP	Non-Res SGIP
Improving Energy Reliability	82%	85%	51%	63%	37%
Energy Bill Savings	76%	81%	80%	63%	84%
SGIP Incentive	75%	37%	78%	N/A	N/A
Investment Tax Credit	67%	70%	37%	50%	26%
Ability to use more Solar Energy	63%	Not asked	23%	63%	21%
Environmental Benefits, e.g., GHG reduction	54%	57%	44%	38%	53%
Participation in a DR program	32%	26%	35%	16%	37%
Reduced Demand Charges	N/A	N/A	80%	N/A	89%

A follow-up question was asked of survey respondents to assess which of the described benefits they believed were realized. The vast majority of residential SGIP respondents (ranging from a low of 85 percent to a high of 94 percent) have successfully realized these benefits. Fewer Storage Non-SGIP respondents have successfully realized these benefits with most realization rates in the 80 percent range. The benefit with the lowest reported realization rate was the SGIP incentive, which aligns with the findings that many of the Storage Non-SGIP respondents have applied for an SGIP incentive but have not received it. (these results are presented in Section 5.7.2 below). Non-residential organizations that have installed storage also reported lower levels of realized benefits (averaging around 70 percent across all described benefits). The lowest realized benefit for non-residential SGIP participants was the Federal Investment Tax Credit (realized by 31 percent).

5.2.3 Systems Described to Customers

Residential and non-residential customers with battery storage installed (both inside and outside of SGIP) were asked whether they recalled their vendor describing the economics of alternative system configurations. The findings, presented in Figure 5-19, indicate that most non-residential respondents believe that their storage vendor did not provide the economics for any systems other than the one they installed (60 percent). Residential respondents were most likely to report they received economic information for the same systems as they installed (43 percent), but another 34 percent reported their vendor provided them with alternative system configurations including solar only, and 17 percent reported them for storage only alternative system configurations.

FIGURE 5-19: ALTERNATIVE SYSTEMS DESCRIBED BY VENDORS



Over three-fourths of SGIP and non-SGIP residential storage households (78 percent) reported their vendor informed them that storage was required with solar PV to maintain power during an outage. However, a higher share of Large-Scale Storage participants (87 percent) reported their vendor informed them of this necessity. Non-residential SGIP participants were significantly less likely to report their vendor informed them that storage was required with solar PV to maintain power during an outage (only 24 percent reported being informed). This is likely due to the significantly fewer non-residential systems that are paired with solar (98 percent of residential SGIP respondents versus 52 percent of non-residential SGIP respondents reported to have a paired solar and storage system).

5.2.4 Net Energy Metering

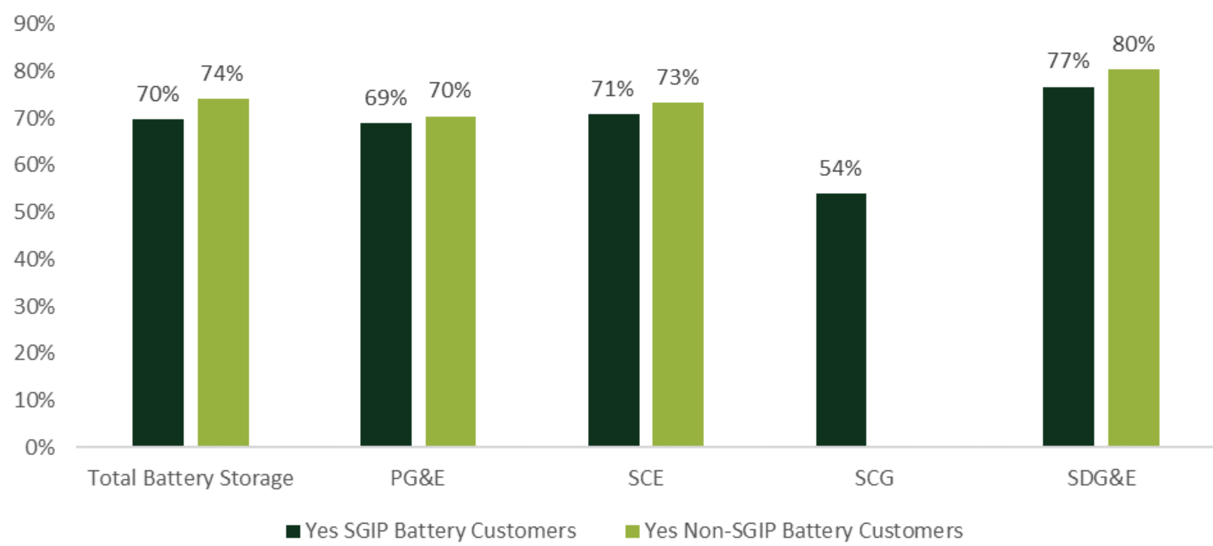
Customers who install small solar, wind, biogas, and fuel cell generation systems to serve all or a portion of onsite electricity needs are eligible for net-energy metering (NEM). NEM allows customers who generate their own energy to serve their energy needs directly onsite and to receive a financial credit on their electric bills for any surplus energy fed back to their utility. Changing NEM policies may create a potential driver for energy storage. NEM exports are currently valued at the retail rate minus non-bypassable charges. The CPUC is currently addressing several issues related to the NEM successor tariff as part of R. 14-07-002. Since 2019, Energy Division staff have been exploring alternate compensation mechanisms for customer-sited distributed generation other than the current NEM framework.

On December 13th, 2021, the CPUC issued a Proposed Decision (PD) to reform net energy metering. The PD proposed to, among other things, value customer exports at the avoided cost rate (based on the CPUC approved Avoided Cost Calculator), rather than retail rates (i.e., NEM 2.0). The proposal would significantly reduce the value of exports and thus potentially increase the value proposition of energy storage systems that could minimize exports during the middle of the day when avoided cost values are low and maximize solar self-consumption. Energy storage systems could also strategically export during hours of very high avoided costs to maximize customer bill savings. As written, the PD would present a potential driver for battery storage in California relative to the economics of standalone solar PV.

Developers were asked whether proposed changes to NEM would influence their sales of energy storage products. Thirteen respondents stated that NEM reform would decrease annual sales of energy storage and eight developers stated NEM reform would increase installations of energy storage in California. Developers who believe NEM reform will result in an increase in storage sales attribute their perspective to solar being less desirable and economically viable without storage. They believe NEM will adversely affect sales of solar, but customers who continue to install solar will need storage for solar self-consumption. Other developers, however, believe solar is the gateway to energy storage, so by reducing the value proposition of solar, the storage industry will experience collateral damage.

Storage owners were asked if their battery storage vendor mentioned California's net energy metering (NEM) policy. The data presented in Figure 5-20 shows that statewide, 70 percent of SGIP and 74 percent of non-SGIP storage respondents reported their vendor mentioned NEM. Within SCG territory, however, participants were significantly less likely to attest to have been informed about NEM (54 percent). The shares of SGIP and non-SGIP battery storage respondents reporting that their vendor mentioned NEM are very similar, likely due to an overlap in vendors installing within and outside of SGIP, the high share of SGIP and non-SGIP customers whose battery systems are paired with solar, and the high likelihood that all battery storage customers interconnect their technologies and participate in the NEM rate.

FIGURE 5-20: RESIDENTIAL STORAGE CUSTOMERS REPORT THAT VENDORS DISCUSSED NEM, BY IOU*



*There is not a sample of non-SGIP battery customers.

Only 51 percent of non-residential SGIP respondents reported their storage equipment vendor talked to them about NEM.

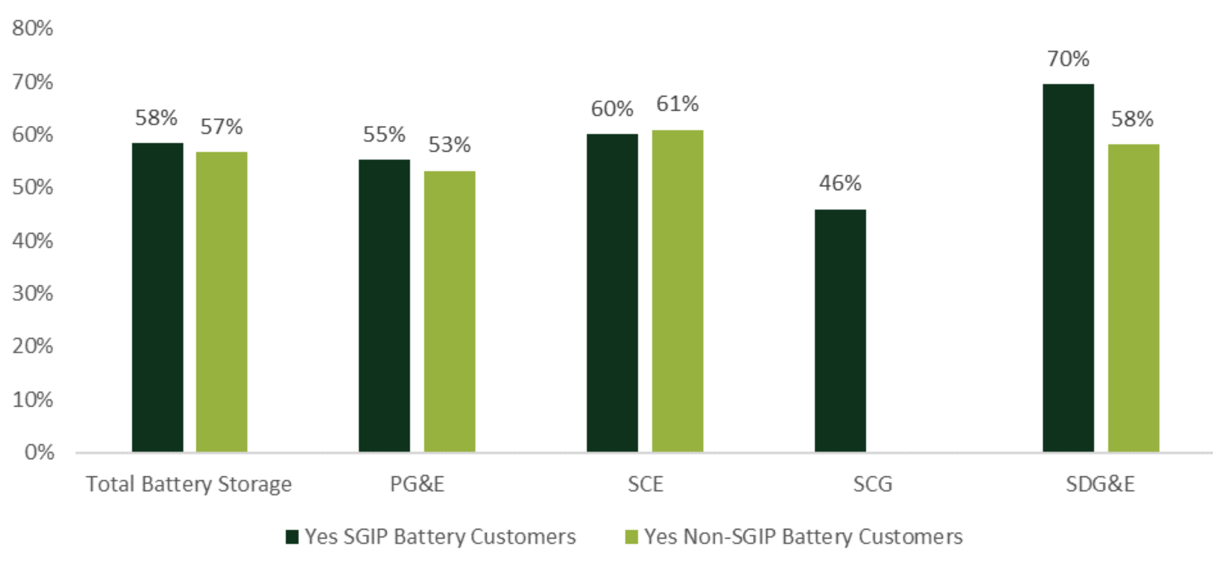
5.2.5 Time-of-Use Rates

California's NEM 2.0 policy requires interconnected customers to transition to time-of-use (TOU) rates. In addition, the IOUs have shifted the TOU peak period from an afternoon peak to an evening peak (4-9 pm or 5-8 pm). The transition to a later peak improves the economics of battery storage paired with solar. The new TOU periods result in economics that encourage storage plus solar owners to use their batteries to store excess energy produced by their solar system during semi- and off-peak hours so it can be either self-consumed or discharged during peak hours (TOU arbitrage) to reduce their utility bills.

The developer surveys questioned vendors about their knowledge of the new TOU rates while the customer surveys asked if vendors had informed storage customers of the economic impact of the new TOU rates. Vendor reported telling their customers about TOU rates, but it was not reported to be one of the most significant financial factors in their marketing messages. This aligns with the moderate recall of TOU rate discussions storage owners had with project developers.

The survey asked storage owners if their storage vendor informed them about how the new TOU rates impact the economics of battery storage. The data presented in Figure 5-21 show that overall, 58 percent of SGIP and 57 percent of non-SGIP storage customers reported their vendor provided them information on the economic impacts of TOU rates. The frequency with which SGIP respondents reported vendors had provided this information varies slightly by customer service territory from a low of 46 percent (SCG) to a high of 70 percent (SDG&E) while the non-SGIP shares were lowest for customers served by PG&E (53 percent) and highest for those is SCE's territory (61 percent). The difference may be attributable to the timing of the IOUs' transition to NEM and TOU rates. SDG&E was the first IOU to transition from NEM 1.0 to NEM 2.0 and to shift from tiered to TOU rates, followed by SCE and then PG&E. The earlier transition by SDG&E and SCE to NEM 2.0 and widespread TOU rates may have contributed to their vendors' and customers' higher share of reported discussion of these two topics.

FIGURE 5-21: RESIDENTIAL SGIP STORAGE PARTICIPANTS REPORTING THEIR STORAGE VENDOR DISCUSSED TOU RATES



A slightly higher percentage of non-residential SGIP participants (65 percent) reported their storage equipment vendor provided them with information about the impact of the new TOU rates on the economics of their storage system.

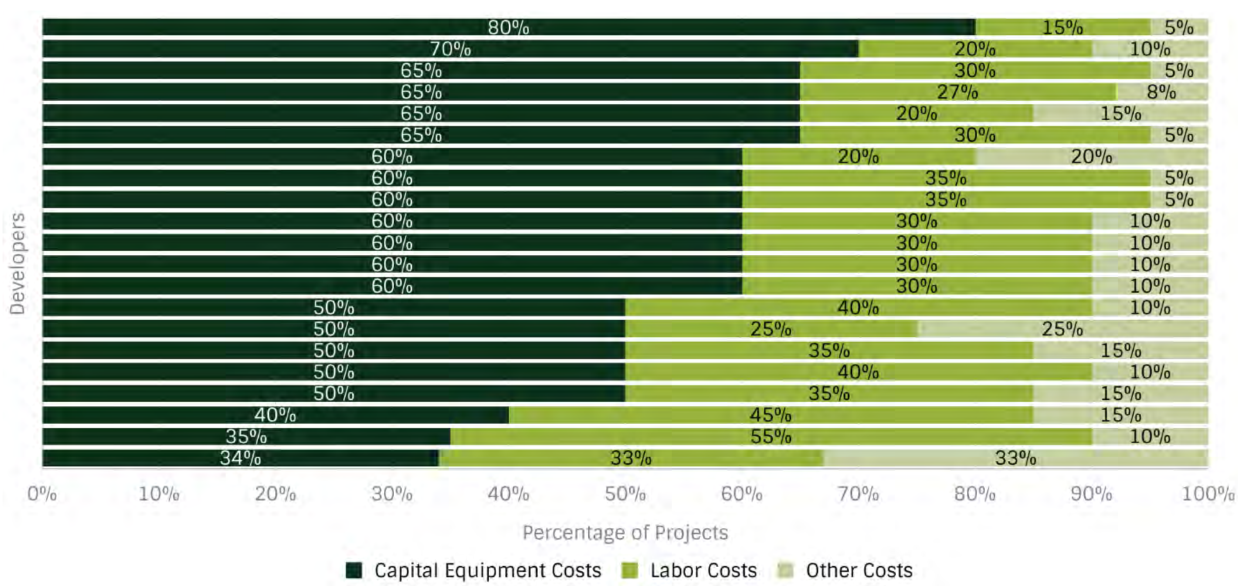
5.3 DEVELOPER SURVEY STORAGE COST ANALYSIS

Section 3 discussed how self-reported total eligible costs have increased over the past several program years. These trends appear independent of budget category and, when normalized by the size of the installed system, are independent of storage sizing – although we observed slightly higher costs in the Equity Resiliency budget category relative to the Small Residential category.

As part of the developer interviews, Verdant also asked survey respondents about the costs associated with installing energy storage technologies within customer homes and businesses. Developers were first asked how typical residential or non-residential storage project costs are distributed across three categories: 1) Capital equipment costs, 2) Labor costs and 3) Other costs (permitting, interconnection, metering, etc.). They were also asked how often projects require electrical panel upgrades or sub-panel installations and, if so, what are their associated upgrade costs. Finally, Verdant also asked project developers to provide their perspectives on how storage costs have changed over the past two years and how they expect them to change over the next two years.

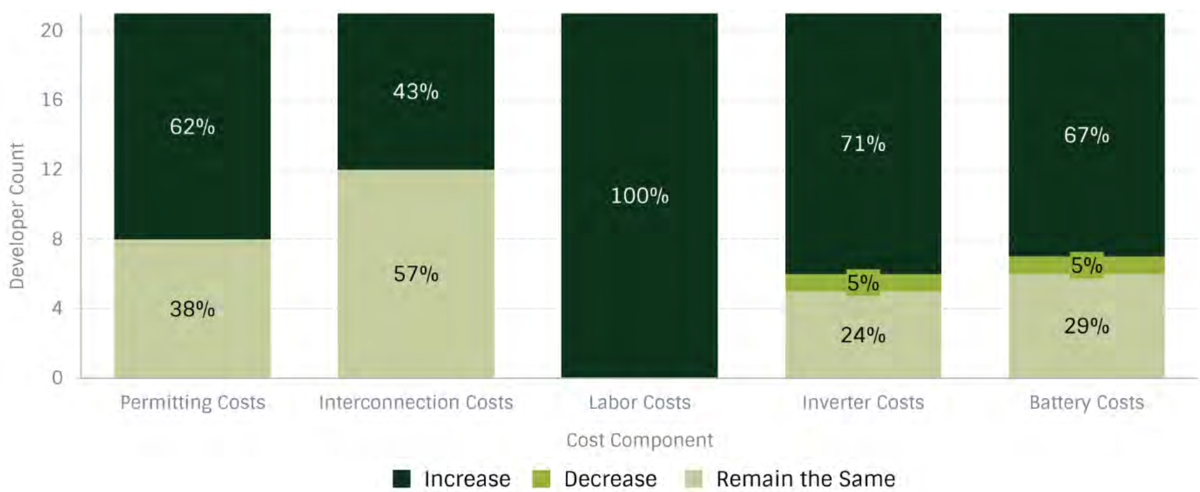
Figure 5-22 presents the self-reported distribution of total project costs by developer for residential projects. Eighteen of 21 developers installing residential systems reported at least 50 percent of the total project costs are associated with capital equipment costs. Labor costs represent anywhere from 15 percent to 55 percent of total costs across developers, and other permitting and interconnection costs make up the difference. A similar trend in evident for developers installing non-residential systems as well.

FIGURE 5-22: DEVELOPER SELF-REPORTED DISTRIBUTION OF PROJECT COSTS FOR RESIDENTIAL CUSTOMERS



Developers were also asked if these project costs have increased, decreased, or remained the same over the past two years, and if so, by how much. The results from that question are presented below in Figure 5-23. Developers were split on increasing or static costs for permitting and interconnection, while a majority self-reported increases in inverter and battery costs over the past two years. All developers self-reported that labor costs have increased within that time. Self-reported battery and inverter cost increases ranged from 10 to 25 percent and labor cost increases ranged from 15 to 30 percent. Developers also self-reported that costs will continue to increase over the next two years in a similar pattern, however, the average expected increases in battery, inverter and labor costs were less than what they've experienced in the past two years.

FIGURE 5-23: DEVELOPER SELF-REPORTED CHANGE IN COSTS OVER THE PAST TWO YEARS



These cost increases, especially throughout the past two years, align with the total eligible costs reported as part of the SGIP application process. Total eligible costs have increased in PY 2020 and 2021, relative to PY 2017-2019 (Figure 3-9). As discussed in Section 3, these increases are predicated on the distribution of electrochemical battery equipment types being installed within the program and these overall increases in labor and capital costs.

Verdant also asked developers whether energy storage installations generally required electric panel upgrades or sub-panel installations and, if so, what were the average additional costs associated with these upgrades. Older homes with 100-amp electrical panels generally will require a panel upgrade or dedicated sub-panel to facilitate the additional electric load from a BTM storage system or paired PV plus storage system. For developers who responded that panel upgrades were necessary (18 of the 21 developers surveyed), the percentage of projects requiring panel upgrades ranged from five percent to 60 percent of all projects. A greater percentage of projects required sub-panel installations and ranged from one percent to 100 percent of developer's storage installations. The average self-reported costs of installing a new panel ranged from $1,200 to $6,500 and ranged from $500 to $3,500 for a sub-panel. A smaller percentage of respondents stated that new electrical circuits were required during the installation of the storage system. The variability in costs highlight the unique, customer-specific nature of installing an energy storage system on a home.

5.3.1 Storage System Ownership

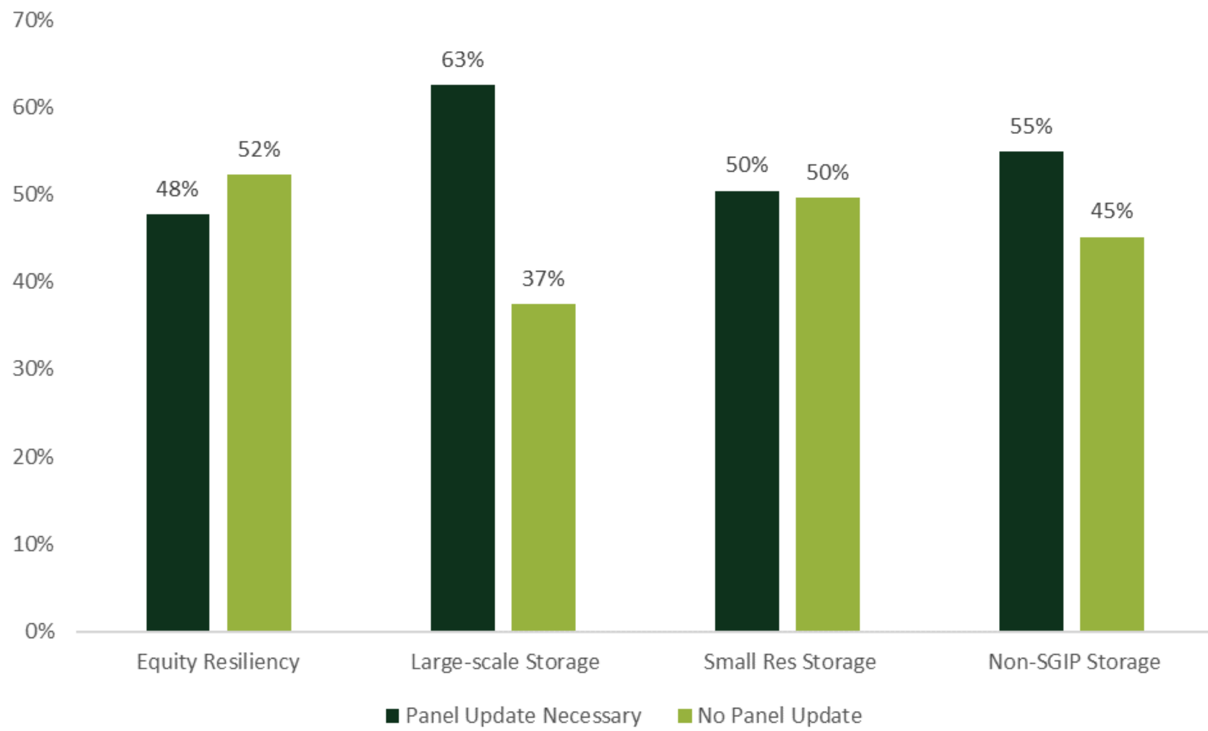
Survey respondents who have battery storage installed were asked whether they bought or are leasing the battery storage system**. The overwhelming majority of residential storage respondents purchase their storage systems** (97 percent of SGIP participants and 94 percent of Storage non-SGIP respondents). Non-residential SGIP participants are much less likely to purchase the storage system (64 percent) and more likely to lease it (31 percent, 5 percent did not know if their system was owned or leased). This is confirmed by the battery storage developers surveyed who reported they primarily sell storage products to host customers. Only four developers reported they offered storage lease to host customers.

Roughly two-thirds of survey respondents who have installed battery storage reported they considered the cost of leasing/purchasing the storage system to be reasonable. This is a substantial reduction from the 2019 Storage MA study which found 81 percent of residential storage respondents and 93 percent of non-residential storage respondents thought the cost was reasonable. Looking across budget categories, Equity Resiliency participants are much less likely to think the cost of storage is reasonable (43 percent) as compared to Large-Scale Storage or Small Residential Storage participants (63 percent and 61 percent) which is likely related to the lower income levels of Equity Resiliency category participants (Figure 5-2 above). Additionally, residential SGIP participants who installed their storage in the last two years (2020 or 2021) are less likely to find the cost of storage to be reasonable (54 percent) compared to those who purchased it between 2017 and 2019 (62 percent).

5.3.2 Electrical Panel Upgrade

Roughly half of residential and one-quarter of non-residential customers with battery storage require an electrical panel upgrade prior to installing storage. Battery storage systems can increase the electrical system requirements for residences and often necessitate an electrical panel upgrade prior to installation. Panel upgrades can be expensive, depending on the need to pull electrical lines and trench if the lines are undergrounded. The cost of panel upgrades can deter the installation of battery storage, but little is known about the share of residential battery systems that require a panel upgrade. Figure 5-24 illustrates the share of residential battery storage customers self-reporting their electrical panel needed an upgrade. Fifty one percent of all residential SGIP participants surveyed reported needing a panel update. The share needing an upgrade is much higher for Large-Scale Storage participants (63 percent), presumably due to the large size of the storage system.

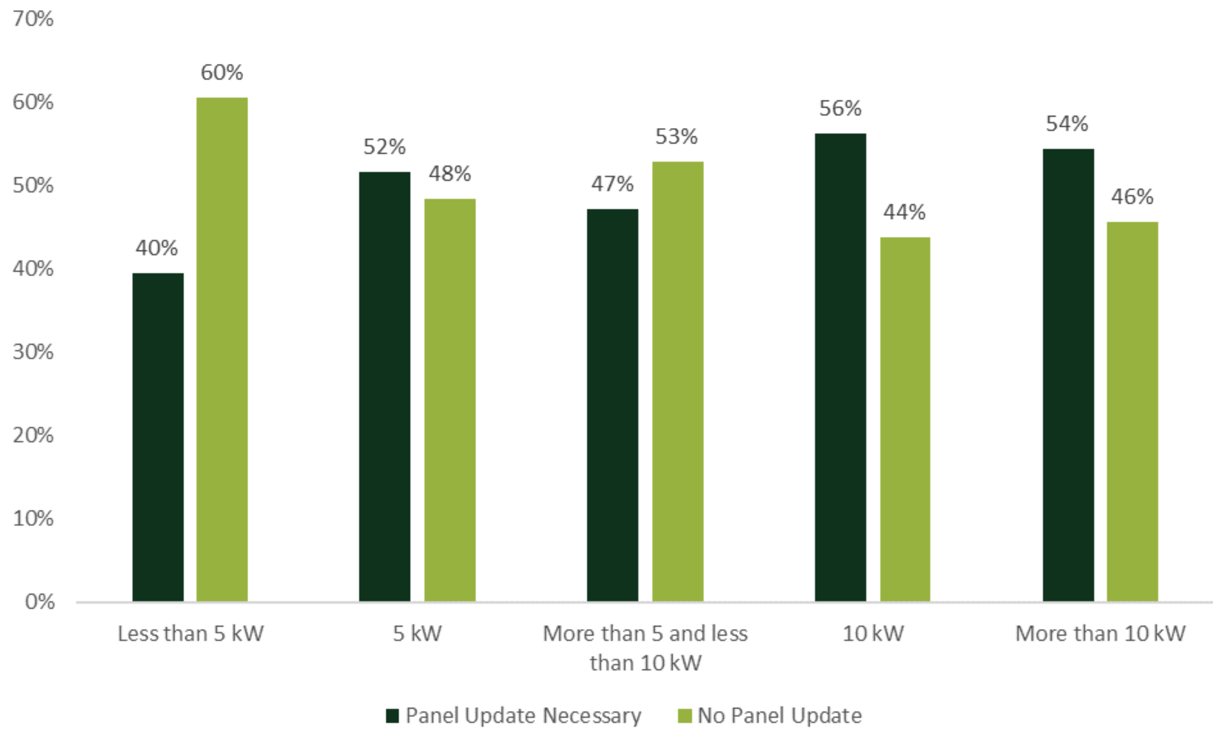
FIGURE 5-24: RESIDENTIAL STORAGE CUSTOMERS NEEDING A PANEL UPGRADE PRIOR TO BATTERY INSTALLATION



Non-residential SGIP customers are significantly less likely to report that a panel system upgrade is needed prior to installing battery storage (26 percent).

While the data in Figure 5-24 support the conclusion that large battery storage systems are more likely to need a panel upgrade, the question remains if there is a capacity threshold at which the likelihood of needing a panel upgrade grows substantially. The data presented in Figure 5-25 indicate that even 40 percent of those with batteries smaller than 5 kW report needing a panel upgrade. These data clearly support the conclusion that most customers installing batteries, even relatively small capacity batteries, will need to upgrade their electrical panels before battery storage can be installed.

FIGURE 5-25: SGIP RESIDENTIAL CUSTOMERS NEEDING A PANEL UPGRADE PRIOR TO BATTERY INSTALLATION, BY BATTERY SIZE



5.4 DRIVERS AND BARRIERS TO STORAGE ADOPTION

This section presents the primary motivations and barriers to battery storage system adoption as viewed by project developers and residential and non-residential survey respondents.

5.4.1 Primary Motivations for Installing Battery Storage

This section explores the primary reasons/motivations storage owners provide for purchasing battery storage systems, as well as the perceived benefits non-storage customers report that would motivate them to install storage. It explores the economic factors influencing the installation of battery storage systems and the likelihood and timing of future storage adoption as reported by non-storage customers.

Storage Owners Motivations to Install Storage

Storage owners were asked to rank the top three reasons (in order) they decided to install battery storage. Potential responses included: to provide backup power during an outage, to meet medical or work-related resiliency needs, to lower their utility bill, to store excess solar production, and to improve the environment. Respondents could also describe other reasons they decided to install battery storage.

Table 5-4 presents the primary, secondary, and tertiary reasons for battery storage installation for SGIP and non-SGIP battery customers. In the aggregate, the stated reasons for battery storage installation are very similar for SGIP and non-SGIP battery customers. The top motivational reasons for installing storage by residential storage owners were:

- **To provide resilient backup power for emergencies or outages.** Over50 percent of SGIP and non-SGIP battery storage respondents state that backup or emergency power is the number one reason for installation. When those who choose it as their second or third reason are included in the analysis, over 90 percent of SGIP and non-SGIP residential respondents report it is one of the top three drivers of their battery storage installation decision.

- **Shifting grid energy consumption from on-peak to off-peak periods, which leads to bill savings**, is reported by 57 percent of SGIP respondents and 61 of non-SGIP battery owners as one of their top three reasons for installing storage.

- **Using more of the solar they generate and environmental reasons,** such as GHG reductions, are the third and fourth most chosen drivers of battery storage adoption.

TABLE 5-4: SGIP AND NON-SGIP RESIDENTIAL BATTERY STORAGE TOP THREE REASONS TO INSTALL STORAGE

	SGIP Primary	Non-SGIP Primary	SGIP Secondary	Non-SGIP Secondary	SGIP Tertiary	Non-SGIP Tertiary
SGIP Incentive	4%	1%	7%	3%	16%	7%
Bill Savings	13%	12%	22%	25%	21%	23%
Backup Power	53%	56%	24%	23%	14%	14%
Medical Need	5%	4%	4%	2%	2%	3%
Work Need	2%	3%	5%	6%	5%	6%
Environment	10%	11%	16%	16%	19%	21%
Use more Solar	11%	11%	21%	24%	19%	22%
Other	2%	1%	1%	1%	2%	2%

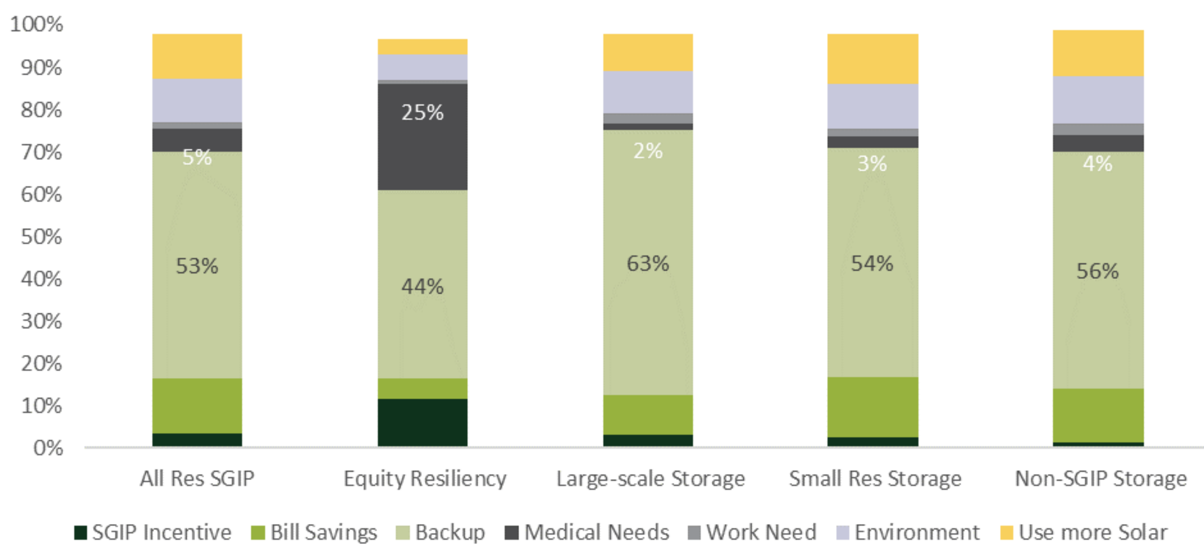
Figure 5-26 shows the primary reasons for battery storage installation for residential SGIP customers, overall and disaggregated by budget category, and Storage Non-SGIP respondents. This exhibit illustrates the following interesting differences that exist for Equity Resiliency customers:

- **Equity Resiliency customers reported backup power is their primary reason for battery storage installation (44 percent), followed by 25 percent stating medical needs.** Equity Resiliency customers are the only budget category for whom medical needs is a primary reason for installation for over 5 percent of the category respondents. Forty seven percent of the Equity Resiliency cohort reported medical needs as one of their top three reasons for battery storage installation. The high share of Equity Resiliency customers stating that medical needs is the primary reason for their battery installation is consistent with 65 percent of these customers stating that a member of their household has a medical need requiring electricity resiliency (see Figure 5-7 above). Medical needs and participation in the utility medical baseline option are two eligibility qualifiers for the Equity Resiliency budget category.

- Twelve percent of Equity Resiliency customers state that the SGIP incentive is the primary reason for their battery installation. For the remaining SGIP budget categories, three percent or fewer respondents state that the SGIP incentive was their primary reason for battery installation. The higher share for the Equity Resiliency customers likely reflects the substantially larger SGIP incentive received by these customers relative to the other two budget categories represented in the survey.

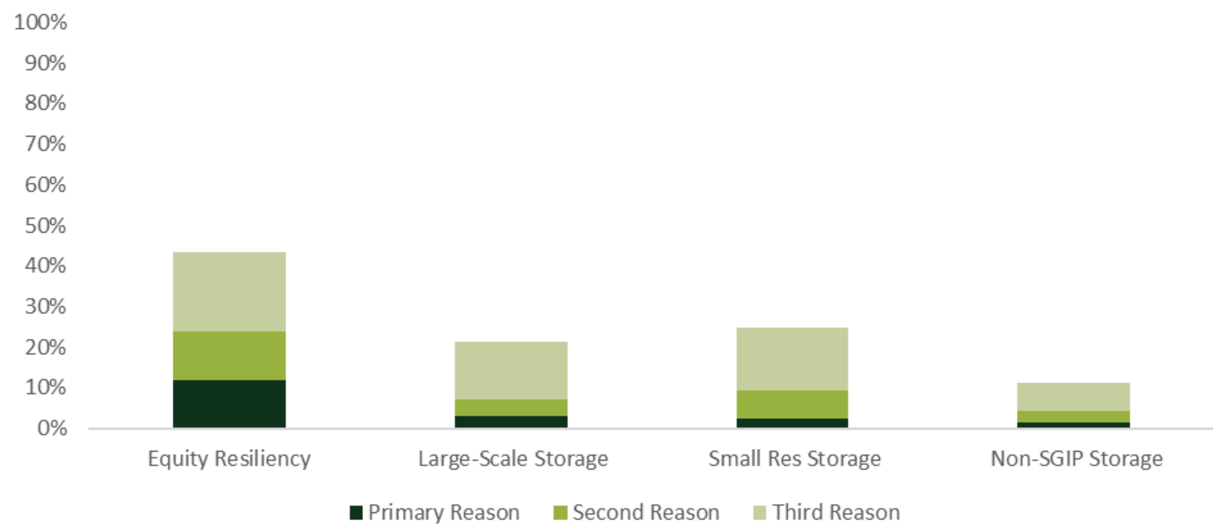
Very similar distributions of primary reasons for battery storage installation are observed across the Small Residential Storage and the Storage Non-SGIP customers. Comparing their responses to the secondary and tertiary reasons for installation, Storage Non-SGIP and Small Residential Storage budget category customers continue to be similar, except Storage Non-SGIP customers are more likely to point to the importance of environmental reasons and Small Residential Storage customers are more likely to cite the SGIP incentive.

FIGURE 5-26: PRIMARY REASONS FOR INSTALLING RESIDENTIAL BATTERY



The SGIP incentive is a significant reason Equity Resiliency participants install battery storage. Figure 5-27 illustrates the share of SGIP and non-SGIP residential respondents reporting the SGIP incentive was one of their top three reasons for installing battery storage. Forty three percent of Equity Resiliency respondents report the SGIP incentive was a top three reason, compared to 21 percent of Large-Scale Storage, 24 percent of Small Residential Storage, and 11 percent of Storage Non-SGIP respondents.

FIGURE 5-27: SHARE OF SGIP AND NON-SGIP RESIDENTIAL STORAGE CUSTOMERS REPORTING SGIP AS A PRIMARY, SECONDARY OR THIRD REASON FOR INSTALLING BATTERY STORAGE BY BUDGET CATEGORY



Non-residential SGIP participants reported a higher share are motivated by monetary savings and less were motivated by resiliency. The top five motivational reasons for installing storage in the non-residential market are:

- To reduce demand charges (86 percent ranked in top 3 reasons, 46 percent ranked as top reason)
- To save money on their electric bill (64 percent ranked in top 3 reasons)
- To receive an SGIP incentive (52 percent ranked in top 3 reasons)
- To improve the environment, reduce GHG emissions, or help address climate change (49 percent ranked in top 3 reasons)
- To provide backup or emergency power and to become less grid dependent (31 percent ranked in top 3 reasons, most of whom ranked as their top reason)

Economic Factors Influencing Installation

Residential battery storage respondents were asked how important a variety of economic factors are in their decision to install battery storage. These economic factors include total out of pocket costs, the SGIP incentive, future bill savings, the federal investment tax credit (FITC), and potential savings resulting from participation in a demand response program. Respondents ranked the importance of these features on a 1 to 5 scale where 1 was not at all important and 5 was extremely important.

Figure 5-28 presents the average ranking of economic factors across all residential SGIP respondents, by SGIP budget category, and for non-SGIP storage customers. This analysis shows that total out-of-pocket costs and the SGIP incentive are the most important to the Equity Resiliency budget category. This is consistent with this group having a smaller share of respondents with income exceeding $200,000 (see Figure 5-2 above) and the larger $/Wh incentive available through the SGIP current budget categories.

- **The highest ranked economic factor for the Large-Scale Storage and the Small Residential Storage budget categories was the FITC.** The higher incomes of these customers, combined with the SGIP incentive covering a smaller share of the battery's cost, likely contributes to the importance of the FITC.

- Storage Non-SGIP residential customers rank bill savings and the FITC as the most important economic factors influencing their decision to install storage.[47]

- The least important economic factor to all budget categories is the demand response program savings potential. The lower importance of this factor likely reflects lower participation in these programs.

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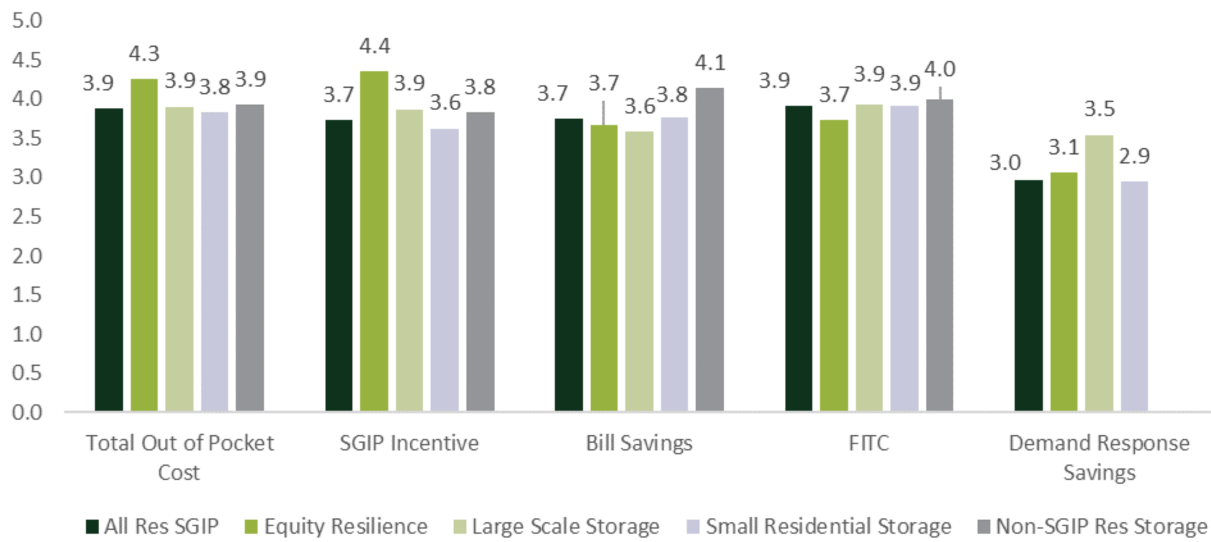
47 The economic importance of the SGIP incentive for residential battery storage customers who have not received an SGIP incentive was asked of those customers who stated that they expected to receive an SGIP incentive in the future.

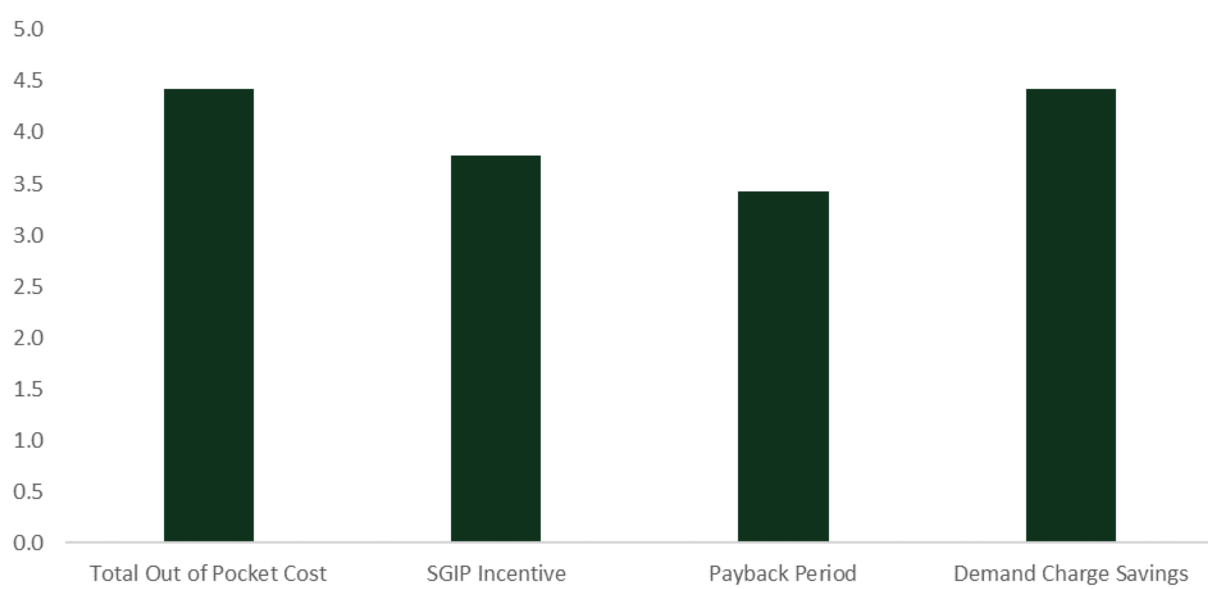
FIGURE 5-28: ECONOMIC FACTORS INFLUENCING THE INSTALLATION OF RESIDENTIAL STORAGE*



*The non-SGIP residential storage survey did not include questions about the economic influence of demand response savings.

Non-residential SGIP participants were also asked a similar ranking question about how important several economic factors were in their decision to install battery storage. Figure 5-29 presents the average ranking across all non-residential SGIP respondents. This analysis shows that total out-of-pocket costs and demand charge savings are the most important for non-residential SGIP participants.

FIGURE 5-29: ECONOMIC FACTORS INFLUENCING THE INSTALLATION OF NON-RESIDENTIAL STORAGE*



More than half of residential SGIP participants received an incentive or tax benefit in addition to the SGIP incentive to help offset the cost of the storage system. Non-residential SGIP participants were considerably less likely to receive an additional incentive. Nearly 60 percent of residential SGIP participants, but only 24 percent of non-residential SGIP participants reported receiving an incentive or tax benefit in addition to the SGIP incentive. Large-Scale Storage and Small Residential Storage respondents are roughly twice as likely to receive an additional incentive than those in the Equity Resilience budget category (68 percent for Large-Scale Storage, 63 percent for Small Residential Storage, and 32 percent for Equity Resilience respondents). Sixty-seven percent of Storage Non-SGIP respondents reported receiving the FITC and 28 percent of respondents were unsure if they had received an incentive.

The Federal Investment Tax Credit (FITC) is the most frequently reported additional source of storage funding for residential SGIP participants. Nearly all residential SGIP respondents who received additional financial assistance to help offset the costs of their storage system reported receiving the FITC (98 percent of those who received an additional source of funding, 54 percent of SGIP respondents) and four percent received an incentive from their CCA. Large-Scale Storage and Small Residential Storage respondents that report receiving additional assistance are likely to report receiving the FITC (97 percent and 99 percent, respectively), whereas 91 percent Equity Resiliency respondents report receiving the FITC.

Only a small share of survey respondents with storage installed in their home or business have participated in a program, such as a demand response program, that provides them payments for discharging their battery during periods of grid constraints. Only 14 percent of residential SGIP customers, 15 percent of residential Storage Non-SGIP respondents, and 20 percent of non-residential SGIP customers had participated in such a program. The participation in demand response programs by SGIP residential storage customers did not vary significantly by SGIP budget category.

Non-Storage Owners Rationale and Likelihood of Storage Adoption

Residential and non-residential survey respondents who don't have a battery storage system installed in their home or place of business were asked whether they had ever considered installing such a system. This question was only asked of those who reported they were aware of battery storage technology. Similar questions were asked about Solar PV to Non-Interconnected (non-DER) respondents who were aware of Solar PV but do not have it installed. Table 5-5 provides the distribution of Solar Non-Storage and Non-Interconnected residential and non-residential survey respondents who reported considering installing either battery storage or solar technologies. The table provides the share of respondents who have considered installing the technologies out of all respondents surveyed as well as the share out of those who reported being aware of the technology. Key findings from this table include:

- Over two-thirds of Residential solar respondents (69 percent) are considering installing solar storage and roughly one-third of Non-Interconnected respondents are considering solar. Residential and non-residential respondents who have solar PV installed are more likely to have considered installing a battery storage system.

- Residential and non-residential Non-Interconnected respondents are more likely to have considered installing solar PV than to have considered installing battery storage.
- Residential respondents aware of battery storage are significantly more likely to have considered installing battery storage than non-residential respondents.
- Comparing these results to the 2019 MA study, residential and non-residential Solar Non-Storage respondents are more likely in the 2022 study to report they had considered installing battery storage (residential: 66 percent in the 2019 MA study versus 78 percent in the current study, non-residential: 40 percent in the 2019 MA study versus 58 percent in the current study).

TABLE 5-5: PROPORTION OF RESPONDENTS CONSIDERING INSTALLING STORAGE OR SOLAR

Surveyed Population		Residential			Non-residential		
		Solar Non-storage	Non-Interconnected		Solar Non-storage	Non-Interconnected	
Technology		**Storage**		**Solar**	**Storage**		**Solar**
All Respondents		69%	28%	35%	41%	17%	35%
Aware of Technology	Yes	78%	46%	57%	58%	25%	38%
	No	18%	48%	38%	39%	67%	49%
	Don't know	3%	6%	6%	2%	8%	13%

Non-Storage residential respondents who reported being aware and familiar with battery storage (roughly two-thirds of Solar Non-Storage respondents and one-third of Non-Interconnected respondents) were asked to select the top three reasons that would encourage them to install storage in their home. Figure 5-30 shows that for both Non-Interconnected and Solar Non-Storage respondents, the primary reason for installing storage would be to provide backup or emergency power. Respondents who had solar installed were more likely to report that reducing dependence on the grid and shifting load in response to TOU rates were reasons to install storage, while Non-Interconnected respondents were more likely to report being driven by a desire to save money on their electric bill.

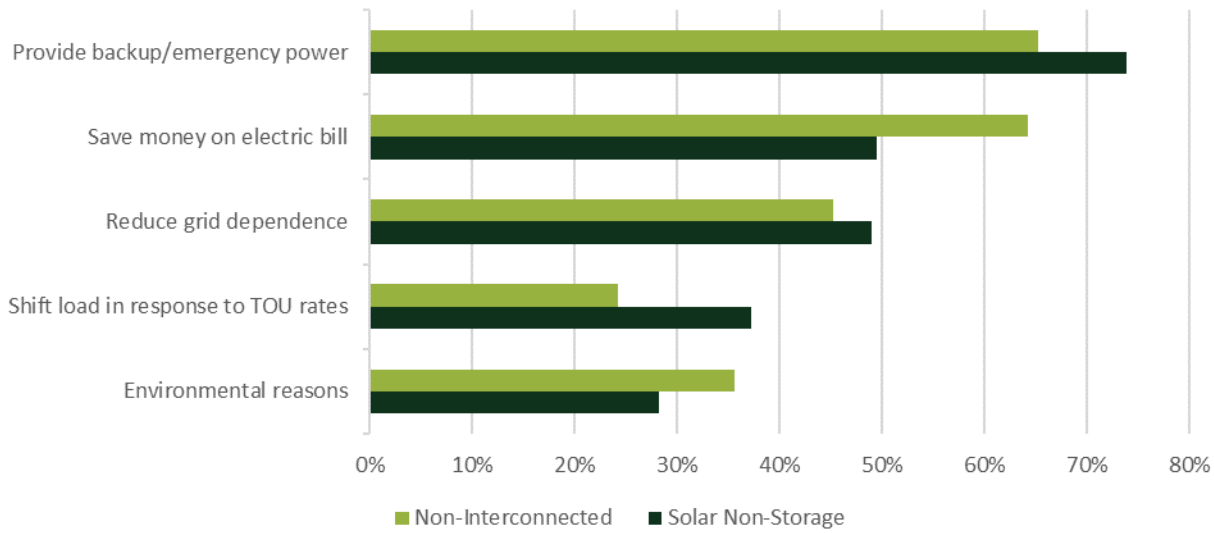
Analysis of this data by IOU service territory and location of their home inside or outside of a HFTD resulted in a few notable differences:

- PG&E Non-Interconnected respondents are more likely to be driven to consider installing storage for its ability to provide backup or emergency power (73 percent PG&E, 59 percent SCE, 61 percent SDG&E). This aligns with the higher percentage of PG&E Non-Interconnected respondents who reported they have lost power due to a PSPS event (35 percent PG&E, 20 percent SCE, and 14 percent SDG&E).

- SCE and SDG&E Non-Interconnected respondents are more likely to consider installing storage because it would save money on their electric bill (71 percent SCE, 65 percent SDG&E, and 56 percent PG&E).

- Solar Non-Storage respondents residing in a HFTD are more likely to report the desire for backup or emergency power as a reason to install battery storage (83 percent in HFTD versus 71 percent outside of HFTD percent) and less likely to report being driven by other factors such as saving money on their bills, shifting load to lower priced time periods, or powering essential medical needs.

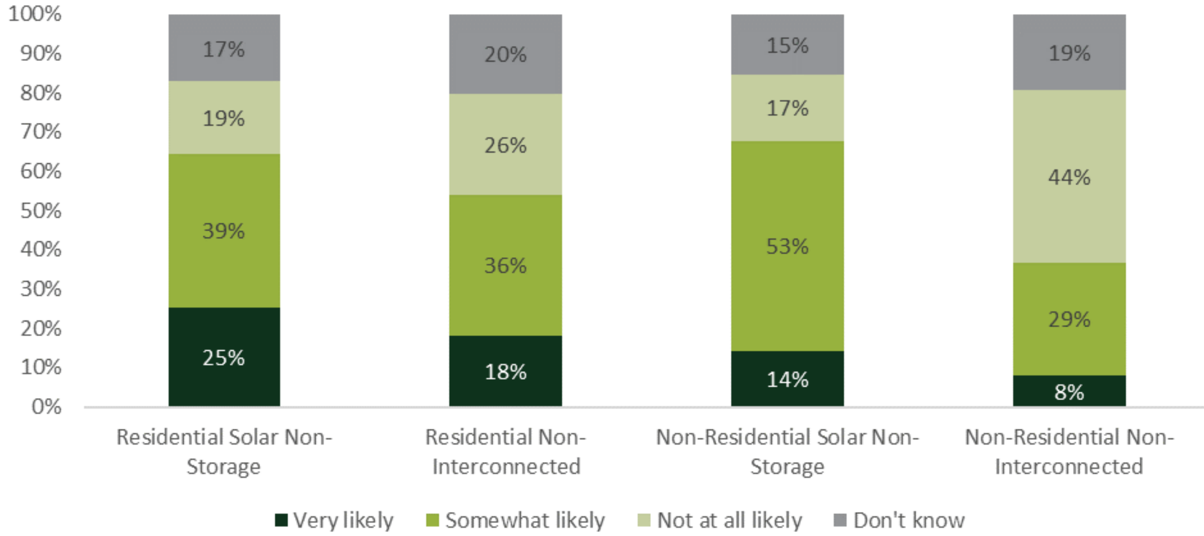
FIGURE 5-30: PRIMARY DRIVERS FOR THOSE CONSIDERING INSTALLING RESIDENTIAL BATTERY STORAGE, NON-STORAGE RESPONDENTS



Non-Residential non-storage respondents were asked a similar question about drivers to battery storage adoption. Their ranking of key drivers to storage adoption is quite similar to those reported by residential respondents (although slightly lower in magnitude), however, an additional 20 percent are also driven by a desire to reduce their demand charges.

Non-Storage residential respondents who were familiar with battery storage technologies were asked about their likelihood of installing battery storage in the future. Figure 5-31 presents the likelihood of installing a battery storage system across residential and non-residential Solar Non-Storage and Non-Interconnected survey respondents. Solar Non-Storage respondents are more likely to report they are very or somewhat likely to install battery storage (64 percent for residential and 67 percent for non-residential) than the Non-Interconnected respondents (54 percent for residential and 37 percent for non-residential).

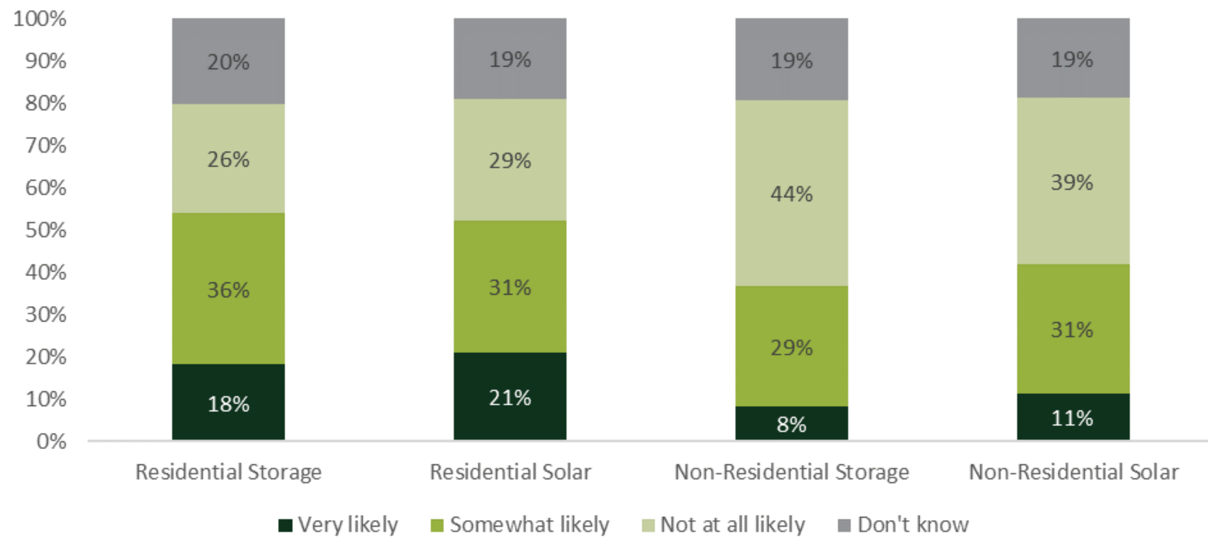
FIGURE 5-31: LIKELIHOOD OF INSTALLING BATTERY STORAGE IN THE FUTURE FROM THOSE FAMILIAR WITH STORAGE



These data were also cross-tabulated against whether a respondent lived within an HFTD or not to determine if a household's wildfire risk made them more or less likely to install storage in the future. The results indicated that Solar Non-Storage respondents residing *outside* of a HFTD are more likely to report being "Very Likely" to install storage in the future (28 percent vs 16 percent if home was in a HFTD) but are less likely to report being "Somewhat Likely" (35 percent versus 52 percent if the home was in a HFTD). Both segments were similarly "Not at all likely" (~19 percent) or unsure (~17 percent).

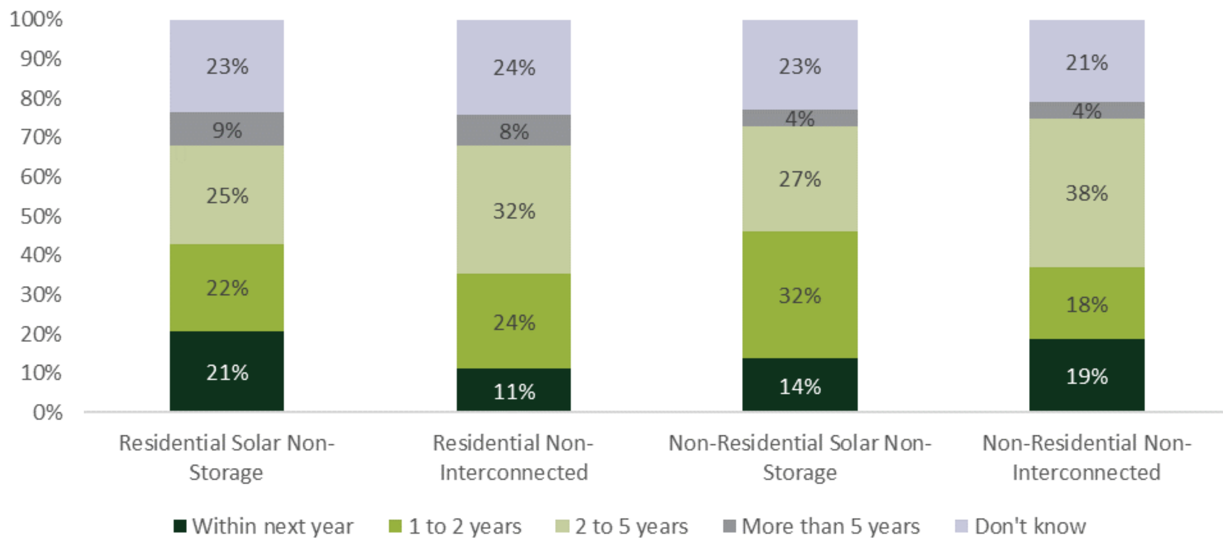
Non-Interconnected respondents were also asked about the likelihood of installing solar PV in their homes or businesses. Figure 5-32 below presents the likelihood of residential and non-residential Non-Interconnected respondents reporting they would install storage and/or solar PV in the future. It should be noted that the respondents to the likelihood of installing solar and likelihood of installing storage are not the same. Only respondents who reported they were aware and somewhat familiar with either technology were asked their likelihood to install that technology in the future.

FIGURE 5-32: LIKELIHOOD OF NON-INTERCONNECTED CUSTOMERS INSTALLING STORAGE OR SOLAR IN THE FUTURE



Respondents who were aware of battery storage and very or somewhat likely to install it in their homes or businesses in the future were asked when they anticipated this storage installation would occur. Figure 5-33 shows that residential customers with solar are more likely to be planning to install storage within the next year, compared with those who do not have solar installed. Roughly one-third of residential respondents who stated they were likely to install storage thought it would be more than five years from now or were unsure when they would install storage.

FIGURE 5-33: ANTICIPATED TIMING OF INSTALLING STORAGE FOR LIKELY ADOPTERS



Non-Interconnected (non-DER) respondents who are aware of and likely to install solar PV in the future were also asked their anticipated timing for that purchase and installation. One fifth (20 percent) anticipate the solar installation would occur within the next year (nearly twice as many who reported they were likely to install storage within the next year, see Figure 5-33 above). This would be a very significant adoption surge if it eventuated, compared, for example, to the fact that, to date, about 10 percent of residential customers have installed solar over a period roughly the last decade. Many other factors need to be accounted for to estimate near-term adoption including home ownership and other demographic factors, market barriers, payback/ROI associated with existing or future NEM tariffs, and customers overall willingness to pay.

Analyzing the responses across all respondents who do not have storage installed in their homes or businesses (both those aware and unaware of solar and/or battery storage technologies) allows for the estimation of future adoption potential of these technologies. The data presented in Table 5-6 shows that 47 percent of residential respondents to the Solar Non-Storage survey report that they are either unaware of battery storage or unlikely to install the technology compared to 71 percent of the Non-Interconnected respondents. Seventy-six percent of the Non-Interconnected respondents also report being unaware or unlikely to install Solar PV.

These data indicate that a large share of residential Non-Interconnected respondents believe they will remain without solar or storage for the foreseeable future. Storage and solar are usually installed at owner-occupied single-family residences, but only 51 percent of Non-Interconnected respondents live in owner-occupied single-family housing. The high share of Non-Interconnected respondents in residences that are not typically associated with these technologies contributes to their reduced likelihood of installation and may support the development of policies targeted at this population to encourage the adoption of solar and/or storage for end-users who do not own single-family homes.

TABLE 5-6: RESIDENTIAL NON-STORAGE CUSTOMERS TIMING OF FUTURE STORAGE OR SOLAR ADOPTION

Future Installed Technology	Storage		Solar
When do you anticipate installing technology?	**Solar Non-Storage**	**Non-Interconnected**	
Unaware of technology*	17%	46%	50%
Unlikely to install*	30%	25%	26%
Within the next year	11%	3%	5%
1 to 2 years	12%	7%	6%
> 2 to 5 years	13%	10%	6%
> 5 years	5%	2%	2%
Don't know	13%	7%	5%

* Also includes those who responded “Don’t know” to awareness or likelihood of adoption questions.

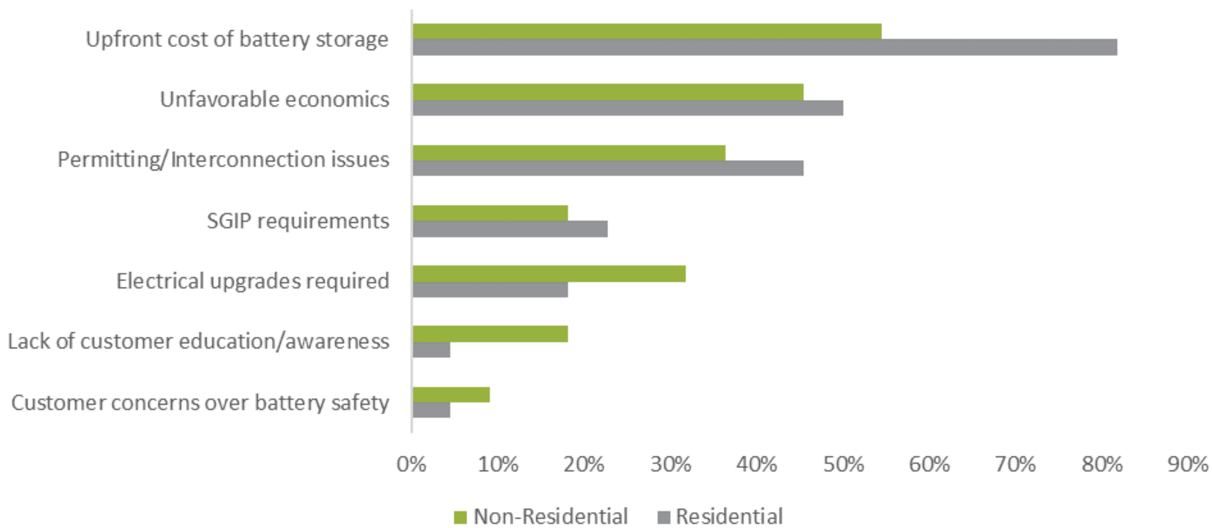
5.4.2 Perceived Barriers to Storage System Adoption

There are several barriers to storage system adoption, such as up-front cost, lack of awareness, program requirements, and other factors, that must be considered to understand the role they will play in altering the future trajectory of system adoption. This section summarizes developer and customer concerns and experiences in this area.

In 2019, the primary barrier to storage system adoption reported by developers of residential storage systems was the up-front cost of the storage system and related unfavorable economics for the customer. This barrier was an issue for both residential and non-residential systems. In 2022, developers continue to report that the primary barrier to residential battery storage adoption, reported by 63 percent of developers, is upfront cost or unfavorable economics. Forty five percent of non-residential developers also report upfront costs or unfavorable economics as the primary barrier to storage adoption.

Figure 5-34 summarizes the near-term barriers their customers face to the adoption of battery storage, according to residential and non-residential developers. Over three-fourths of residential developers (80 percent) believe that upfront battery system cost is a barrier to adoption while more than half of non-residential developers (55 percent) name this as a barrier faced by their non-residential customers. Additional significant barriers to adoption include unfavorable economics (reported by 50 percent of residential and 45 percent of non-residential developers) and permitting and/or interconnection issues (reported by 45 percent of residential and 36 percent of non-residential developers). Surprisingly, a higher share of developers report that electric upgrades are a barrier to adoption in the non-residential sector than in the residential. Figure 5-24 and Figure 5-25 above, however, shows that more than half of residential storage customers report needing a panel upgrade to install their battery storage systems.

FIGURE 5-34: DEVELOPER REPORTED NEAR-TERM BARRIERS TO STORAGE SYSTEM PURCHASES



Project developers were also questioned about what they believed would be the primary barriers to battery storage adoption in the future. As shown in Table 5-7 below, the most frequently reported barrier to storage adoption is the upfront cost of battery storage followed by unfavorable economics. Nearly all of the developers (95 percent), reported that they had experienced supply chain issues within the last 2 years, however only 14 percent reported they thought it would be a primary barrier in the future. Similarly, 64 percent stated that they had encountered difficulties hiring well-trained battery installation employees or contractors, however only 5 percent reported that an insufficient battery installation workforce would be a primary barrier to future adoption. When developers were asked how difficulties related to an insufficient battery installation workforce can be addressed, several developers supported creating or supporting programs that train individuals to join battery storage workforce programs.

TABLE 5-7: DEVELOPERS REPORTED PRIMARY BARRIERS TO FUTURE BATTERY STORAGE ADOPTION

Barriers to Future Storage Adoption	Developers Reporting
Upfront Cost of Battery Storage	32%
Unfavorable Economics	23%
Permitting/Interconnection Issues	14%
Supply Chain Issues	14%
Insufficient Battery Installation Workforce	5%

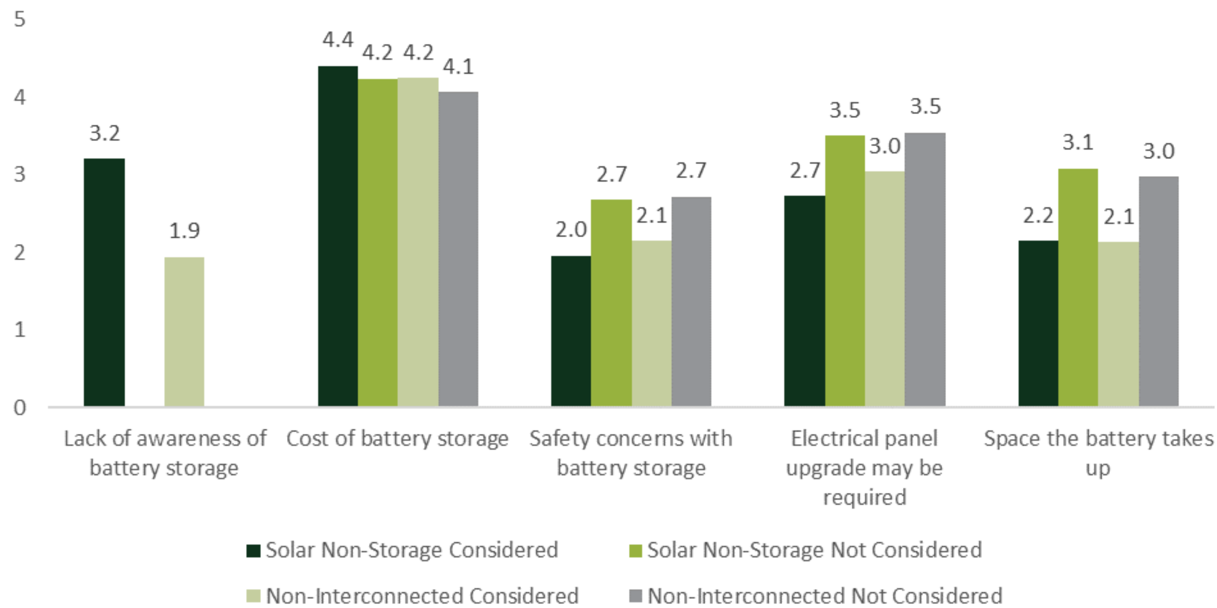
Residential customers who have not installed battery storage were asked to rate on a 1 to 5 scale, where 5 is very significant and 1 is not at all significant, how significant various reasons were in their decision not to install battery storage. The reasons included awareness of battery storage, the cost of battery storage, safety concerns with battery storage, the need for an electrical panel upgrade, and the space the battery takes up.

Figure 5-35 presents the average significance ratings provided for Solar Non-Storage and Non-Interconnected respondents broken down by whether they had considered installing battery storage. This analysis found:

- **The cost of battery storage is the most significant reason non-storage respondents have not installed storage.** This is a much bigger concern for respondents with household incomes less than $100,000 a year (4.5 average ranking) than for those whose household income exceeds $200,000 a year (4.0).

- **Battery safety concerns, electrical panel upgrades, and the space the battery takes up are all significantly more of a concern for survey respondents who have not considered installing storage than for those that have.** This seems to indicate that concerns that non-storage customers have about battery storage installation have been lessened through information gained when they were considering adoption (i.e., potential issues related to battery storage are less of a problem than one who has not considered installing storage might think).

FIGURE 5-35: RESIDENTIAL NON-STORAGE CUSTOMER REASONS FOR NOT INSTALLING STORAGE



5.5 STORAGE AND RESILIENCY

As described in the drivers and barriers section, the desire for backup power is one of the top three reasons for battery storage installation by over 90 percent of residential SGIP respondents. Figure 5-36 disaggregates the stated desire for backup power by SGIP budget category and presents the non-SGIP storage results for comparison. Those participating in the SGIP Large-Scale budget stated their top reason for installing battery storage was backup power (63 percent), while nearly all (99 percent) reported it was one of their top three reasons. Ninety-three percent of residential non-SGIP storage respondents, 92 percent of Small Residential Storage and 84 percent of Equity Resiliency respondents chose backup power as one of their top three reasons for installing battery storage. Equity Resiliency participants have a lower share choosing backup, due in part to their higher share choosing the need to meet medical needs. Twenty five percent of Equity Resiliency participants state that medical needs are their primary reason for battery storage installation, and 47 percent choose it as one of the top three reasons, compared to five percent and 11 percent for all SGIP residential respondents and four percent and eight percent for residential non-SGIP storage respondents.

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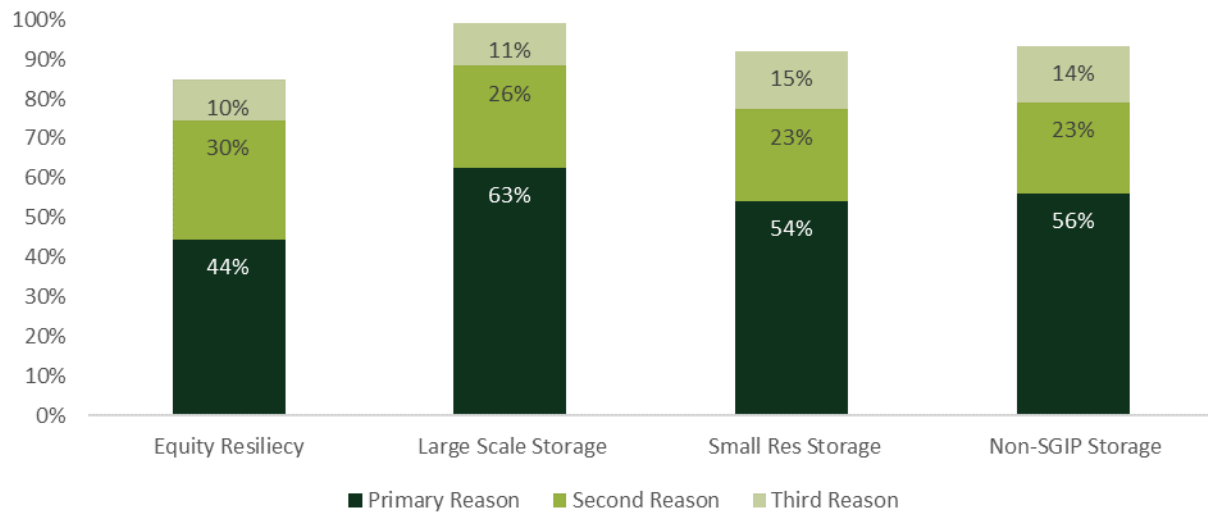
FIGURE 5-36: SHARE OF SGIP RESIDENTIAL PARTICIPANTS STATING THAT BACKUP POWER IS ONE OF THEIR TOP THREE REASONS FOR INSTALLATION BY BUDGET CATEGORY



5.5.1 Outages Experienced

Nearly all SGIP (92 percent) and non-SGIP (90 percent) residential battery storage owners have experienced an outage in the last two years, with Equity Resiliency and Large-Scale Storage participants slightly more likely to have experienced an outage than those who participated in the Small Residential Storage budget category (see Table 5-8). The data also indicate that only 14 percent of all SGIP and non-SGIP residential battery storage respondents experienced an outage lasting longer than 48 hours, while 35 percent of Equity Resiliency respondents reported experiencing an outage of this length.

TABLE 5-8: RESIDENTIAL STORAGE CUSTOMERS OUTAGE LENGTH

What was the longest electricity outage experienced within the past two years?	Equity Resiliency	Large-Scale Storage	Small Res Storage	All SGIP	Storage Non-SGIP
Less than an hour	5%	16%	16%	15%	13%
1 to 6 hours	13%	29%	37%	33%	30%
> 6 to 24 hours	19%	18%	17%	18%	20%
> 24 to less than 48 hours	23%	12%	9%	11%	11%
48 hours to one week	32%	18%	9%	13%	13%
Longer than one week	3%	2%	1%	1%	2%
Don't know	2%	0%	2%	2%	2%
No outage experienced	4%	4%	9%	8%	10%

Non-Storage respondents were asked a similar question about the longest electricity outage they had experienced in the last two years. Figure 5-37 compares the responses of the Storage and non-storage respondents. **Non-storage customers were slightly more likely to report they had not experienced an outage in the last two years and the outages experienced by those who did were slightly more likely to be shorter.**

FIGURE 5-37: RESIDENTIAL CUSTOMER OUTAGES EXPERIENCED IN THE LAST TWO YEARS

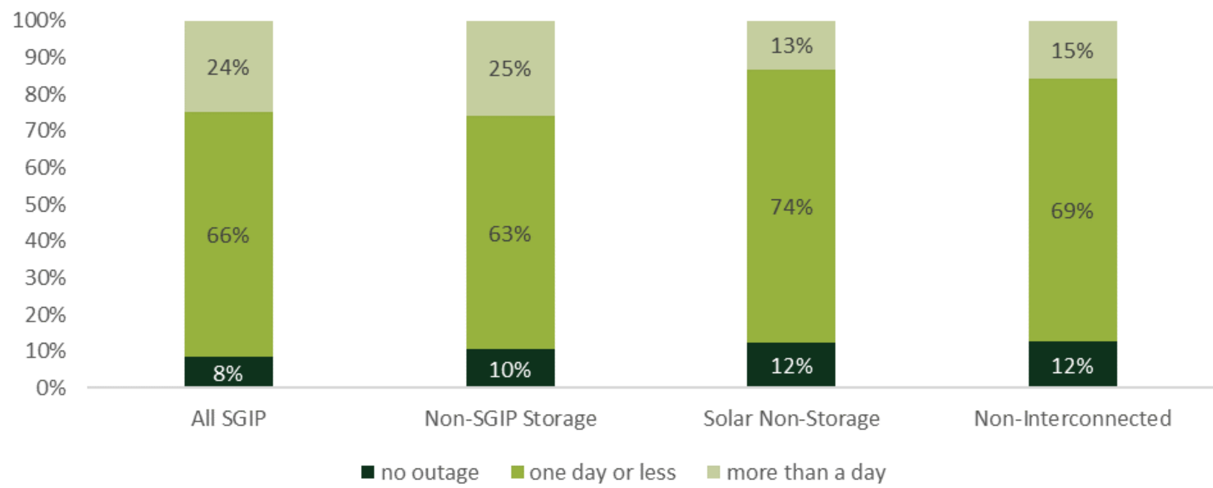


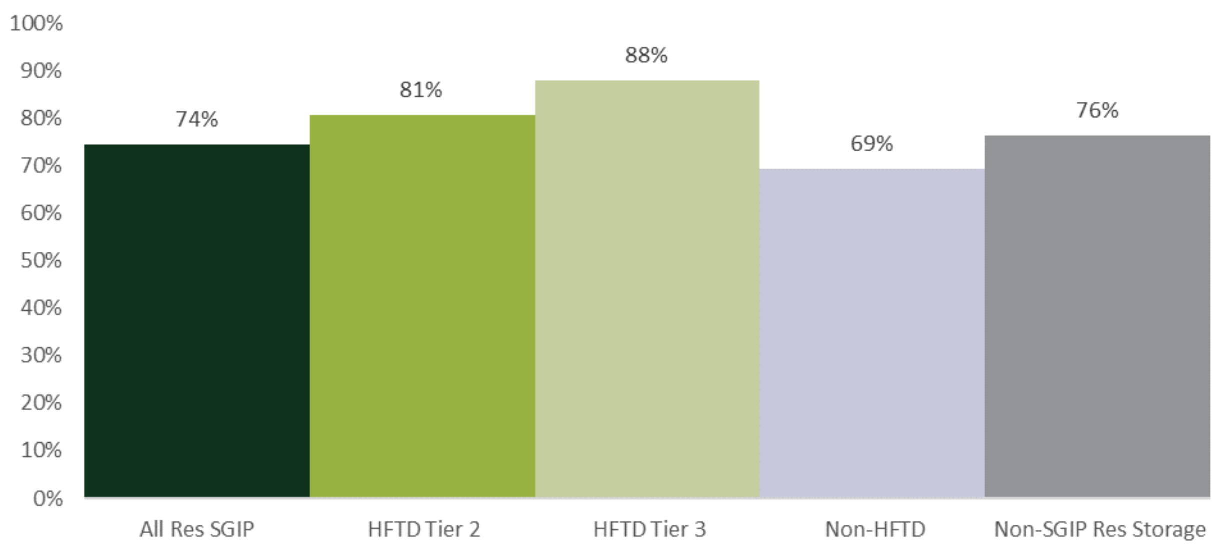
Table 5-9 below shows responses provided by Non-Interconnected respondents broken out by IOU service territory. As this table shows, PG&E customers are more likely to report experiencing an outage and the length of that outage is likely to be longer.

TABLE 5-9: NON-INTERCONNECTED RESPONDENT OUTAGES EXPERIENCED IN THE LAST TWO YEARS BY IOU

What was the longest electricity outage experienced within the past two years?	All Non-Interconnected	PG&E	SCE	SDG&E
Less than an hour	19%	16%	21%	18%
1 to 6 hours	34%	35%	33%	36%
> 6 to 24 hours	16%	17%	16%	13%
> 24 to less than 48 hours	8%	11%	7%	3%
48 hours to one week	6%	11%	4%	1%
Longer than one week	1%	2%	0%	0%
Don't know	4%	1%	6%	6%
No outage experienced	12%	7%	13%	23%

The majority of residential respondents with battery storage have used it to provide backup power to their home or business, while less than half of non-residential SGIP participants report they have used it for backup power. Nearly three-fourths of SGIP (74 percent) and non-SGIP (76 percent) residential battery storage respondents stated that they had used their battery storage systems to provide backup power during an outage lasting longer than one hour. An even greater share of SGIP Equity Resiliency participants reported using their battery storage systems for backup lasting longer than an hour, while 79 percent of Large-Scale Storage and 73 percent of Small Residential Storage participants had used their systems in this way. The use of battery systems for backup power also differs considerably by location. Respondents living in a Tier 2 or 3 High Fire Threat District (HFTD) are substantially more likely to use their system for backup than customers who do not reside in a HFTD (see Figure 5-38).

FIGURE 5-38: SHARE OF RESIDENTIAL CUSTOMERS USING THEIR BATTERY STORAGE SYSTEM FOR BACKUP, BY HIGH FIRE THREAT DISTRICT



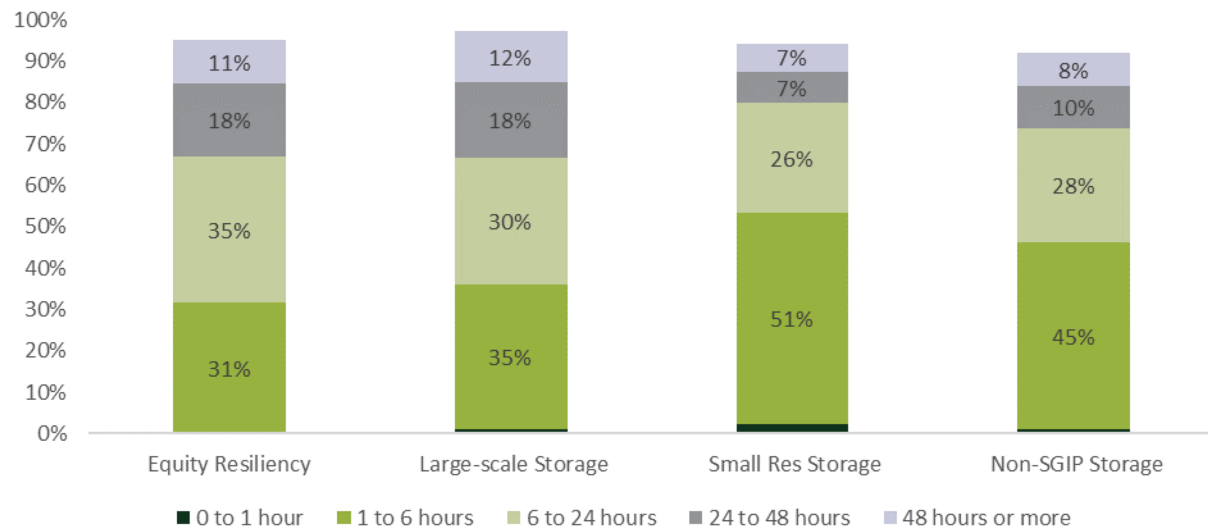
Analyzing residential storage respondent data by service territory and self-reported Urban/Suburban/Rural location resulted in the following findings:

- PG&E residential customers are the most likely to report using their storage to provide backup power during an outage lasting longer than one hour (79 percent versus 72 percent for SCE, 68 percent for SDG&E, and 59 percent for SCG customers).
- SGIP participants living in a rural location were much more likely to report using their storage to provide backup power during an outage that lasted longer than one hour (89 percent) than respondents who resided in suburban or urban settings (72 percent and 68 percent, respectively).

Less than half of non-residential SGIP participants report having used their storage system to provide backup for an outage lasting longer than one hour (44 percent).

Equity Resiliency and Large-Scale Storage customers report using their batteries for longer periods of backup than Small-Residential or Storage Non-SGIP. Respondents with battery storage who have used their systems for backup were asked how long the system provided backup power during the outage. Figure 5-39 presents the distribution of hours of backup provided across the three primary SGIP residential budget categories and for non-SGIP battery respondents. These data show that for over half of Small Residential budget category respondents and 45 percent of non-SGIP storage customers, the longest period their battery provided backup power was 1 to 6 hours, while Large-Scale Storage and Equity Resiliency participants (35 percent and 31 percent, respectively,) reported that short of a period. Approximately 30 percent of Equity Resiliency and Large-Scale Storage participants stated that their battery system provided backup during an outage lasting 24 hours or longer, while. In contrast, only 14 percent of small residential participants and 18 percent of non-SGIP storage reported backup for this length of time. The longer period of battery system backup for Equity Resiliency and Large-Scale Storage customers is likely due to these customers typically having larger battery system sizes (see Figure 3-5) and experiencing longer outages (see Table 5-8).

FIGURE 5-39: LENGTH BATTERY SYSTEM PROVIDED BACKUP POWER DURING AN OUTAGE BY BUDGET CATEGORY*



*Customers could respond other and don't know therefore the shares do not sum to 100 percent.

Satisfaction with Battery Backup During Outages

Energy storage owners were asked about their level of satisfaction with their battery and their satisfaction with the performance of the battery if they had used it to provide backup during an outage. While is it likely that the responses to these two questions are highly correlated, responses to these questions may differ if the battery was purchased for reasons other than resiliency or if they have found the battery is capable of fulfilling other objectives (see Table 5-4 above for the top three reason customers install storage).

Respondents were asked to rate their satisfaction with their battery on a 1 to 5 scale, where 1 represented "not at all satisfied" and 5 was "extremely satisfied". Figure 5-40 illustrates the distribution of the 1 to 5 ratings by battery size for storage respondents who provided a rating.[48] As shown in this exhibit, **the level of battery storage satisfaction is highly correlated with the size of the battery system,** with only 56 percent of SGIP Participants and 59 percent of Storage Non-SGIP respondents with smaller batteries (< 5 kW) reporting they were somewhat or extremely satisfied (rating of 4 or 5) compared to all larger battery size buckets, which had upwards of 85 percent reporting these levels of satisfaction.

48 Six percent of SGIP participants and seven percent of non-SGIP storage who purchased small batteries (<5kW) were unable to rate their satisfaction. No other size category had more than 2 percent.

Seven percent of residential SGIP Participants reported they were dissatisfied (rating of 1 or 2) with the battery storage system. The primary reasons for dissatisfaction were:

- The battery storage system is not working as expected (47 percent)
- Respondent would like more control over the battery storage system's operation (40 percent)
- The battery storage system is under a recall (25 percent)
- The dealer misrepresented the operational capabilities of battery storage system (22 percent)
- The storage system did not achieve the expected financial savings (21 percent)

Other reasons for dissatisfaction with the battery storage system included:

- *"After almost a year of the battery being installed, project is still on hold and inoperable."*
- *"Battery failed and contractor went bankrupt. We do not have $2,000 to repair battery."*
- *"Need more education on how to use battery to reduce reliance on the grid."*

FIGURE 5-40: RESIDENTIAL PARTICIPANT SATISFACTION LEVEL WITH BATTERY SYSTEM BY SYSTEM SIZE

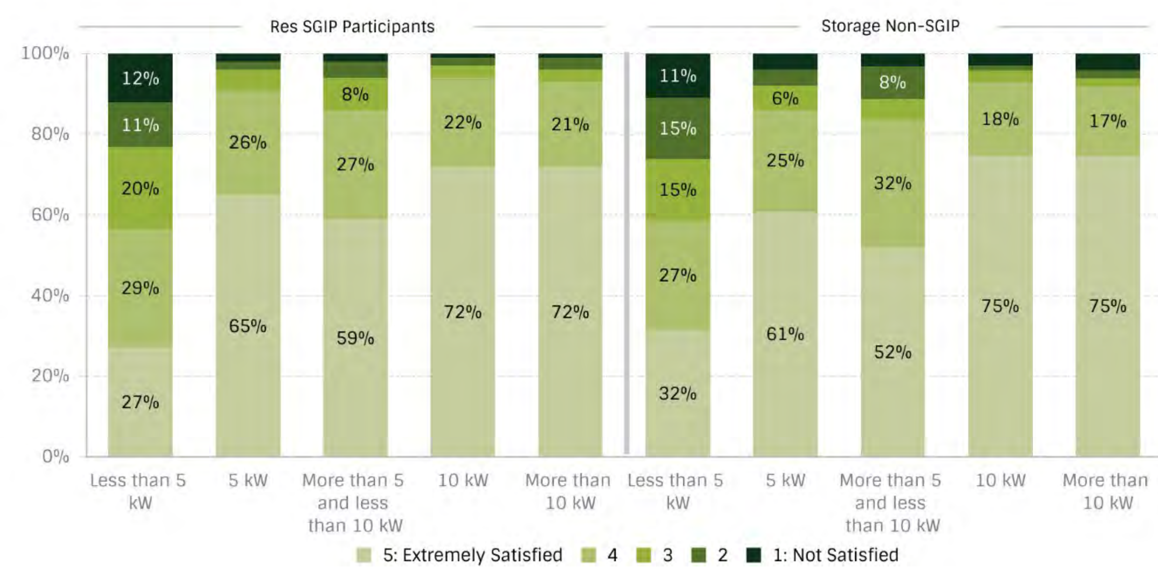
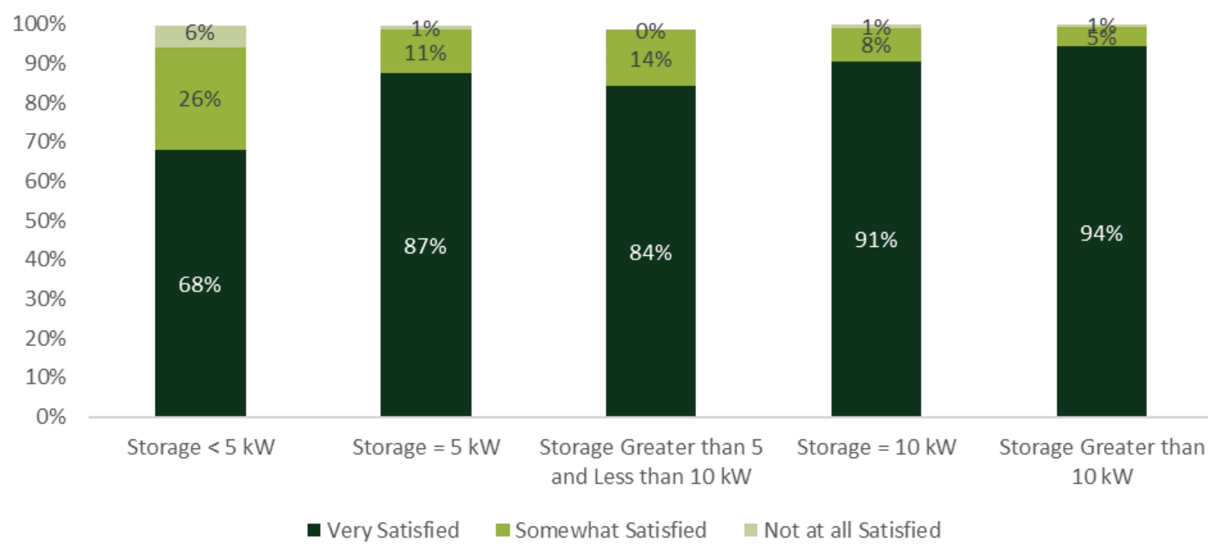


Figure 5-41 presents findings on the satisfaction of residential SGIP respondents with the performance of their storage system during an outage disaggregated by the size of the storage system.[49] **Overall 85 percent of residential SGIP participants are very satisfied with their system's performance during outages, however those with larger systems are again found to be substantially more satisfied with their system's performance than participants with systems smaller than 5 kW.** The majority of residential Storage Non-SGIP respondents (88 percent) report being very satisfied with the performance of their battery storage system.

FIGURE 5-41: SGIP PARTICIPANT SATISFACTION WITH THE PERFORMANCE OF THEIR BATTERY SYSTEM DURING AN OUTAGE BY BATTERY SIZE



Storage respondents who reported being somewhat or not at all satisfied with the performance of their battery system during an outage were asked to describe the reasons why. The most frequently reported reason for dissatisfaction was that the battery had an insufficient capacity to meet their needs. Respondents stated items such as:

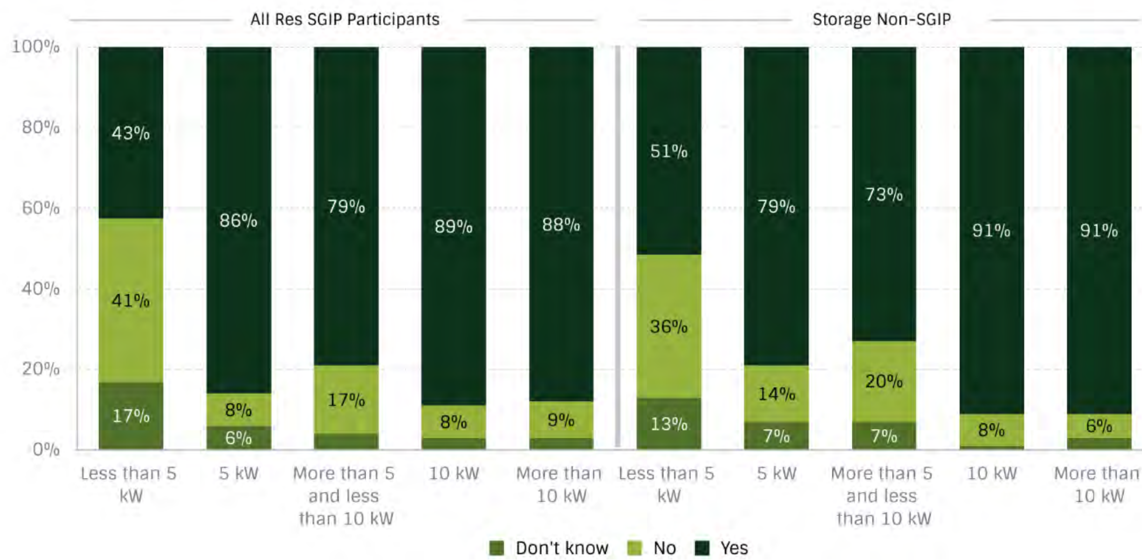
- *"Although I have 46 photovoltaic cells producing electricity, I have only one Tesla battery, which is inadequate. I have a large home with electric heat and should have several batteries. I had brought up this issue with the installers of the battery, but they said that I would be fine. The battery power doesn't last very long during an outage."*

- *"I would like a battery storage system with greater capacity to make sure my home could make it through a 24-hour outage, to carry me to the next day's solar panel charging opportunity."*

49 The statistics presented in Figure 5-41 is limited to respondents who experienced an outage and who used their batteries for backup power.

Respondents were also asked if the level of controllability of their battery storage system met their expectations. Similar to the figures above, Figure 5-42 illustrates that SGIP and Non-SGIP respondents with batteries smaller than 5 kW are substantially more likely to report dissatisfaction than those with larger-sized batteries.

FIGURE 5-42: BATTERY CONTROLLABILITY MEET EXPECTATIONS, BY BATTERY SIZE



5.5.2 Whole and Partial House Backup

Respondents who had experienced an outage were asked if their battery storage system was designed to provide backup for their whole house or for a portion of their home. **The SGIP and non-SGIP residential storage respondents were nearly evenly distributed between whole and partial home batteries, with 50 percent of SGIP Participants and 54 percent of Storage Non-SGIP respondents having whole home battery systems** and 49 and 46 percent, respectively, having systems that back up a portion of their home (see Figure 5-43). Battery systems installed within the Equity Resiliency and Large-Scale Storage budget category, however, are significantly more likely to be designed to back up the whole home (73 percent and 88 percent, respectively). SGIP's Equity Resiliency budget category provides larger incentives to help customers with higher resiliency needs, such as those residing in areas with high fire threats, those who have experienced PSPS events, and those who have a medical need or who meet other program-specified criteria.

FIGURE 5-43: WHOLE AND PARTIAL HOUSE BATTERIES BY SGIP PROGRAM BUDGET CATEGORY

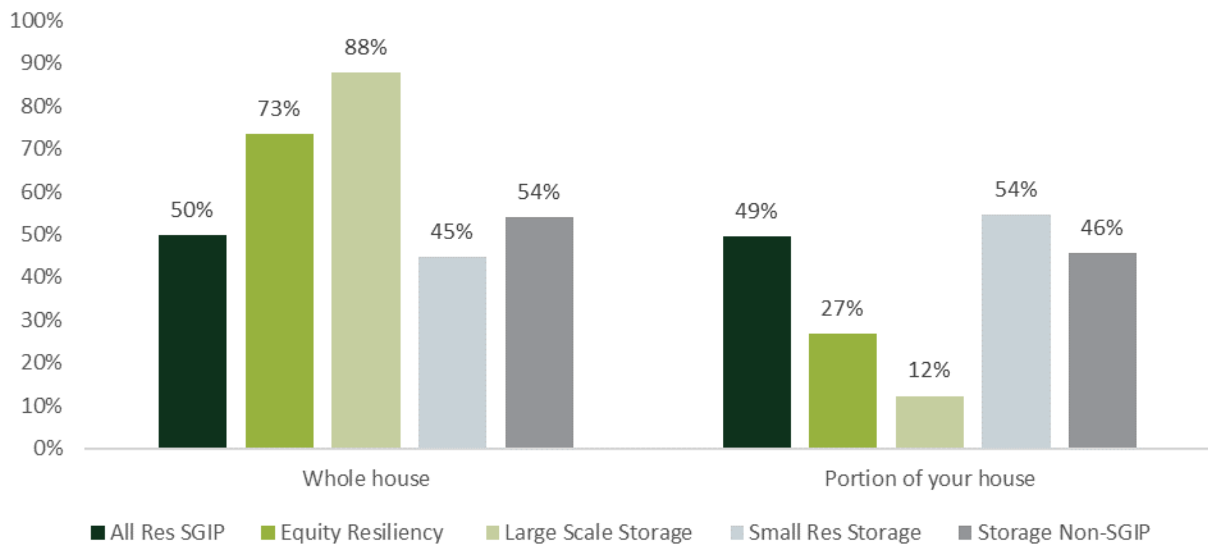
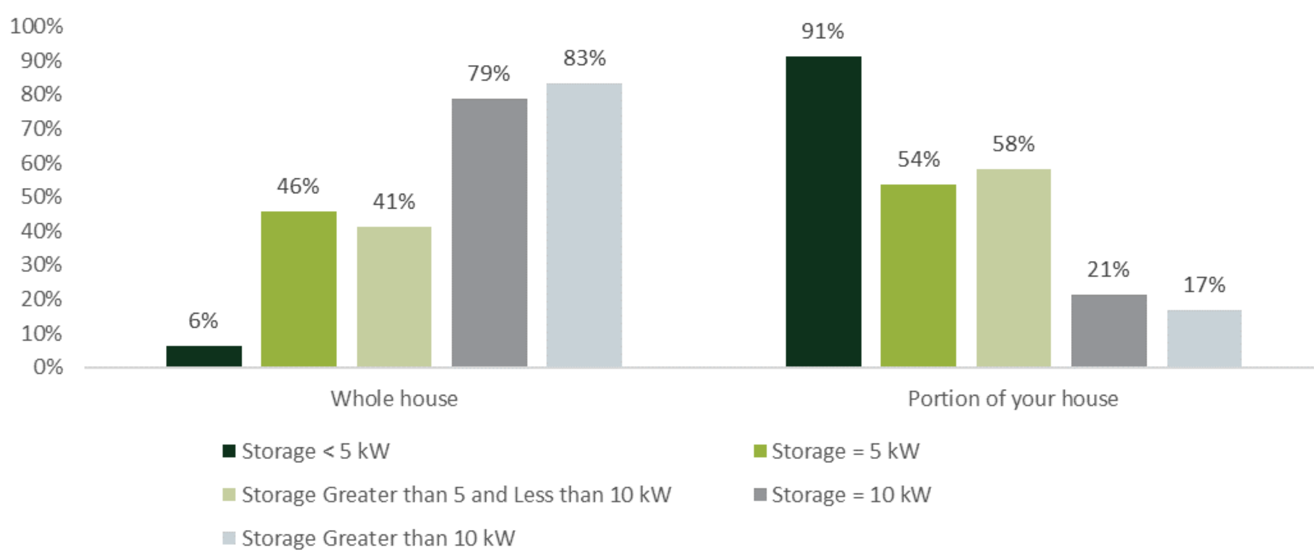


Figure 5-44 reports the share of SGIP participants with whole and partial house batteries by battery size. Those with large-sized batteries are more likely to report that their battery backs up their whole home. SGIP residential participants with system capacity equal to 10 kW or larger are substantially more likely to report that their system is designed to back up their whole house than those with storage system capacity less than 5 kW.

FIGURE 5-44: WHOLE AND PARTIAL HOUSE BATTERIES FOR SGIP PARTICIPANTS BY BATTERY SIZE (KW)



5.5.3 Medical and Work Needs

Battery storage systems paired with solar can provide vital resiliency benefits during power outages for households with health-related needs that require electricity to power medical equipment. **The SGIP Equity Resiliency program is helping to provide energy resiliency to those with medical needs.**

- Twenty-four percent of SGIP residential storage respondents have a member of their household with a health-related need requiring electricity to power electrical equipment.
  - Sixty-five percent of SGIP residential Equity Resiliency participants reported medical needs and 25 percent of these customers stated that meeting an essential medical need was the primary reason why they purchased their battery storage system.
  - Approximately 15 percent of participants in the Large-Scale and Small Residential Storage budget categories reported having a household member with health-related needs that requires electricity to power medical devices.
- Eighteen percent of non-SGIP residential storage respondents have a member of their household with a health related need that requires electricity. The share of non-SGIP residential storage respondents with medical needs is very similar to the share of SGIP Large-Scale and Small Residential Storage participants.

Those with medical needs who had experienced an outage lasting longer than an hour were asked if their battery storage system was able to maintain the power needed for their essential medical equipment throughout the length of the outage. Ninety-three percent of SGIP and non-SGIP respondents with medical needs responded “yes” that their battery system enabled them to maintain the necessary power, but the response was dependent on the size of the battery system. Only 81 percent of respondents with medical needs whose storage system was smaller than 5 kW were able to maintain the power needed for their medical devices during an outage.

Battery storage can provide resiliency to those who work from home and require electricity for their work.

- Sixty-three percent of SGIP residential storage respondents reported that they work from home. By budget category, this represents 59 percent of Equity Resiliency respondents, 74 percent of Large-Scale Storage, and 64 percent of the Small Residential Storage respondents.
- Seventy percent of Non-SGIP residential storage respondents work from home.

5.5.4 Devices Powered by Partial House Systems

The 49 percent of SGIP and 46 percent of Storage non-SGIP respondents with battery systems designed to provide backup to a portion of their homes were asked to indicate the appliances and other equipment their battery was backing up. Table 5-10 presents these data for residential respondents with a partial home backup system. When viewing these data, note that most of the respondents reporting this information on the appliances and devices backed up by their partial home systems are either Small Residential Storage participants (1,222 of 1,386 SGIP responses) or Storage non-SGIP respondents. A large share of the Equity Resiliency and Large-Scale Storage respondents stated that their systems are whole home batteries.

Refrigerators/freezers, lighting, and personal computing and cell phones constitute the equipment most likely to be backed up by partial home battery storage systems. Medical equipment is often backed up for individuals on the Equity Resiliency program. As indicated previously, 65 percent of Equity Resiliency participants have medical needs requiring electricity, though many of these participants have battery systems providing whole house backup and were not asked to identify the appliances backed up by their battery system.

For SGIP Equity Resiliency and Large-Scale Storage participants, well pumps are also commonly backed up. The large share of Equity Resiliency participants stating that their battery storage system is backing up their well pump is consistent with well pumps previously being one of the criteria that could help customers become eligible for the larger incentives available in this budget category.

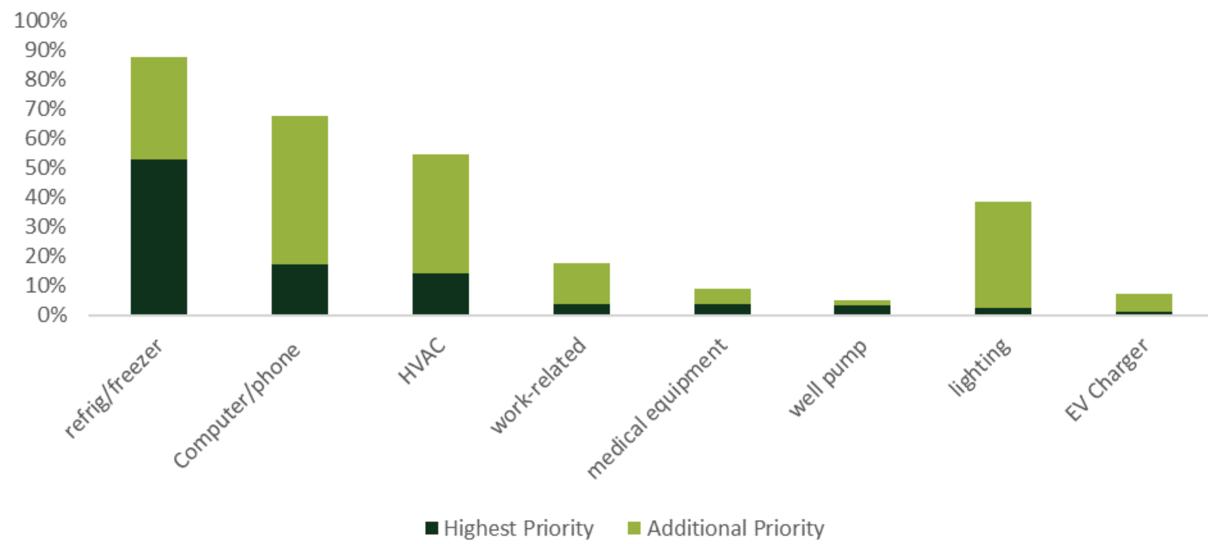
Roughly a quarter of those whose battery systems was designed to back up a portion of their home's electrical needs (26 percent), reported that their heating and cooling systems were backed up. Heating and cooling equipment typically has large electrical requirements and a significant energy demand to activate, reducing the likelihood that these systems can be backed up with a system sized for only a portion of the home's electrical needs.

TABLE 5-10: APPLIANCES AND DEVICES BACKED UP BY PARTIAL BATTERY SYSTEMS

Device Types	All SGIP Storage	Equity Resiliency Storage	Large-Scale Storage	Small Res Storage	Non-SGIP Storage
Refrigerator/freezer	97%	99%	100%	97%	96%
Lighting	82%	93%	94%	81%	82%
Personal computer or cellphone	77%	80%	88%	77%	83%
Work-related electrical equipment	35%	40%	50%	34%	38%
Heating/cooling	25%	37%	50%	24%	22%
Essential medical equipment	15%	68%	0%	11%	16%
EV Charging					5%
Well pump	6%	38%	25%	3%	5%
Other equipment	22%	13%	13%	24%	17%
Total	**1,386**	**148**	**16**	**1,222**	**884**

Figure 5-45 presents the Non-Interconnected customer needs during an outage. These priorities appear very similar to the appliances and devices backed up by partial battery systems. The refrigerator/freezer is most likely to be reported as the highest priority need, followed by the customers computer or cell phone. Fourteen percent of Non-Interconnected customers choose HVAC as their highest priority need and 40 percent listed it as an additional priority. This share is higher than for SGIP and Non-SGIP Storage customers who have their HVAC backed up by their partial house battery storage system. A smaller share of Non-Interconnected customers have lighting listed as a primary or additional need (three percent and 36 percent, respectively), than the 82 percent share of SGIP and Storage Non-SGIP customers who have their lighting backed up.

FIGURE 5-45: NON-INTERCONNECTED CUSTOMER HIGHEST AND ADDITIONAL PRIORITY NEED DURING OUTAGES



5.5.5 Alternatives to Battery Storage

A majority of SGIP participants have not purchased or considered purchasing a fossil-fueled backup generator. The purchase rate of a fossil-fueled backup generator is highest among Equity Resiliency and non-residential SGIP customers. The 2022 Storage Market Assessment surveys asked customers if they had considered alternatives to battery storage for backup and if they had purchased a fossil fueled backup generator. Table 5-11 shows that only about one-fourth of residential SGIP respondents and Storage Non-SGIP respondents (24 percent and 23 percent, respectively) had considered (but had not purchased) an alternative to battery storage and only 3 percent reported they had purchased a backup generator. The share of customers considering and purchasing a backup generator differs substantially by budget category and by size of the battery storage system. Per Table 5-11, only 21 percent of Small Residential Storage participants had considered purchasing an alternative, while 39 percent of Equity Resiliency and Large-Scale Storage participants had considered it. Equity Resiliency participants also have the highest share of respondents who had purchased a fossil fueled generator (eight percent). More than half (55 percent) of Equity Resiliency participants who purchased a fossil fueled generator have a household member with an essential medical need.

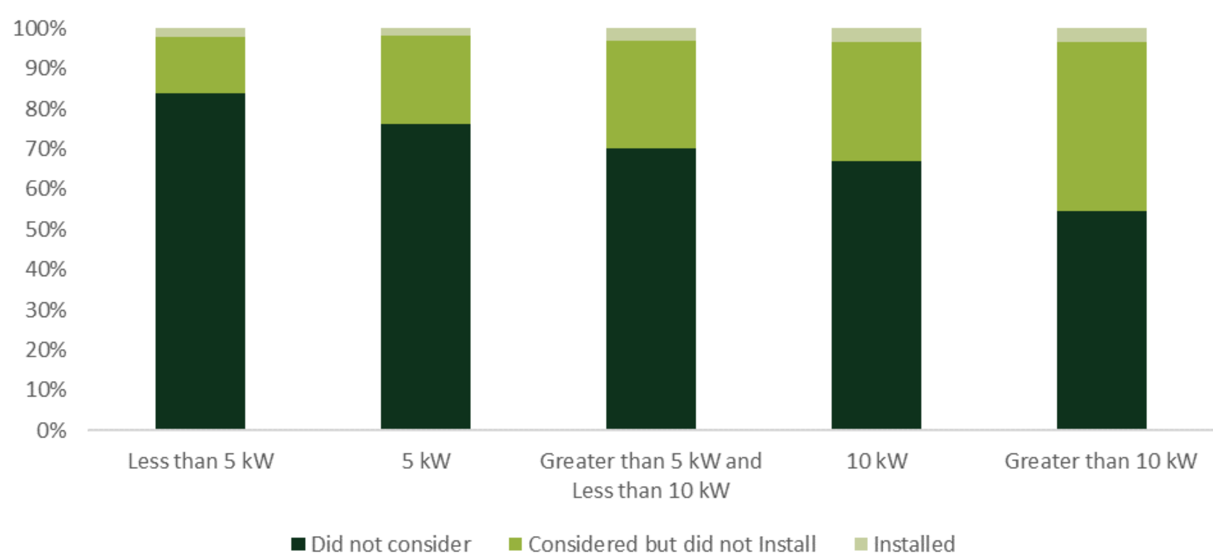
TABLE 5-11: RESIDENTIAL CUSTOMERS CONSIDERATIONS OF ALTERNATIVES TO BATTERY STORAGE

Fossil-fueled backup generator purchase	Res SGIP	Equity Resiliency	Large-Scale Storage	Small Res Storage	Non-SGIP Storage	Solar Non-Storage	Non-Interconnected
Have not considered	73%	53%	60%	77%	74%	36%	57%
Considered, but did not purchase	24%	39%	39%	21%	23%	40%	29%
Purchased	3%	8%	2%	2%	3%	24%	14%

The share of non-residential SGIP participants who had considered but did not purchase backup generation is similar to that of residential SGIP participants (26 percent) but a higher share reported they had eventually purchased backup generation (9 percent).

Figure 5-46 summarizes the share of residential SGIP storage participants who considered alternatives to battery storage, based on the size of their battery storage system. Customers with larger battery storage systems are considerably more likely to have considered purchasing an alternative to battery storage, but the share of customers reporting the installation of a fossil fueled backup power system is not dependent on the size of the battery storage system. Purchasing a fossil fueled backup power system is more driven by the requirements associated with the Equity Resiliency budget category than with the size of the customer's battery storage.

FIGURE 5-46: SHARE OF SGIP STORAGE OWNERS WHO CONSIDERED ALTERNATIVES TO BATTERY STORAGE BY STORAGE CAPACITY



Residential SGIP and Storage Non-SGIP respondents who purchased a fossil fueled backup generator were asked which appliances and devices they used the generator to power during an outage. Similar to the results presented in Table 5-10 above, the most commonly described devices were refrigerators and freezers, lighting, and personal computers. They were also asked why they had decided to purchase a fossil fueled backup generator. The majority of responses fell into three main categories: reliability, cost, and convenience.

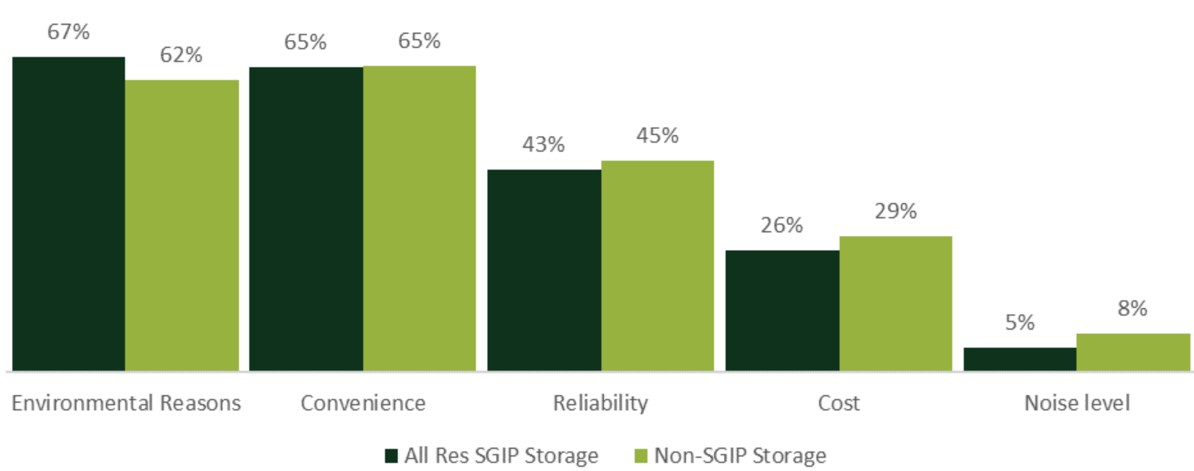
Respondents with a fossil fueled backup generator provided reasons for purchase such as:

- *"A backup generator will provide power through a much longer outage than one or two backup batteries. It would be too expensive to purchase enough backup batteries to last through the 24-48 hour outages we've experienced as a result of the PSPS."*

- *"We needed power during power outages and it was easy and fast to purchase a generator"*

Residential storage owners who had considered purchasing alternative forms of reliability were asked why they choose to install battery storage instead of a backup generator (see Figure 5-47). The top five reasons reported for installing battery storage are environmental reasons, convenience, reliability, cost, and noise. The responses of storage owners who have and have not received an SGIP incentive were very similar.

FIGURE 5-47: WHY BATTERY STORAGE OWNERS WHO CONSIDERED GENERATORS CHOSE BATTERY STORAGE



Respondents who chose battery storage over a fossil fueled backup generator provided reasons such as:

- *"Battery storage cost more but elected battery over gas generator because of environmental concerns, battery operation does not adversely affect neighbors or my family by noise and poisonous CO2 gas emissions, and when the power comes back on, no power surges to fry appliances and electronics in the house."*
- *"A battery will pay for itself eventually where a generator will only cost money."*
- *"Battery storage has the most flexibility and allows for the greatest resilience, as well as being a day-to-day asset for energy arbitrage and grid-friendly load shifting"*

5.6 WILLINGNESS TO PAY FOR BATTERY STORAGE RESIDENTIAL CUSTOMERS

To better understand residential customers' willingness to pay for battery storage, and the value of resiliency provided by battery storage systems, Verdant presented survey respondents with a series of multiple-choice questions designed to elicit their willingness to pay for the resiliency provided by battery storage systems.

5.6.1 Willingness to Pay for Battery Storage Methods

Residential customer willingness to pay was estimated through discrete choice modeling. Residential respondents in the SGIP Participant, Storage Non-SGIP, Solar Non-Storage, and Non-Interconnected (non-DER) surveys were presented with a series of questions to investigate their willingness to pay for battery storage. Prior to the willingness to pay questions, the customers were provided the following paragraphs about battery storage and resiliency:

> *Utility power outages can be very short, lasting only a couple of minutes. On the other hand, outages that are implemented to reduce the risk of fires during dry, high-wind conditions can range from a couple of hours to over a week.* ***Solar panels must be paired with battery storage*** *to maintain power during an outage. The solar plus battery system can be sized to provide electricity to the whole house or only to critical loads such as a refrigerator, essential medical equipment, or lighting. Systems designed to back up the whole house are larger and more expensive than those designed to provide backup for critical loads.*
>
> *We understand that your home [has/does not have] a [solar/storage/storage and solar] system. The following questions are investigating your willingness to pay for battery storage systems. Your responses will help improve California's storage programs and support California's clean energy goals.*
>
> *Please respond to the questions below as if your home has solar but does not have a battery storage system.*

The series of scenarios associated with purchasing a battery storage system were presented to respondents, who were asked to choose between different battery purchase options. The following three options were generally described:

- Option 1) purchase a battery storage system that would provide electricity for their whole house
- Option 2) purchase a battery storage system that would provide electricity for 30 percent of their electrical needs (their most critical needs)
- Option 3) do not purchase a battery storage system

Option 1 (whole house system) and option 2 (partial house system) were presented to a single customer multiple times with a series of different price points. If the customer chose option 3 to the first question (to not purchase a battery storage system), they were presented with a scenario where an incentive was available to lower the price for both the whole and partial house battery systems, to determine if they would change their purchase decision.

The price presented to customers for a whole house system varied from a high of $20,000 to a low of $7,000. The partial house price options ranged from a high of $7,000 to a low of $1,000. Each respondent received three or four sets of scenario options depending on their response to questions. There were eight different sets of scenario prices that respondents were randomly assigned to receive.

We used these data in a mixed logit model to estimate the willingness to pay for the whole and partial house batteries. The model estimates the probability of a respondent choosing a whole house, partial house, or no battery storage system as a function of price and battery size. The model estimates parameters that are assumed to vary from one individual to another. The whole and partial battery size parameters are modeled as random variables with a normal distribution, where the random variables are allowed to be correlated. The model takes advantage of the multiple question responses provided by a given respondent to estimate the impact of price on the respondent's choice to purchase a whole house battery, a partial house battery, or not to purchase a battery.

To calculate the willingness to pay for whole house batteries relative to not purchasing a battery, the model's estimated coefficient on whole house is divided by the price coefficient. The willingness to pay for the partial house battery is developed using a similar approach. The mixed logit willingness to pay model was analyzed across many different domains of interest to better understand how different factors influence the results.

5.6.2 Willingness to Pay for Battery Storage Results

Customers with battery storage have a relatively high willingness to pay for a whole house battery storage system and a low valuation for a partial house system relative to customers who do not currently own battery storage systems. Table 5-12 presents the statewide willingness to pay for battery storage results for the four survey cohorts. These results show that customers who own battery storage systems are willing to pay substantially more for a battery system that provides backup for their whole house than one that only provides backup for 30 percent of their electrical needs (approximately $19,500 to $20,000 versus $2,500 to $2,700). The willingness to pay findings once again support the conclusion that the average SGIP residential battery storage customer is very similar to the average battery storage customer that did not receive an SGIP incentive.

TABLE 5-12: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE BY SURVEY POPULATION

WTP for Storage	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	$19,928	$19,443	$11,157	$6,520
Partial House (30% of electrical needs)	$2,432	$2,714	$5,072	$4,741

The results presented in Table 5-12 above show that solar and non-interconnected customers are willing to pay substantially less for whole house battery storage than customers who currently own storage, but these customers are estimated to have a higher willingness to pay for a partial house storage system than customers who currently own storage. The lower willingness to pay for whole house storage may be attributed to their lack of experience with battery storage, lower average household income levels (see Figure 5-2 above), their perception that they live in an area with lower wildfire risk (see Figure 5-5 above), the smaller share of customers who report working from home (see Figure 5-8 above), and their lower likelihood of experiencing an outage and the shorter average length of reported outages (see Figure 5-37 above).

Customers who do not currently own a battery, however, are willing to pay more for a partial house battery (described to provide backup for 30 percent of their homes electrical needs) than customers who own a battery. The higher relative willingness to pay for a partial home battery, by customers who do not currently own a battery, may reflect their assumption that these batteries may provide them with the resiliency they desire (e.g., provide backup for their refrigerator) without the larger expenditure necessary for a whole house battery system. Survey results from current owners of battery storage, however, indicate they are less satisfied with smaller sized batteries relative to larger sized battery storage systems (see Figure 5-40, Figure 5-41, and Figure 5-42 above).

Willingness to Pay Compared with SGIP Incentives

Table 5-13 shows the average incentive provided to residential customers in the SGIP during program years 2020 and 2021 was approximately $10,900. Assuming the customer expects to receive a 26 percent Federal Investment Tax Credit (ITC), the average out-of-pocket cost for SGIP residential participants was around $7,900. Per Table 5-12 above, the willingness to pay for a whole house system for each DER cohort is above the SGIP average out-of-pocket after ITC of $7,860. Whereas the non-interconnected (non-DER) average willingness to pay is around $1,300 below the average estimated out-of-pocket cost after the ITC. It is possible that the DER customers are more familiar with the availability of the ITC and therefore resulted in higher willingness to pay amounts because they assumed they would receive back a portion of their initial out-of-pocket cost through the tax credit. The average willingness to pay for each DER cohort is also above the average SGIP out-of-pocket cost before ITC of $10,621. Note that customers are only eligible to claim the Federal ITC if the battery storage system is paired with solar PV and it charges from on-site solar.[50]

TABLE 5-13: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE BY SURVEY POPULATION

2020-2021 Average	Equity Resiliency	Small Residential Storage	Large Scale Storage	All SGIP Residential
System Capacity	27.3 kWh	15.4 kWh	41.2 kWh	20.4 kWh
Eligible System Cost	$29,060	$16,333	$41,080	$21,535
Incentive Amount	$26,855	$3,064	$10,364	$10,914
Out of Pocket Cost	$2,205	$13,269	$30,716	$10,621
Estimated Out-Of-Pocket Cost after ITC	$1,632	$9,819	$22,730	$7,860

While the size of battery needed to provide whole house backup will vary with the customer's load, for an example, let's assume a whole house system would need a capacity close to 27.3 kWh (with a cost of $29,060). If customers received an incentive at the small residential storage rate, the average incentive received on a 27.3 kWh system would be $5,432. The customer would have $23,628 in out-of-pocket costs or $17,385 after ITC. This cost is less than the amount the average storage customer is willing to pay for a whole house system, but higher than what solar or non-DER customers are willing to pay on average. A higher, but very targeted, incentive may be necessary to achieve continued adoption of storage outside the early adoption customers given the lower willingness to pay values for the solar and non-DER customers.

50 Battery storage owners can also only use the FITC to cover costs not covered by the SGIP incentives which helps to explain why customers participating in the Equity Resiliency budget category, where incentives approach the cost of the battery storage system, were less likely to list the FITC as economically important (see Figure 5-28). Customers using the FITC must also have tax responsibilities that meet the value of the credit to receive its full value.

Willingness to Pay per Avoided kWh Outage

To calculate the willingness to pay for battery storage on a kWh basis, or the $/kWh of outage, the willingness to pay for battery storage must be divided by the lifetime estimate of customer kWh backup during outages. The lifetime estimate of customer outage kWh that will be backed up by a whole house battery was estimated using the following equation:

EQUATION 1

$$Outage\ kWh = Battery\ Life * Hourly\ Usage * Length\ of\ Outage * Number\ of\ Outages$$

Where the values for the variables and the outage kWh from Equation 1, for the different survey cohorts in Table 5-12, are listed in Table 5-14. The battery life is set to 10 years, a common warranty length for residential battery storage systems. The hourly usage is the average household usage for storage and solar customers. The hourly usage is set to the average household usage for NEM customer divided by 8760.[51] For Non-Interconnected customers, the average household usage per hour is the 2019 RASS average single-family usage (7,265 kWh) divided by 8760. The length of outage is developed using reported responses to a survey question that asked respondents to describe the length of the utility electricity outage they were assuming while responding to the battery storage willingness to pay questions. The number of outages per year is an assumption.

The data presented in Table 5-14 shows that end-users with storage are assuming a longer average outage length than end-users without storage. The longer outage assumptions for these customers are consistent with these customers believing they have more resiliency needs.

TABLE 5-14: STATEWIDE WILLINGNESS TO PAY OUTAGE INPUTS

	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Battery Life	10 Years	10 Years	10 Years	10 Years
Hourly Usage	1.03 kWh	1.03 kWh	1.03 kWh	0.93 kWh
Length of Outage	44.54 hours	48.85 hours	37.63 hours	38.17 hours
Number of Outages per year	2	2	2	2
Outage kWh	918 kWh	1,010 kWh	724 kWh	589 kWh

51 The average household usage for a NEM customer was calculated using the IOU average usages from the NEM 2.0 Lookback Study and the MW of NEM customer installations by IOU from the California DG Stats website. The average is set to 9,040 kWh.

The willingness to pay for whole house battery storage system on a $/kWh basis is the estimated willingness to pay divided by the outage kWh. For partial house batteries, where the willingness to pay was developed using an assumption that the battery would back up 30 percent of the household's electricity usage, the partial house outage kWh is set to 30 percent of the whole house outage kWh.

Table 5-15 presents the statewide willingness to pay for whole and partial house battery storage on a $/kWh basis for the four cohorts surveyed for the Market Assessment. These data show that the SGIP Storage and Storage Non-SGIP cohorts are estimated to have a similar willingness to pay for whole and partial house systems. As with their willingness to pay for battery storage (see Table 5-12 above), the $/kWh values for storage customers are higher for whole house battery storage systems than for partial house systems. These cohorts may be more concerned about longer outages and have experienced backup with battery storage during outages, leading them to prefer or value a larger system that can back up their whole house.

TABLE 5-15: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE ON A $/KWH BASIS, BY SURVEY POPULATION

WTP for Storage	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	$21.66	$19.27	$14.35	$10.30
Partial House (30% of electrical needs)	$8.81	$8.97	$21.75	$24.96

The survey cohorts who do not currently have battery storage, the Solar Non-Storage and Non-Interconnected respondents, are estimated to have a higher willingness to pay, on a $/kWh basis, for partial house battery storage systems than for whole house systems. The higher willingness to pay is consistent with the desire to back up high value, essential loads with the partial house battery storage system, while not paying for a larger system that would be able to also backup lower value, non-essential equipment. The non-storage cohort may also have a lower value for whole house battery storage systems than storage owners because they do not believe they will experience the longer outages assumed by households who have purchased storage.

Willingness to Pay by Location

Table 5-16 presents the statewide willingness to pay for battery storage results for the four cohorts of interest by their location in an urban, suburban, or rural region. These results show that customers in rural areas are willing to pay more than customers in suburban areas (nearly twice as much in the non-interconnected cohort), for a battery system that provides backup for their whole house. This could be because rural customers perceive their electrical infrastructure as less reliable, with a higher likelihood of frequent outages. Their rural location could also make them feel more vulnerable as there is less supportive community infrastructure in the event of an outage.

The rural non-interconnected (non-DER) customers are estimated to have a lower willingness to pay than other customers in rural areas who already have storage systems. One explanation for this is that the customers who already have storage systems enjoy those benefits and therefore value those systems higher. Another explanation could be that since the non-interconnected cohort has fewer high-income customers, they are less able to pay for a battery storage system.

TABLE 5-16: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE BY SURVEY POPULATION AND REGION

Storage Size	Region	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	Urban	$17,331	$18,476	--[52]	--
	Suburban	$16,402	$18,813	$11,009	$7,156
	Rural	$18,615	$24,509	--	$14,036
Partial House (30% of electrical needs)	Urban	$3,901	$3,725	--	--
	Suburban	$4,526	$2,117	$5,131	$4,602
	Rural	$3,473	$5,060	--	$8,685

Table 5-17 presents the statewide willingness to pay for whole and partial house battery storage on a $/kWh basis for the four cohorts of interest by location in an urban, suburban, or rural region. When normalized by outage length, there's little difference between customers in urban, suburban, and rural areas. This suggests that although customers in rural areas had higher willingness to pay for whole systems, they are also more willing to tolerate longer outages in comparison to customers in urban and suburban areas.

[52] Results are not reported for some sub-groups due to small sample sizes and insufficient statistical significance.

TABLE 5-17: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE ON A $/KWH BASIS, BY SURVEY POPULATION AND REGION

Storage Size	Region	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	Urban	$20.03	$15.70	--	--
	Suburban	$19.07	$20.94	$14.91	$12.39
	Rural	$16.08	$17.22	--	$14.67
Partial House (30% of electrical needs)	Urban	$15.03	$10.55	--	--
	Suburban	$17.54	$7.86	$23.16	$26.56
	Rural	$10.00	$11.85	--	$30.27

Willingness to Pay by Medical Need

Table 5-18 presents the statewide willingness to pay for battery storage results for the four cohorts of interest by whether they stated their household has a health-related need that requires electricity to power medical equipment. These results show that customers without storage systems that have medical need are willing to pay nearly 50 to 60 percent more for a whole house system than those without a medical need. For those that already have a storage system, there is very little difference between willingness to pay based on medical need for either a whole or partial house system.

TABLE 5-18: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE BY SURVEY POPULATION AND MEDICAL NEED

Storage Size	Medical Need	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	Yes	$16,204	$20,135	$14,818	$8,766
	No	$16,876	$19,176	$10,080	$5,478
Partial House (30% of electrical needs)	Yes	$4,049	--	$3,869	$4,429
	No	$4,321	$3,042	$5,207	$4,986

Table 5-19 presents the statewide willingness to pay for whole and partial house battery storage on a $/kWh basis for the four cohorts of interest by medical need. Within cohorts without storage systems, customers with medical needs have higher $/kWh values for a whole house system than those with no medical need. They also have lower $/kWh values for a partial system in comparison to those with no medical need. Customers without storage systems with medical needs may value a whole house system higher than those without medical needs. This is possibly due to extenuating medical factors that would make everyday life more difficult without lower-level electrical loads such as lighting. There is little difference in $/kWh valuation for customers that already have a storage system between those with and without medical needs.

TABLE 5-19: STATEWIDE WILLINGNESS TO PAY FOR BATTERY STORAGE ON A $/KWH BASIS, BY SURVEY POPULATION AND MEDICAL NEED

Storage Size	Medical Need	SGIP Residential Storage Customer	Storage, Non-SGIP	Solar Non-Storage	Non-Interconnected
Whole House	Yes	$17.41	$18.07	$20.05	$11.86
	No	$18.40	$19.44	$12.80	$8.78
Partial House (30% of electrical needs)	Yes	$14.50	--	$17.45	$19.98
	No	$15.71	$10.28	$22.03	$26.64

5.7 SGIP INFLUENCE

The SGIP and/or the customer's utility can have many different influences on the decision to adopt battery storage, including introducing the customer to battery storage and providing an incentive that helps the customer afford the upfront cost of the system. Survey respondents who have battery storage installed in their home or business were asked where they first learned about battery storage. Only one percent of SGIP participants reported learning about battery storage from SGIP while less than 0.5 percent responded that they learned about batteries from their utility. These shares are very similar to those described by individuals with battery storage who did not receive an SGIP incentive. Customers participating in the SGIP Equity Resiliency program were slightly more likely to respond that they learned about battery storage from SGIP (three percent) or their utility (two percent). The higher share of these customers reporting that they learned about storage from SGIP and/or their utility may be due to the unique eligibility requirements of this budget category including the medical baseline or medical needs options.

5.7.1 SGIP Customers Likelihood of Installation Without SGIP

Developers surveyed indicated roughly half of their residential projects and one-third of their non-residential projects would still be completed if the SGIP incentive was no longer available. Anecdotally, developers suggest that installations in the general market would likely recover in the medium term, but projects in the Equity Resiliency budget would not go forward without the incentive.

The majority of residential Large-Scale and Small Residential Storage respondents were likely to install battery storage without the SGIP incentive. Equity Resiliency participants were significantly less likely to do so without the incentive. Figure 5-48 shows that:

- Nearly three quarters of all SGIP residential survey respondents (72 percent) were extremely or somewhat likely to install storage without the incentive.

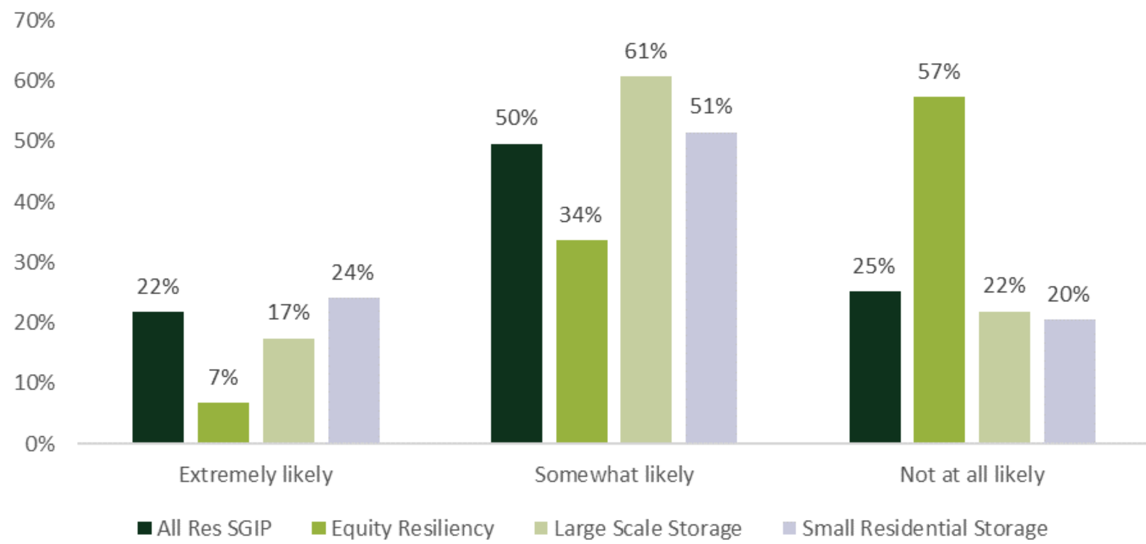
– Large-Scale Storage and Small Residential Storage respondents were even more likely to do so (78 percent and 75 percent, respectively).

- One-quarter of all SGIP residential survey respondents (25 percent) were unlikely to install storage without the SGIP incentive.

  – Equity Resiliency respondents were significantly more unlikely to do so (57 percent).

These results indicate the SGIP has significantly increased the likelihood of storage installation for customers in the Equity Resiliency budget category.

FIGURE 5-48: LIKELIHOOD OF BATTERY STORAGE INSTALLATION WITHOUT THE SGIP INCENTIVE, BY BUDGET CATEGORY



Interestingly, while the self-reported likelihood of battery storage purchase without the SGIP incentive is highly dependent on budget category, the likelihood shows very little dependence on customer income. Thirty percent of customers with less than $50,000 annual income are not at all likely to purchase their system without the incentive, while 31 percent of customers with annual income from $100,000 to $200,000 are not at all likely to purchase without an incentive (Table 5-20).

TABLE 5-20: LIKELIHOOD OF BATTERY STORAGE INSTALLATION WITHOUT THE SGIP INCENTIVE, BY CUSTOMER INCOME

	Annual Income < $50,000	Annual Income $50,000 to < $75,000	Annual Income $75,000 to < $100,000	Annual Income $100,000 to < $200,000	Annual Income $200,000 or Larger
Extremely likely	28%	20%	21%	20%	23%
Somewhat likely	39%	38%	46%	47%	53%
Not at all likely	30%	36%	30%	31%	23%

Non-Residential SGIP participants are much less likely to have installed their battery storage system without the SGIP incentive. Only 10 percent reported they would have been extremely likely to do so, 17 percent reported they would have been somewhat likely to do so, and 63 percent reported they would have been not at all likely to install the storage without the SGIP incentive.

5.7.2 Non-SGIP Residential Storage Customers' Knowledge of SGIP

The non-SGIP storage customer population was developed from customers with storage who had not received an SGIP incentive. These customers may have applied for an SGIP incentive and been approved, but not yet received an incentive. Others may be earlier in the application process or may have been denied an incentive. The Storage non-SGIP respondents may also not be aware of SGIP or have applied for an incentive. Potential reasons for not applying for an SGIP incentive could include lack of knowledge about SGIP, knowing that the battery storage system did not meet the eligibility requirements, a belief that the incentive was insufficient to apply, a concern that the waitlist was too long, or a vendor that was not willing to go through the application process.

Residential customers with battery storage who had not received an SGIP incentive at the time the Storage Non-SGIP survey was fielded were asked if they had heard of the SGIP program.[53] Over half (54 percent or 1,118 respondents) of these respondents reported knowing about the SGIP, 39 percent had never heard of it (854 respondents), and 7 percent were unsure (155 customers). Respondents who knew about the SGIP were asked if they learned about the program before, after, or simultaneously with their battery storage installation.

- Over half (52 percent or 585 customers) of these respondents reported they knew about SGIP prior to the installation of their battery storage system, 24 percent (293 respondents)stated that they learned about SGIP after their storage system installation, and 24 percent (271 respondents) reported learning about SGIP simultaneously with their system installation.

[53] As listed in Table 4-3, 2,183 customers responded to the residential storage non-SGIP survey, though quality controls and skip patterns may reduce the response number to any given question.

Those who were aware of the SGIP were asked if they had applied for an SGIP incentive.

- Nearly two-thirds (63 percent or 655 survey respondents) reported that they had applied for an SGIP incentive, 26 percent had not applied (358 respondents), and 12 percent were unsure whether they had applied for an incentive (161 respondents).

Those who knew about the SGIP and had applied for an incentive were asked if they had received the incentive.

- Over half (53 percent) reported they had received an SGIP incentive (369 respondents). These individuals represent 18 percent of the Storage Non-SGIP survey respondents.[54]

The majority of Storage Non-SGIP respondents who had applied for an SGIP incentive but had not received an incentive believed their application was currently under review (56 percent). Other frequently reported reasons given for not receiving the SGIP incentive was there were none available at the time (18 percent), their application was denied (9 percent), or they believe their incentive went to the installer (6 percent).

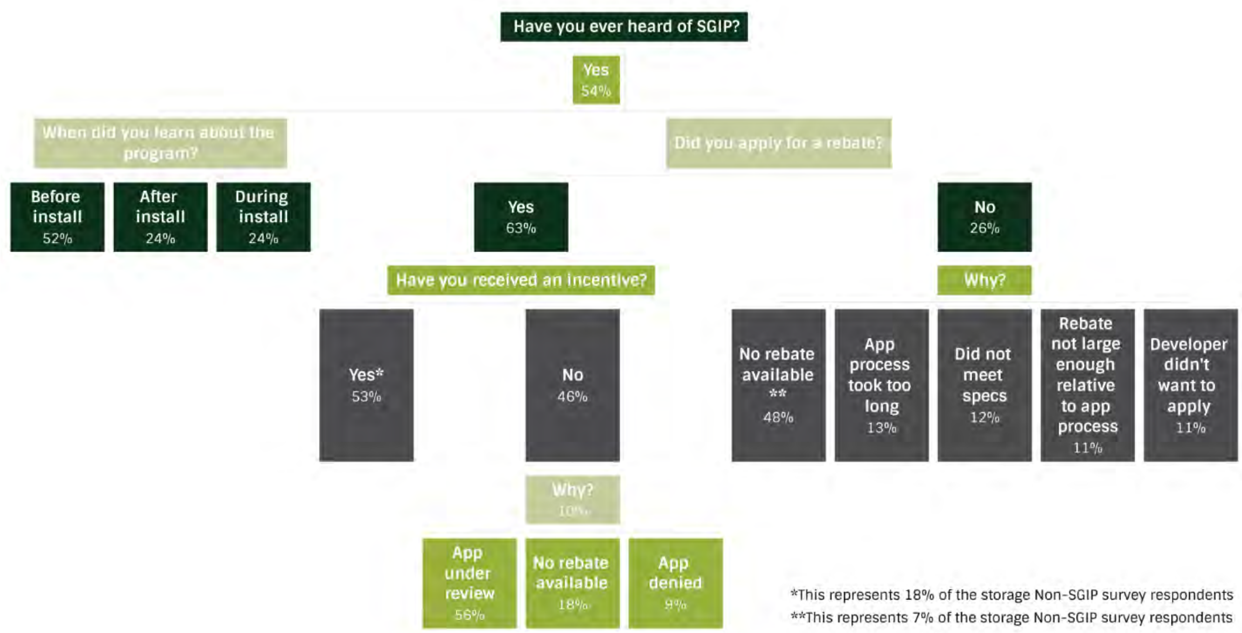
The survey asked non-SGIP storage respondents who were aware of SGIP, but had not applied for SGIP, why they did not apply for an incentive.[55]

- Forty eight percent reported there were no SGIP incentives available at the time their storage was installed. These customers represent 7 percent of the non-SGIP storage survey respondents. Other common responses for not applying for an SGIP incentive included:
  - The application process took too long (13 percent)
  - Their system did not meet SGIP eligibility requirements (12 percent)
  - Their developer did not want to apply (11 percent)
  - The incentive amount was small and not worth the effort to fill out the application (11 percent)

54 While the Verdant team took great care to ensure SGIP participants were not included in the Storage Non-SGIP sample, some of the Storage Non-SGIP respondents may have received the SGIP incentive between the time the sample was developed, and the survey was implemented.

55 Fourteen percent of the Non-SGIP storage customers state that they are aware of SGIP but did not apply for SGIP. In addition, 46 percent of non-SGIP storage customer reported that they were not aware of SGIP or replied don't know to this question.

FIGURE 5-49: KNOWLEDGE OF SGIP BY RESIDENTIAL STORAGE NON-SGIP RESPONDENTS



5.7.3 Recommend SGIP and Battery Storage

Residential and Non-residential respondents who have installed storage are highly likely to recommend the SGIP and Battery storage to others. Those with storage were asked, "based on your experience, how likely are you to recommend the SGIP to others?" and "based on your experience, how likely are you to recommend battery storage to others?" Figure 5-50 illustrates that 96 percent of residential SGIP respondents and 94 percent of non-SGIP storage respondents are very or somewhat likely to recommend battery storage to others. Ninety-one percent of the residential SGIP respondents are very or somewhat likely to recommend the SGIP to others. Non-residential SGIP host customers are slightly less likely than residential host customers to recommend the SGIP and battery storage to other but are still overwhelmingly likely to do so (81 percent reported they would recommend the SGIP and 76 percent reported they would recommend battery storage). These findings reflect a very high level of satisfaction with battery storage and of the program by SGIP participants.

Only customers who had previously stated that they were aware of SGIP and had applied for an SGIP incentive were asked to report whether they would recommend the SGIP to others (34 percent of respondents). Seventy percent of these customers would be very or somewhat likely to recommend the SGIP, which represents approximately 24 percent of the non-SGIP storage customers surveyed.

FIGURE 5-50: SHARE OF RESIDENTIAL STORAGE RESPONDENTS RECOMMENDING BATTERY STORAGE OR THE SGIP

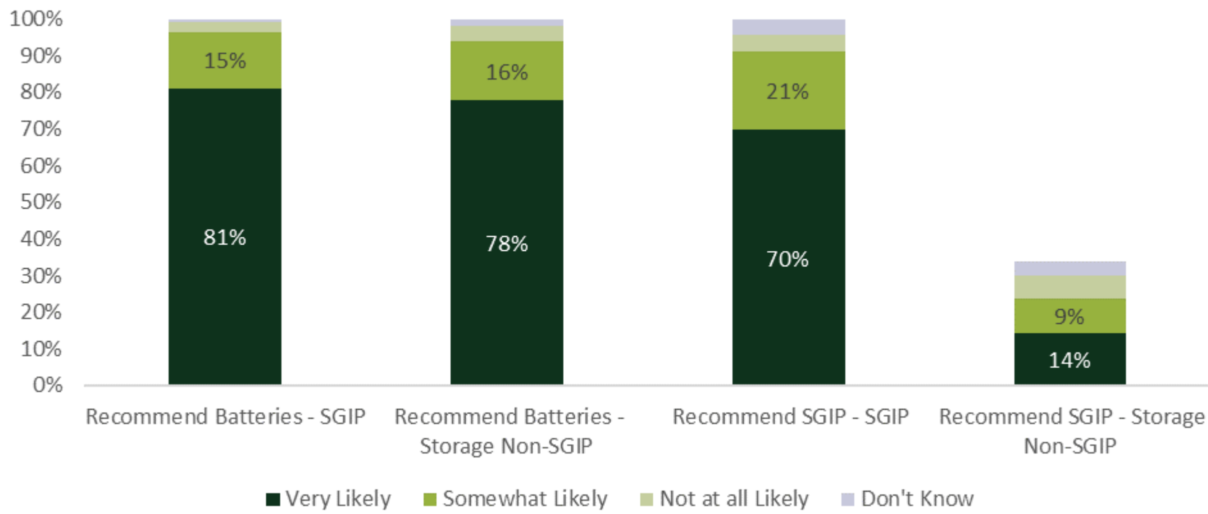


Table 5-21 presents information on the share of residential respondents who would recommend battery storage and SGIP by the capacity of their storage system. These data show that across all storage capacities, a higher percentage of respondents would be extremely likely to recommend battery storage than to recommend the SGIP. Respondents with larger sized battery storage systems are more likely to be extremely likely to recommend battery storage and the SGIP than customers with smaller sized systems. These data illustrate that customers across the range of battery sizes are relatively satisfied with their batteries and SGIP (extremely likely or somewhat likely to recommend), but customers with larger sized systems have a higher level of satisfaction (extremely likely).

TABLE 5-21: RESIDENTIAL SGIP CUSTOMER LIKELIHOOD OF RECOMMENDING STORAGE AND SGIP BY STORAGE CAPACITY

	Less than 5 kW	5 kW	Greater than 5 kW to Less than 10 kW	10 kW	Greater than 10 kW
Likely to Recommend Battery Storage					
Extremely likely	68%	83%	80%	86%	88%
Somewhat likely	22%	15%	16%	12%	11%
Not at all likely	8%	1%	2%	1%	1%
Likely to Recommend SGIP					
Extremely likely	53%	69%	66%	81%	80%
Somewhat likely	26%	25%	23%	15%	16%
Not at all likely	10%	4%	8%	2%	2%
n	**442**	**872**	**132**	**886**	**186**

The likelihood of recommending battery storage and SGIP can also be analyzed by SGIP budget category (see Table 5-22). Those in the Equity Resiliency and Large-Scale Storage budget categories generally installed larger systems, were motivated to install storage due to their medical needs and/or desire for improved resiliency during power outages, which may contribute to their higher likelihood of recommending battery storage. Equity Resiliency participants may be more likely to recommend SGIP due to their receiving substantially larger incentives per watt hour than those in the Large-Scale Storage or Small Residential Storage budget categories.

TABLE 5-22: LIKELIHOOD OF RECOMMENDING BATTERY STORAGE AND SGIP BY BUDGET CATEGORY

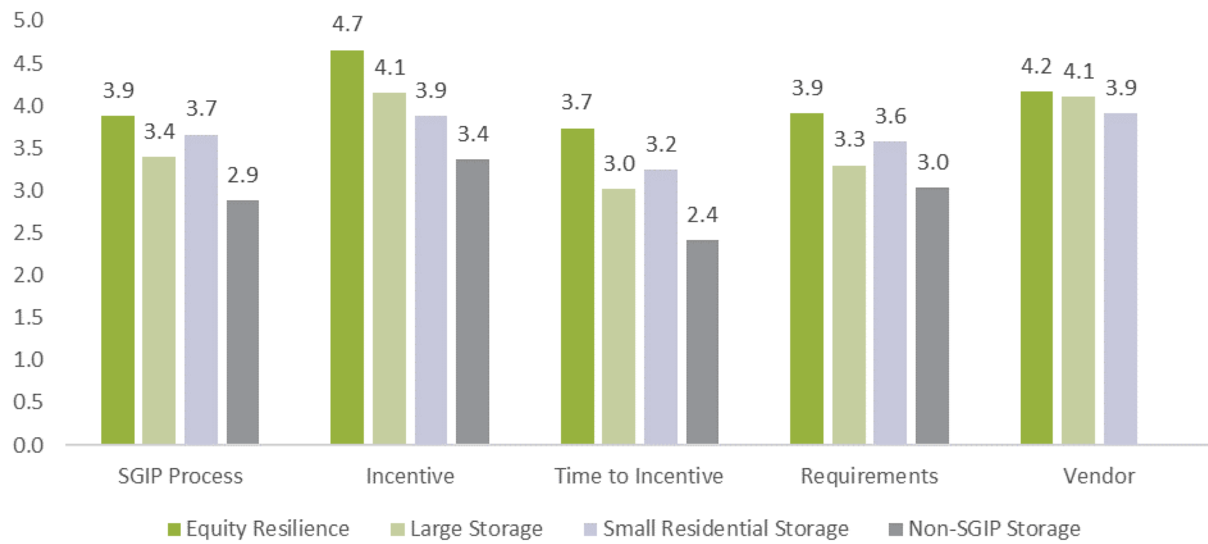
	Equity Resiliency	Large-Scale Storage	Small Residential Storage
Likelihood Recommend Battery Storage			
Extremely likely	86%	88%	80%
Somewhat likely	13%	11%	16%
Not at all likely	2%	2%	5%
Don’t Know	0%	1%	1%
Likelihood Recommend SGIP			
Extremely likely	87%	75%	67%
Somewhat likely	11%	20%	23%
Not at all likely	2%	2%	5%
Don’t Know	0%	3%	5%
n	**491**	**121**	**1,906**

5.7.4 Satisfaction with SGIP Elements

The survey collected information on residential SGIP and non-SGIP respondents’ satisfaction with multiple SGIP elements including the participation process and timeline, the incentive amount, the time it took to receive the program incentive, the participation requirements, and their storage equipment vendor (non-SGIP storage customers were not asked to rate their SGIP vendor). Respondents were asked to rate these program elements on a scale of 1 to 5, where 1 was not at all satisfied and 5 was extremely satisfied. Figure 5-51 presents the average value of SGIP and non-SGIP respondents’ scores by SGIP budget category. The SGIP participants ranked all SGIP elements relatively high, with the lowest score of a 3.0 for time to receipt of incentive from Large-Scale Storage respondents and the highest score of a 4.7 for incentive amount from Equity Resiliency respondents. Across all five elements, the Equity Resiliency respondents reported a slightly higher level of satisfaction than respondents in the other two budget categories.

The Storage Non-SGIP respondents who were aware of SGIP and had applied for an incentive were asked to rank the SGIP elements, and they generally ranked these elements lower than the SGIP participants. The lower rankings are substantial, with more than 40 percent of the respondents giving the lowest ranking to their satisfaction with the time needed to receive an SGIP incentive. This very low ranking is not surprising, given that these customers are in the non-SGIP storage survey, implying that they had not received an incentive when we developed the sample for the non-SGIP survey.

FIGURE 5-51: SATISFACTION WITH SGIP ELEMENTS BY SGIP PROGRAM BUDGET CATEGORY



Non-residential participants were also asked to rate their satisfaction with SGIP elements. These non-residential SGIP participants are slightly less satisfied with all program elements across the board. They are the most satisfied with the SGIP incentive amount (average score of 3.9 out of 5) and the least satisfied with the SGIP participation requirements (2.7 out of 5).

5.8 SUMMARY OF STORAGE MARKET ASSESSMENT SURVEY FINDINGS

Below we present a summary of the key market assessment survey findings. These summaries are informed by the analyses conducted throughout Section 5. They collapse the findings found throughout that section and each can be referenced back to the more detailed and robust discussion in Section 5.

FIGURE 5-52: SUMMARY OF MARKET ASSESSMENT SURVEY FINDINGS – PART 1

Summary of Storage Market Assessment Survey Findings

Storage Customer Characteristics

- Households who have installed storage tend to be high income, highly educated
- They live in suburban locations, consider themselves early adopters, and own their homes
- Equity Resiliency (ERB) customers are lower income ---> more likely to live in rural and high wildfire locations ---> less likely to be early adopters ---> more likely to be households with medical needs
- Almost all ERB customers reside in a High-Fire Threat Districts (HFTDs)
- Some Small Residential and Large-Scale storage participants also reside in HFTDs
- Customer demographics similar for SGIP and non-SGIP residential customers

Storage System Characteristics

- Residential storage systems are typically paired with solar and equally likely to be sized to provide backup for a whole home and for a portion of the home.

Developer Characteristics

- 400% increase in the total number of developers operating within the SGIP since 2019
- Storage developers also sell solar with the majority selling more solar than storage
- Residential customers are target segment -----> 89% of projects were residential

Sources of Awareness

- Residential and non-residential customers learn about storage through personal research or a project developer, few learn about it through the SGIP or their utility.
- Nearly all solar customers are aware of storage but only 64% of non-DER respondents are aware.

Drivers of Storage Adoption

- 50% of SGIP and non-SGIP storage respondents state that backup is the number one reason for installation
- Roughly 60% of SGIP and non-SGIP respondents list bill savings - or load shifting from on-peak hours to off-peak hours - as one of their top 3 drivers
- Consuming more solar generation and environmental reasons (reducing GHG emissions) are also drivers
- 25% of Equity Resiliency customers primary motivation is medical needs
- The SGIP incentive is much more important for Equity Resiliency customers than others
- Developers see an increase in storage demand by customers wanting grid independence ---> living in HFTD or PSPS areas ---> having medical needs and ---> with high incomes
- The Federal Investment Tax Credit is the highest ranked economic factor influencing installation for Large-Scale and Small Residential SGIP customers
- 69% of solar customers and 28% of customers with no DERS are considering storage adoption

Barriers to Storage Adoption

- Upfront capital costs are the primary reason non-storage respondents have not installed energy storage
- Project developers confirm that upfront battery costs and unfavorable economics are the greatest current and near-term barriers
- How multi-family dwellings are classified within California and the unfavorable economics for rental properties have led to focused attention on single-family installations within the SGIP
- Nearly half of SGIP and non-SGIP storage respondents needed an electric panel upgrade
- Project developers report electric panel upgrades from $1,200 to $6,500, so this is an additional barrier for those currently without any DERs on site or at home
- Other reasons for not installing storage include safety concerns and not having the appropriate space to install the system
- Regulatory changes like NEM reform and supply chain issues create some uncertainty for future adoption

FIGURE 5-53: SUMMARY OF MARKET ASSESSMENT SURVEY FINDINGS – PART 2

Summary of Storage Market Assessment Survey Findings

Customer Resiliency

- 92% of SGIP respondents self-reported experiencing an outage in the past two years
  -58% of ERB respondents experienced an outage greater than 24 hours
  -32% of ERB respondents experienced an outage from 2 days to 7 days
- 90% of non-SGIP storage respondents self-reported an outage in the past two years
  -26% experienced an outage greater than 24 hours
- 88% of non-DER respondents self-reported an outage in the past two years
  -15% were greater than 24 hours
- 65% of ERB respondents have a household member with a medical need requiring power for equipment
  -25% of those stated meeting an essential medical need was the #1 reason they purchased the storage system
- 15% of Small Residential and Large-Scale storage respondents have a household member with a medical need requiring power for equipment
- 18% of non-SGIP storage respondents have a household member with a medical need requiring power for equipment
- 93% of SGIP and non-SGIP respondents said the storage system allowed them to maintain necessary power throughout the outages
- 81% of respondents with medical needs with systems less than 5 kW were able to maintain power needed for medical devices
- Refrigerators/freezers, lighting, and computing and phones are the equipment most backed up by partial home systems. These are also the primary resiliency needs for non-storage customers
- The share of storage owners with a fossil fuel generator is much lower than for non-DER customers, and solar owners have the highest share of fossil fuel generator ownership

SGIP Influence

- Likelihood of installing energy storage without an SGIP incentive
  -Equity Resiliency customers: 7% extremely likely ---> 34% somewhat likely ---> 57% not at all likely
  -Large-Scale Residential: 17% extremely likely ---> 61% somewhat likely ---> 22% not at all likely
  -Small Residential: 24% extremely likely ---> 51% somewhat likely ---> 20% not at all likely
  -Non-residential customers: 10% extremely likely ---> 17% somewhat likely ---> 63% not at all likely
- While likelihood is dependent on budget category, we observe little difference across customer income
- Developers estimate 50% of residential and 33% non-residential projects would be completed if the SGIP incentive was no longer available. ERB customers much less so, however
- We observe an increase in residential non-SGIP BTM energy storage installations the last couple of years
- 54% of storage non-SGIP respondents had heard of SGIP
  -63% of them said they had applied for a rebate ---> more than 1/2 reported receiving an incentive
  -26% said they did not apply for a rebate ---> roughly 1/2 reported no rebate was available at the time
- Residential and non-residential customers learn about storage through personal research or a project developer, and few learn about it through the SGIP or their utility
- SGIP and non-SGIP respondents are very likely to recommend energy storage
  -Customers with larger systems are more likely to recommend energy storage
- SGIP participants are very likely to recommend SGIP as well

FIGURE 5-54: SUMMARY OF MARKET ASSESSMENT SURVEY FINDINGS – PART 3

Summary of Storage Market Assessment Survey Findings

Solar and Storage Characteristics

- 48% of SGIP respondents self-report PV installed prior to storage
- 45% of SGIP respondents self-report simultaneous solar and storage installation
- 1.5% of SGIP respondents self-report solar installation after storage
  - Higher share of ERB customers self-report solar installed before storage (73%)
- 99% of non-SGIP residential storage customers have solar as well
- 70% of non-SGIP respondents self-report simultaneous solar and storage installation
- 1.1% of non-SGIP respondents self-report solar installation after storage
- 60% of large storage systems (>10 kW) are paired with solar systems 10 kW or greater
- 50-60% of smaller storage systems (<=5 kW) are paired with solar systems 7.4 kW and less

Storage Cost Characteristics

- Upfront capital costs are primary reason for not installing storage based on survey respondents
- Project developers report costs are dominated by capital equipment and labor costs
  - 19 of 22 developers reported capital equipment costs represented at least 50% of total
  - Labor costs range from 15% to 55% of total costs
- Developers report increases in total costs over the past two years
  - 67% of developers report an increase in capital storage costs
  - 100% of developers report an increase in labor costs
  - Percent increases range from 5% to 30% depending on the cost component and developer
- Nearly half of installations require electrical panel upgrades
  - Greater percentage of large-scale systems require panel upgrade (63%)

Customer Willingness-to-Pay (WTP) for Storage

- Respondents with battery storage have a higher WTP for whole house storage and lower valuation for partial house (30% of electrical needs) storage compared to customers who do not have storage installed
- SGIP customer WTP ---> $19,928 for whole house is very similar to non-SGIP customer WTP ---> $19,443
- Non-storage solar customer WTP ---> $11,157 for whole house storage ---> $5,072 for partial house
- Non-DER customers WTP ---> $6,520 for whole house storage ---> $4,741 for partial house
- SGIP participants are WTP slightly more for whole house storage than they actually pay - based on developer self-reported eligible cost estimates discussed in Section 2
- Much lower WTP for storage from non-storage solar customers and non-DER customers
- Since capital expenditures are the greatest self-reported barrier to storage adoption (developers and survey respondents)
  - Total eligible costs would need to be lower and/or incentive would need to be greater to reach the next group of storage adopters
- Lifetime WTP from a kWh perspective considers battery life ---> hourly consumption ---> Length of outage and ---> the frequency of outages
- WTP ranges from $21.66 per kWh for ERB customers to $10.30 per kWh for Non-DER respondents for whole house storage
- WTP ranges from $24.96 per kWh for non-DER respondents to $8.81 per kWh for ERB customers for partial house storage
- Overall, customers in rural areas are WTP more than customers in suburban areas for whole house storage
- Non-DER households with medical needs are willing to pay 50-60% more for whole house storage than non-DER households without medical needs

APPENDIX A DETAILED EVALUATION FINDINGS

Below we present key findings from this storage market assessment. These findings were developed based on an analysis of SGIP participant tracking data, utility interconnection data, and results garnered from market surveys with customers and storage project developers. More specifically, they included online surveys of residential and non-residential customers who have installed battery storage systems (both inside and outside of the SGIP), customers with solar but no storage installed, and a representative sample of customers who have not installed solar or storage (non-distributed energy resource or non-DER customers). In-depth interviews (IDIs) and online surveys were also conducted with battery storage project developers. The specific research questions informing these findings can be found in Section 2.4 and in-depth findings and analyses can be found in Section 3 and Section 5 of this report.

Storage System Characteristics

Storage Systems – *What are the characteristics of storage within and outside of SGIP?*

- Slight increase in installed capacities from 2017 to 2021 within the residential sector, potentially associated with the emphasis on resiliency and Equity Resiliency Budget (ERB) participation

- Significant differences in storage sizing across residential budget categories
  -Small Residential ------> 15 kWh
  -Equity Resiliency ------> 27 kWh
  -Large-Scale Storage ------> 41 kWh

- Increase in non-SGIP storage installations across utilities from 46% in 2017 to 76% in 2021

- SGIP installed capacities slightly higher than non-SGIP storage installations
  -2017 SGIP ------> 14 kWh vs. non-SGIP ------> 12 kWh
  -2021 SGIP ------> 23 kWh vs. non-SGIP ------> 20 kWh

- Systems installed in High Fire-Threat Districts (HFTDs) are larger
  -2021 SGIP HFTD ------> 25 kWh and SGIP non-HFTD ------> 20 kWh
  -2021 non-SGIP HFTD ------> 21 kWh and non-SGIP non-HFTD ------> 18 kWh

Storage Cost Characteristics

Storage Costs - *What are the different equipment and installation costs associated with BTM storage?*

- Developer self-reported eligible costs have increased over the past several years within all budget categories
  - -Small Residential: $0.83/Wh in 2017 ------> $1.18/Wh in 2021
  - -Equity Resiliency: $1.06/Wh in 2020 and 2021
  - -Large-Scale Storage: $0.69/Wh in 2017 ------> $1.07/Wh in 2021
- Project developers report costs are dominated by capital equipment and labor costs
  - -19 of 22 developers reported capital equipment costs represented at least 50% of total
  - -Labor costs range from 15% to 55% of total costs
- Developers report increases in total costs over the past two years
  - -67% of developers report an increase in capital storage costs
  - -100% of developers report an increase in labor costs
  - -Percent increases range from 5% to 30% depending on the cost component and developer
- Nearly half of installations require electrical panel upgrades
  - -Greater percentage of large-scale systems require panel upgrade (63%)
- Incentives tied to budget category and incentive step
  - -Small Residential begins at $0.50/Wh. Currently in Step 6-7 with incentive stepdown depending on PA
  - -Decrease in average incentive across PY -> Currently $0.20/Wh
  - -Equity Resiliency set to $1.00/Wh. Budget is fully subscribed across PAs
  - -Large-Scale Storage begins at $0.50/Wh. Currently in Step 4-5 with stepdown depending on PA
  - -Decrease in average incentive across PY -> Currently $0.25/Wh
- Out-of-pocket expenses: project costs minus incentive payment (without Federal ITC)
  - -Small Residential paid 67% of total cost in PY 2017-2019 --> 80% of total cost in PY 2020- 2021
  - -ERB customers paid 8% of total cost in PY 2020-2021
  - -Large-Scale residential customers paid 70% of total cost in PY 2017-2019 --> 75% in PY 2020-2021

Storage and Solar PV

Storage and Solar PV - *How is installation of these BTM resources linked?*

- Since Program Year (PY) 2017, 98% of SGIP residential storage projects are paired with solar PV
  - -45% self-report PV installed prior to storage
  - -48% self-report simultaneous solar and storage installation
  - -1.5% self-report solar installation after storage
- Higher share of ERB customers self-report solar installed before storage (73%)
- 99% of non-SGIP residential storage customers are paired with solar PV
  - -27% self-report PV installed prior to storage
  - -72% self-report simultaneous solar and storage installation
  - -1.0% self-report solar installation after storage

Project Developer Characteristics

Project Developer – *What does the storage installer market constitute?*

- Well over 150 project developers installing over a dozen manufacturer batteries
  - -A few large developers continue to dominate sales, but the number of smaller developers has increased
  - -400% increase in the total number of developers operating within the SGIP since 2019
- Storage developers also sell solar with the majority selling more solar than storage
  - -60% of surveyed developers have been selling storage for more than 5 years
  - -86% have been selling solar PV for more than 5 years
- Developers target residential customers -----> 89% of projects were residential
- Higher self-reported costs from newer storage products in PY 2020-2021 relative to developers who traditionally have had a higher market share of installations within the SGIP

Storage Customer Characteristics

Storage Customers – *What customers constitute the storage market?*

- Households who have installed storage tend to be 1) high income, 2) highly educated, 3) live in suburban locations, 4) consider themselves early adopters and 5) own their own homes
- Equity Resiliency (ERB) customers tend to be 1) lower income, 2) more likely to live in rural and high wildfire threat locations, 3) less likely to be early adopters and 4) more likely to be households with medical needs
- Almost all ERB customers reside in a High-Fire Threat Districts (HFTDs)
  - -22% of PG&E ERB customers *don't* reside in a HFTD, *but* have experienced 2+ PSPS events
- Some Small Residential and Large-Scale storage participants also reside in HFTDs
  - -31% live in HFTDs and/or experienced 2+ PSPS events

Drivers of Storage Adoption

Drivers of Storage Adoption - *What are main drivers to installing BTM Storage?*

- 50% of SGIP and non-SGIP storage respondents state that backup is the number one reason for installation
  -Over 90% of respondents place back-up in their top 3 drivers for installing storage
- Roughly 60% of SGIP and non-SGIP respondents list bill savings - or load shifting from on-peak hours to off-peak hours - as one of their top 3 drivers
- Consuming more solar generation and environmental reasons (reducing GHG emissions) are also drivers
- 25% of Equity Resiliency customers primary motivation is medical needs
- The SGIP incentive is much more important for Equity Resiliency customers than others
- Developers see an increase in storage demand by customers wanting grid independence ---> living in HFTD or PSPS areas ---> having medical needs and ---> with high incomes
- The Federal Investment Tax Credit is the highest ranked economic factor influencing installation for Large-Scale and Small Residential SGIP customers
- 69% of solar customers and 28% of customers with no DERS are considering storage adoption
  -Resiliency and bill savings are their primary drivers

Barriers to Storage Adoption

Barriers to Storage Adoption - *What are the main barriers to installing BTM storage?*

- Upfront capital costs are the primary reason non-storage respondents have not installed energy storage
- Project developers confirm that upfront battery costs and unfavorable economics are the greatest current and near-term barriers
- How multi-family dwellings are classified within California and the unfavorable economics for rental properties have led to focused attention on single-family installations within the SGIP
- Nearly half of SGIP and non-SGIP storage respondents needed an electric panel upgrade
  -Project developers report electric panel upgrade costs from $1,200 to $6,500
- Other reasons for not installing storage include safety concerns and not having the appropriate space to install the system
- Regulatory changes like NEM reform and supply chain issues create some uncertainty for future adoption

Storage Customer Resiliency Needs

Customer Resiliency Needs – *Are customer resiliency benefits being realized with storage?*

- 92% of SGIP participants self-reported experiencing an outage in the past two years
  - -58% of ERB participants experienced an outage greater than 24 hours
  - -32% of ERB participants experienced an outage from 2 days to 7 days
- 90% of non-SGIP storage participants self-reported an outage in the past two years
  - -26% experienced an outage greater than 24 hours
- 88% of non-DER respondents self-reported an outage in the past two years
  - -15% were greater than 24 hours
- 65% of ERB participants have a household member with a medical need requiring power for equipment
  - -25% of those stated meeting an essential medical need was the #1 reason they purchased storage
- 15% of Small Residential and Large-Scale storage SGIP participants have a household member with a medical need requiring power for equipment
- 18% of non-SGIP storage respondents have a household member with a medical need requiring power for equipment
- 93% of SGIP and non-SGIP respondents said the storage system allowed them to maintain necessary power throughout the outages
- 81% of respondents with medical needs with systems less than 5 kW were able to maintain power needed for medical devices
- Residential storage systems are equally likely to be sized to provide backup for a whole home as for a portion of the home
- Refrigerators/freezers, lighting, and computing and phones are the equipment most backed up by partial home systems. These are also the primary resiliency needs for non-storage customers
- The share of storage owners with a fossil fuel generator is much lower than for non-DER customers, and solar owners (without storage) have the highest share of fossil fuel generator ownership (roughly 24%)

Customer Willingness to Pay (WTP) for Storage

Willingness-to-Pay - *How do customers value resiliency and what is there WTP for storage?*

- Respondents with battery storage have a higher WTP for whole house storage and lower valuation for partial house (30% of electrical needs) storage compared to customers who do not have storage installed

- SGIP customer WTP ---> $19,928 for whole house is very similar to non-SGIP customer WTP ---> $19,443

- Non-storage solar customer WTP ---> $11,157 for whole house storage ---> $5,072 for partial house

- Non-DER customers WTP ---> $6,520 for whole house storage ---> $4,741 for partial house

- SGIP participants are WTP slightly more for whole house storage than they actually pay - based on developer self-reported eligible cost estimates discussed in Section 2
  - -With an average system size of 27 kWh, total eligible costs were roughly $29,000 in 2021, independent of budget category
  - -With a $0.20/Wh incentive (current Small Residential budget step) and 26% FITC ---> total out-of-pocket is $17,385 compared to WTP of $19,928

- Since capital expenditures are the greatest self-reported barrier to storage adoption (developers and survey respondents) --->
  - -Total eligible costs would need to be lower and/or incentive would need to be greater to reach the next group of storage adopters

- Lifetime WTP from a kWh perspective considers battery life ---> hourly consumption ---> Length of outage and ---> the frequency of outages

- WTP ranges from $21.66 per kWh for ERB customers to $10.30 per kWh for Non-DER respondents for whole house storage

- WTP ranges from $24.96 per kWh for non-DER respondents to $8.81 per kWh for ERB customers for partial house storage

- Overall, customers in rural areas are WTP more than customers in suburban areas for whole house storage

- Non-DER households with medical needs are willing to pay 50-60% more for whole house storage than non-DER households without medical needs

SGIP Influence

SGIP Influence – *How is SGIP influencing adoption?*

- Self-reported likelihood of installing energy storage without an SGIP incentive
  - -Equity Resiliency: 7% extremely ---> 34% somewhat ---> 57% not at all
  - -Large-Scale Residential: 17% extremely ---> 61% somewhat ---> 22% not at all
  - -Small Residential: 24% extremely ---> 51% somewhat ---> 20% not at all
  - -Non-residential: 10% extremely ---> 17% somewhat ---> 63% not at all
- While likelihood is dependent on budget category, we observe little difference across customer income
- Developers estimate 50% of residential and 33% non-residential projects would be completed if the SGIP incentive was no longer available. They self-report ERB customers would likely not complete the project without the incentive
- We observe an increase in residential non-SGIP BTM energy storage installations in the last couple of years
- 54% of storage non-SGIP respondents had heard of SGIP
  - -63% of them said they had applied for a rebate ---> more than 1/2 reported receiving an incentive
    - -Some of the storage Non-SGIP respondents may have received the SGIP incentive between the time the sample was developed, and the survey was implemented.
  - -26% of them said they did not apply for a rebate ---> roughly 1/2 reported no rebate was available at the time
- Residential and non-residential customers learn about storage through personal research or a project developer, and few learn about it through the SGIP or their utility
- SGIP and non-SGIP respondents are very likely to recommend energy storage
  - -Customers with larger systems are more likely to recommend energy storage
- SGIP participants are very likely to recommend SGIP as well

APPENDIX B SURVEY INSTRUMENTS

B.1 HOST CUSTOMER RESIDENTIAL SURVEY INSTRUMENT

Qualtrics_Version_S
GIP_MA_Storage_Su

B.2 HOST CUSTOMER NON-RESIDENTIAL SURVEY INSTRUMENT

Qualtrics_Version_S
GIP_MA_Storage_Su

B.3 NON-STORAGE SURVEY INSTRUMENT

Qualtrics_Version_S
GIP_MA_Nonstorage

B.4 DEVELOPER SURVEY INSTRUMENT

Qualtrics_Version_S
GIP_Developer_Surv

APPENDIX C SURVEY BANNERS

This section includes banner tables showing the distributions of the surveys completed

C.1 HOST CUSTOMER RESIDENTIAL SURVEY BANNERS

To view the Excel files below, click on the small arrow on the left side of the Adobe Acrobat window to access additional Acrobat tools ( ). Click on the Paperclip to access these files as attachments ( ). Double-clicking the files will open them in Excel.

1-Appendix_SGIP_Res_Response_Frequ

2-Appendix_Storage_NoSGIP_Res_Resp

3-Appendix_SGIP_NonRes_Response_Fr

4-Appendix_Storage_NoSGIP_NonRes_I

5-Appendix_Solar_Nonstorage_Res_Re

6-Appendix_NonInterconnected_Res_Re

7-Appendix_Solar_NonStorage_NonRe

8-Appendix_NonInterconnected_NonRe