U.S. SOLAR-PLUS-STORAGE MARKET

Drivers, Economics And Outlook

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Executive Summary

Executive Summary

The U.S. solar-plus-storage market is very nascent today; less than 0.1 percent of 2014 solar installations were paired with storage. In fact, the penetration rate of storage in solar installations has gone down year-over-year for the past three years, although the overall solar-plus-storage market has been flat in capacity terms. But in spite of this small share, industry activity and discussion around this technology combination has been frantic.

Drivers: There are a number of drivers for the increased level of industry and customer interest. Several technologies, led by lithium-ion, continue on rapid commercialization paths, bringing down costs and providing one of the biggest drivers for the industry.

Along with cost reduction, solar-plus-storage value streams continue to advance from traditional back-up to multiple use cases. These benefits vary in three ways – frequency of use, discharge duration and key beneficiary. Generally speaking, benefits that have more frequent use improve the overall economics of the system. These benefits are not necessarily mutually exclusive, although there are limitations based on technology, availability of charge, frequency and timing of multiple applications. Apart from the technical constraints, front-of-meter benefits have not been monetized, except in few markets on pilot scale. Market rules and policies are still evolving in reaction to distributed energy resources proliferation.

Several states have existing and proposed incentive programs for solar-plus-storage deployments, in the form of upfront and performance-based incentives, as well as pilot programs to enable more storage-paired solar.

Residential segment: For residential customers, the key emerging use case is time-of-use shifting. Net energy metering rate reforms and time-of-use retail rates can also increase the value of self-consuming solar generation by shifting it using energy storage.

Non-residential segment: Demand charge management offers a distinct value proposition for commercial customers, particularly in markets with high demand charges. Additionally, non-residential customers typically are on time-of-use tariff, and solar-plus-storage provides peak shifting benefits.

Executive Summary

Behind-the-meter for grid services: Behind-the-meter solar-plus-storage can provide benefits not just to end-customers, but also to the connected grid, both locally as well as at the system level. We broadly call these benefits grid services. Existing market rules and state policies restrict the use of behind-the-meter resources for grid services. However, as distributed energy resources grow in multiple markets, the regulatory, technological and business model bottlenecks will likely get resolved and increase the participation of behind-the-meter solar-plus-storage resources for grid services.

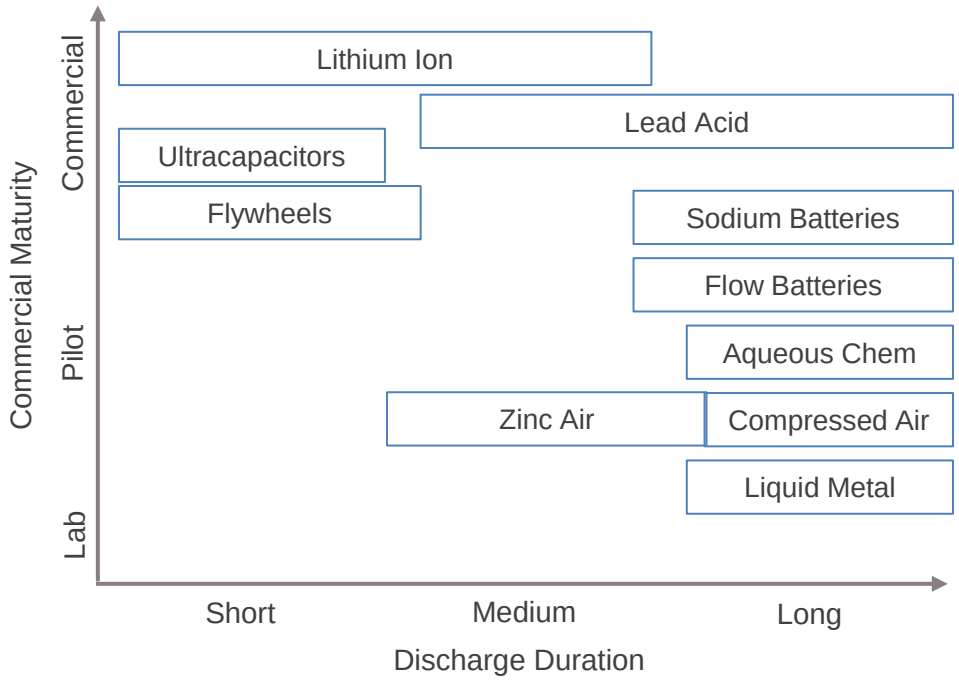
Utility-scale segment: Utility solar-plus-storage is growing as a means to relieve the grid of various constraints. There are no direct incentives for utility segment, but California's storage mandate will see some solar-plus-storage projects. Some utilities have also issued RFPs for solar-plus-storage plants, and very soon there could be solar-plus-storage projects participating as capacity resources. Island markets such as Hawaii and Puerto Rico have technical requirements for renewables, including ramp rate control, that necessitate storage.

Outlook: Solar-plus-storage deployments totaled 4 MW in 2014, but are expected to grow to 22 MW in 2015 and reach 769 MW by 2020. California is expected to be the biggest solar-plus-storage market with 9 MW in 2015 and 422 MW by 2020. The U.S. solar-plus-storage market (in USD) shrunk by 12% in 2014, even though the deployments increased by 8%. This downward trend is expected to reverse in 2015 and 2016, when the market will grow to $246 million in 2015 and $643 million in 2016. By 2020, the annual U.S. solar-plus-storage market will be $3.1 billion.

Storage Technologies

No Silver Bullet Storage Technology for Solar Pairing

Storage Technologies Matrix



Source: GTM Research

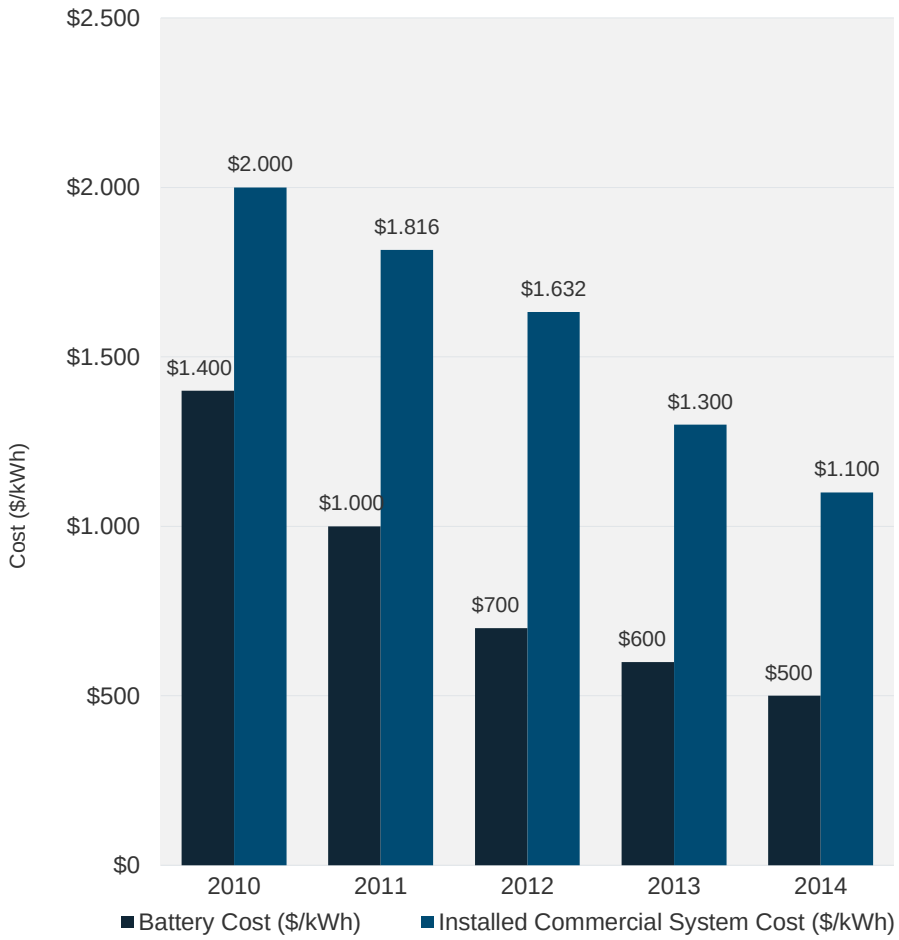
While there are several energy storage technologies, each technology has its own strengths and limitations. In addition to wide-ranging technical capabilities, these technologies are at different points in their commercial maturity. As a result, in order to assess the storage fit for solar pairing requires navigating an interwoven matrix of factors.

In the accompanying illustration, we have compared different energy storage technologies based on commercial maturity and one of the key technical capabilities – discharge duration. Most of the long duration storage technologies are at best in advanced pilot scale, with some still in pre-pilot phase.

Applications and related operational requirements govern a lot of technology choices, including ideal power to energy ratio. Energy storage system costs can vary greatly even for the same storage technology based on the power to energy ratio.

Battery and System Costs Will Continue to Drop

Battery and System Cost ($/kWh)



Source: GTM Research

Cost structures of mature (or near mature) technologies will continue to come down in the next 4-5 years, primarily driven by scaling efficiencies. On the other hand, nascent technologies have room for cost reductions through technological and manufacturing innovations.

It is important to not just focus on storage technology, but the entire system, including power conversion system (included inverters), other hardware, storage management systems, integration, installation and interconnection costs. These components are typically about 40% of total installed costs, but can add up to as much as 60% of the total cost.

Lithium-ion battery costs have dropped by an average of 23% each year since 2010. By 2020, we expect battery costs to reach $250/kWh-$300/kWh.

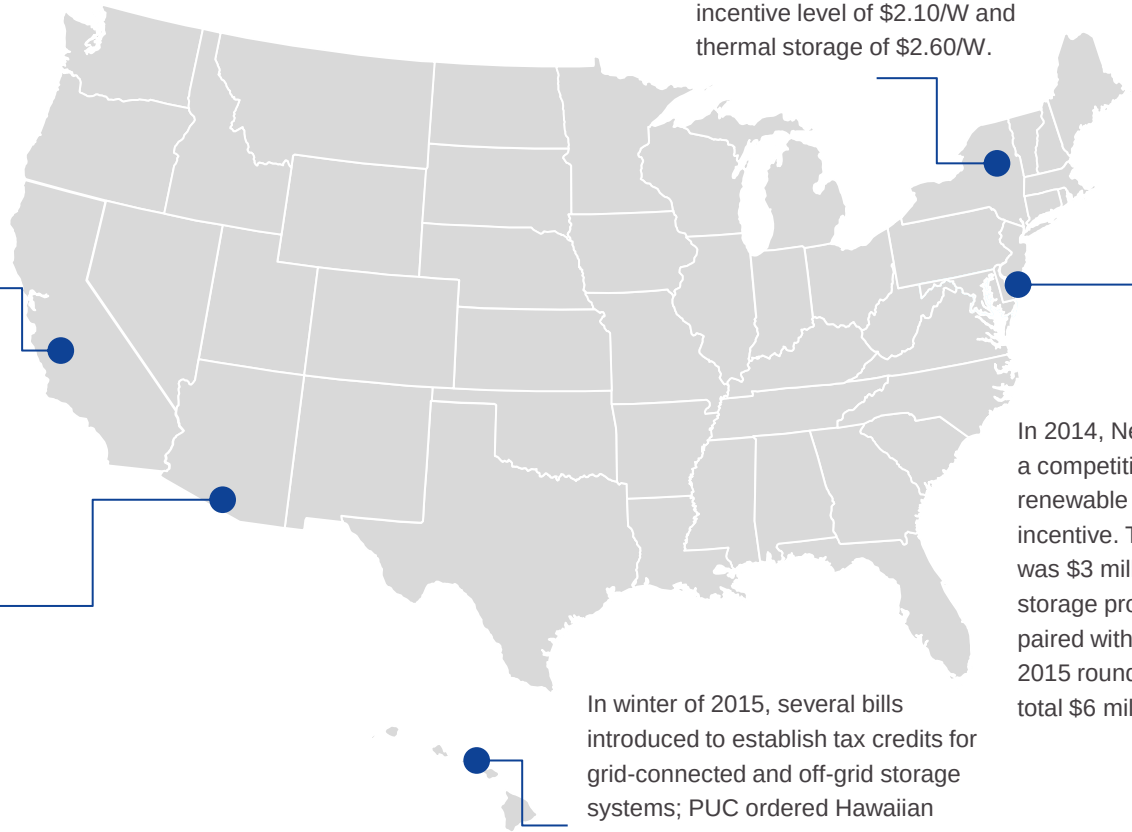
Behind-the-Meter Solar-Plus-Storage

Behind-the-Meter Incentive Programs and Pilots

U.S.: **DOE** $15 million funding behind-the-meter solar and storage integration

In 2014, Con Edison and NYSERDA initiated a Demand Management Program to achieve 125 MW of peak demand reduction in summer. Battery storage has a base incentive level of $2.10/W and thermal storage of $2.60/W.

California PUC added advanced energy storage as a qualified technology for the Self-Generation Incentive Program in 2009. 2015 base incentive level for energy storage is $1.46/W and is set to decrease by 10% annually.



APS 2 MW solar-plus-storage; $1 million rebates for pilot program, residential non-volumetric charges that could impact storage

In 2014, New Jersey BPU issued a competitive solicitation for a renewable electric storage incentive. The program budget was $3 million and awarded to 13 storage projects totaling 8.75 MW paired with renewable generation. 2015 round of funding will likely total $6 million.

In winter of 2015, several bills introduced to establish tax credits for grid-connected and off-grid storage systems; PUC ordered Hawaiian Electric to streamline interconnection requirements for customer-sited energy storage with solar. Stem has 1 MW pilot program underway.

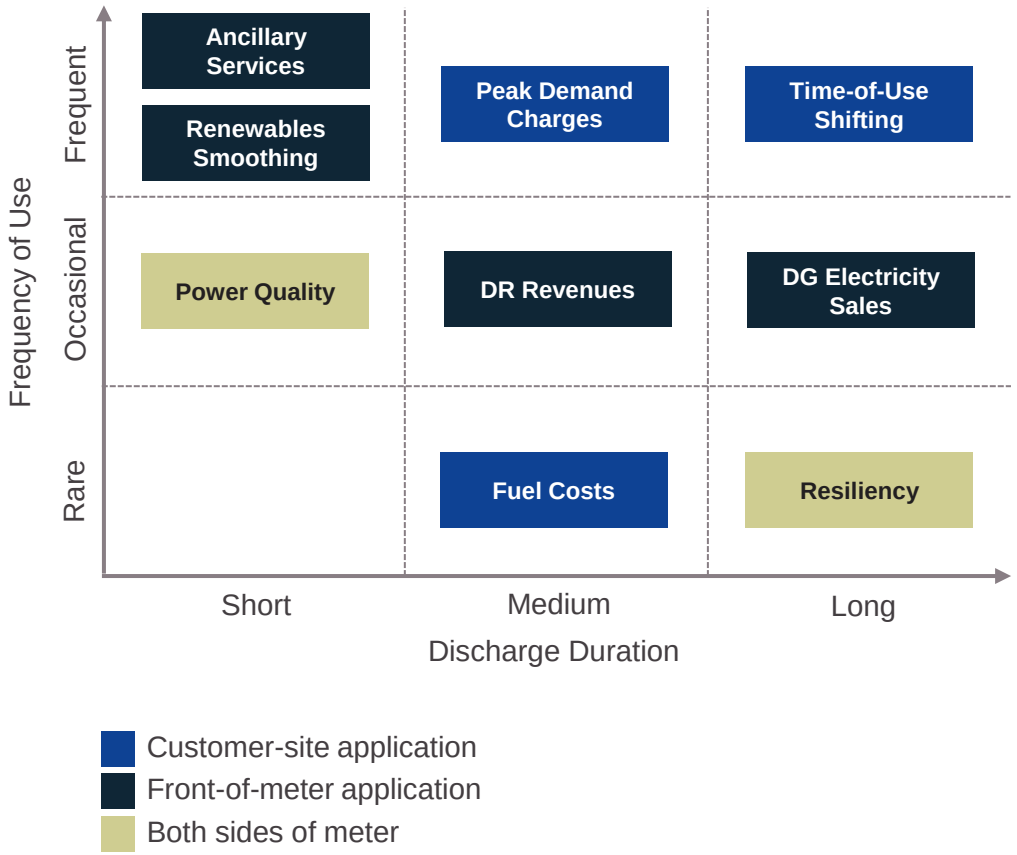
Source: GTM Research

Behind-the-Meter Incentive Programs and Pilots

Currently, five states (or utilities within these states) have incentive programs, specifically for stand-alone storage or solar-plus-storage projects. California's Self Generation Incentive Program (SGIP) is one of the largest such incentive programs and offers upfront or performance-based incentives for behind-the-meter storage systems. Most of these projects are coupled with solar (particularly in residential segment).

Hawaii, New Jersey and New York have are supporting solar-plus-storage projects through cost sharing and upfront incentives for commercial customers, with the intention of providing capacity, resiliency and grid stability benefits. Arizona Public Service in Arizona has proposed a 2 MW pilot program to study grid benefits of solar-plus-storage and explore non-volumetric rate tariff options for residential customers.

Solar-Plus-Storage Benefits Vary in Duration and Frequency



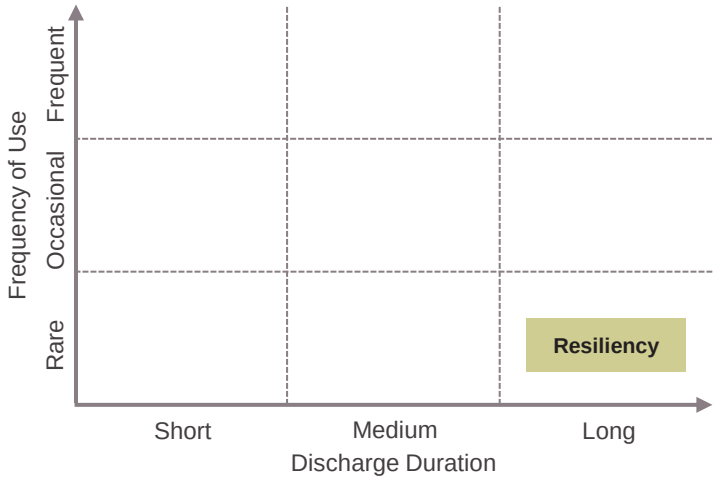
Source: GTM Research

Solar-plus-storage benefits vary in three ways – frequency of use, discharge duration and key beneficiary. Generally speaking, benefits that have more frequent use improve the overall economics of the system. These benefits are not necessarily mutually exclusive, although there are limitations based on technology, availability of charge, frequency and timing of multiple applications.

Apart from the technical constraints, front-of-meter benefits have not been monetized, except in few markets on pilot scale. Market rules and policies are still evolving in reaction to distributed energy resources proliferation.

With improvements in technologies, market rules and policies, some of these value streams could be stacked and monetized across stakeholders.

Backup Use Case Lowest Economic Value, Unless Grid is Unreliable



Source: GTM Research

Backup has been one of the most common use cases for solar-plus-storage historically. This has been true for remote locations, and is still immensely important for regions with unreliable grid – in emerging countries
for instance.

In markets such as California, backup is an additional benefit to existing and new solar customers. However, in order for it to make economic sense as a stand-alone application, the consequence of inaction during power outages has to be sufficiently high. Customers that have critical equipment in their homes or C&I facilities could justify pairing storage with solar as a backup.

For industries with high labor costs and low labor productivity during outages, or businesses that rely on 24x7 electricity access (such as financial services or data centers), solar-plus-storage will have higher backup value. But even in such cases, natural gas generator sets have much lower upfront cost.

The only exception for backup as a primary use case can be made when there is a public good value for establishing resilient load centers. There has been a recent impetus in geographies that have frequent weather events causing power outages, such as Northeast and Southeast states. Typical sites for solar-plus-storage installations have been schools, hospitals, municipal and government buildings. Even in these cases, the projects have been made possible due to state and federal incentives.

There have been few pilot and incentive programs in following states for solar-plus-storage deployments:

Florida: Florida has implemented the E-Shelter program that included installation of solar-plus-storage systems in 115 schools through the federal ARRA program.

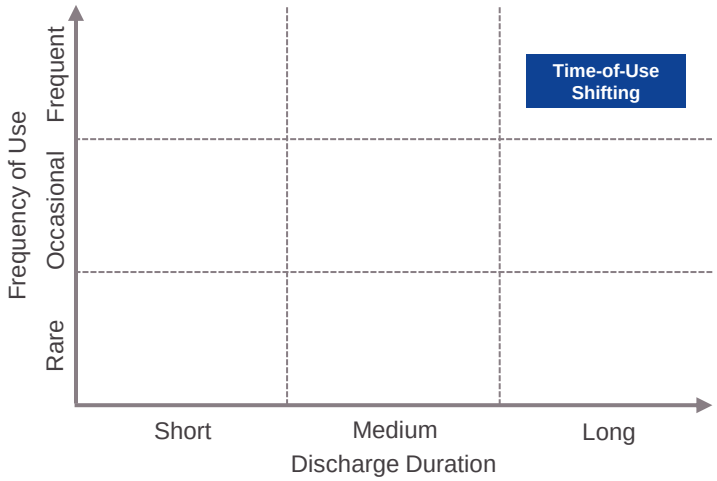
Massachusetts: Massachusetts is in the process of deploying six solar-plus-storage systems as part of its Community Energy Resiliency initiative.

New Jersey: New Jersey has established an Energy Resiliency Bank (ERB) to support resiliency projects. One of the first investments under this broader initiative were 13 solar-plus-storage systems approved for a total of $2.9 million funding.

Behind-the-Meter Solar-Plus-Storage

Residential Segment

Load Shifting for Residential Customers Under Time-of-Use and NEM Reforms



Source: GTM Research

Load shifting (or Time-of-Use Shifting) is an emerging use case for residential customers.

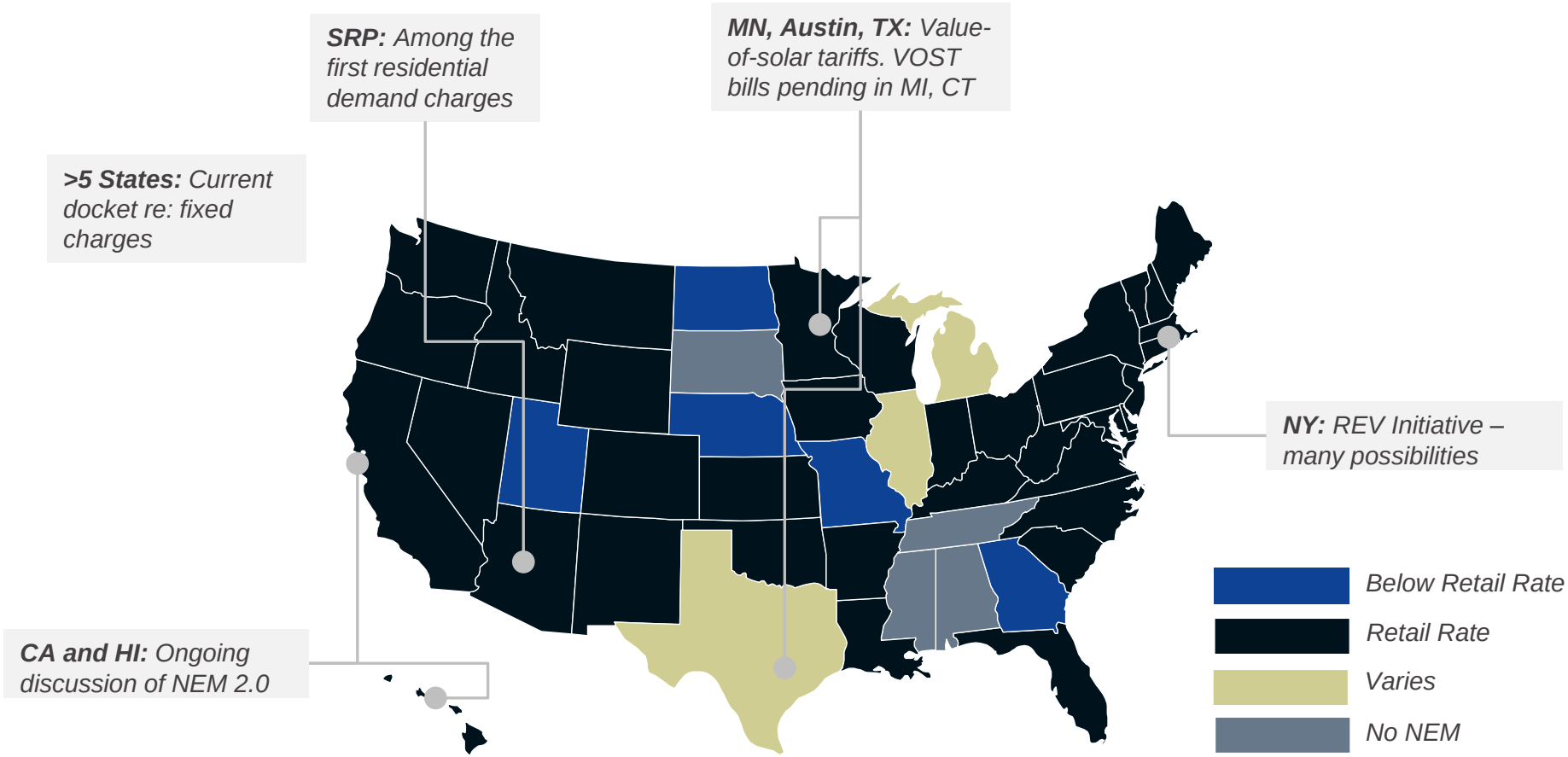
Time-of-Use Tariff: Traditionally, most residential retail rates are flat and only have volumetric energy charge (in addition to certain riders and meter charges). In other words, the value of electricity consumed at peak demand hours is exactly the same as that at off-peak hours. There are a growing number of utilities that are moving away from flat retail tariffs for residential customers. This will result in higher retail prices during peak hours (typically morning and early evenings).

Time-dependent retail rates open up the value of shifting end-customer's excess solar generation from middle of day, when residential electricity consumption in an average household is low, to evening peak hours. However, just the existence of time-dependent rates does not guarantee improved economics of solar-plus-storage. The differential between peak and off-peak rate has to be sufficiently high, at least higher than levelized cost of electricity from the solar-plus-storage system.

Net Energy Metering: Residential solar penetration has increased in states that offer net energy metering incentives. Net energy metering (NEM) is a policy structure that allows end-customer to receive credit for excess solar generation by selling it back to the utility. Forty three states in the U.S. have net energy metering laws, with over 30 states net energy metering at full retail rate. Many utilities (and some other stakeholders) have argued that full retail NEM does not account for distribution infrastructure that solar end-customers still benefit from, without paying for it. Several states are now discussing alternatives to full retail NEM. With net energy metering, there is less need for on-site storage to maximize the benefits to the customer of a solar system.

NEM rate reforms and time-of-use tariffs can increase value of self-consuming solar generation by shifting it using energy storage. We will look at a couple of real and hypothetical cases with time-of-use tariffs and/or below retail rate net energy metering options to illustrate the altered economics of solar with and without storage.

Distributed Generation Compensation Is Getting More Complex



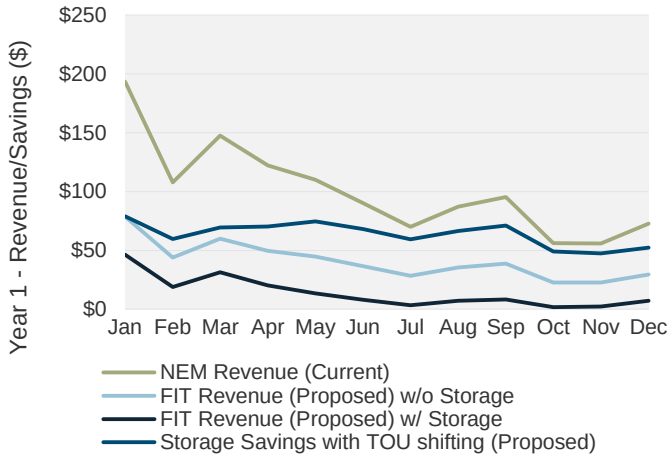
Source: GTM Research

Over 45 states (and Washington D.C.) have net energy metering laws. Out of those, over 30 states have net energy metering at full retail rate. But this widespread support for retail rate NEM is on attack in at least 20 states, where alternatives to retail rate NEM proposals have been discussed and in a few instances approved. Most common NEM replacement tariffs offered have been below retail rates, in some instances as low as wholesale rates.

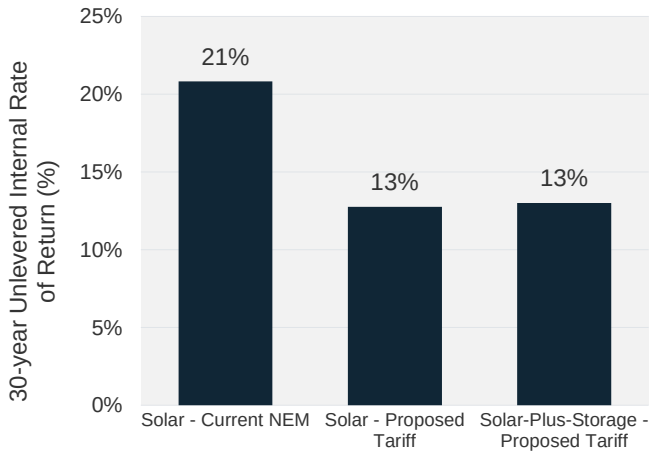
Minnesota and Austin (Texas) have implemented value-of-solar tariffs (which in theory could price the value of solar even higher than retail rate). One of the first such reform in the country was recently approved by Salt River Project, a public utility in Arizona. It announced demand charges of up to $34.19/kW to on residential customers, similar to commercial and industrial customers.

Storage Can Improve Residential Solar Economics in Lower Export Tariff Scenario - Hawaiian Electric Company

First Year Revenue/Savings - Excess Solar Generation



End-Customer Economics - Lower Export Tariff in Hawaii



Source: GTM Research

In response to the Hawaii Public Utilities Commission proceeding to investigate distributed energy resource (DER) policies, Hawaiian Electric (HECO) has proposed an interconnection plan that includes changes in net energy metering rates and a fixed charge for all distributed generation (DG) customers.

As part of the proposed tariff structure, there will be two customer options. One will restrict solar export (Self-Supply), while the other option will allow for export at a much lower “reasonable wholesale rate” (Grid-Supply option). This lower export tariff is estimated at $0.16/kWh. A direct result of such a rate reform will be a steep reduction in economics of a solar customer. We estimate that for a 8 kW rooftop solar system, year one excess solar revenue will drop from $1,208 to $491. Adding storage in such situation will improve the economics for self-consumption and result in an improved total revenue (and savings) to $935 in year one. Even with this improved savings vs. solar in the proposed rate regime, storage-related upfront and O&M costs bring the overall system economics to about the same.

Key Inputs			
Customer Type	Large Residential	Solar System Size	8 kW
Utility	Hawaiian Electric Company	Storage System Size	2.2 kW/7 kWh
Tariff Structure	Schedule TOU-R	Solar System Cost	$3.11/W
Assumed Export Tariff	$0.16/kWh	Energy Storage System Cost	$646/kWh
Year of Installation	2018	Solar Installed Cost	$18,667
Retail Rate Escalator	1.5%	Solar-Plus-Storage Installed Cost	$29,413
Cost of Equity	10%	State Incentive	0

Key Findings: Residential Segment

Load shifting use case for solar-plus-storage is uneconomical in markets with net energy metering at full retail rate. Flat electricity retail tariffs without time-of-use rates also eliminate economic value of storing excess solar generation for later use.

Some alternative approaches to net energy metering involve reduction in the value of solar export to at or close to wholesale tariffs, value of solar tariff, or inclusion of demand charges. Such reforms would inherently improve the economics of solar-plus-storage.

Time-of-use shifting can offer a valuable use case in markets such as California and Hawaii, as the public utility commissions (PUCs) in both states are discussing potential changes to net energy metering policies.

In the Hawaii case study, time-of-use shifting by adding storage to residential solar under the Hawaiian Electric proposed NEM replacement scenario results in reduced economic returns. This could change if the Hawaii legislature enacts a storage investment tax credit (which is under discussion).

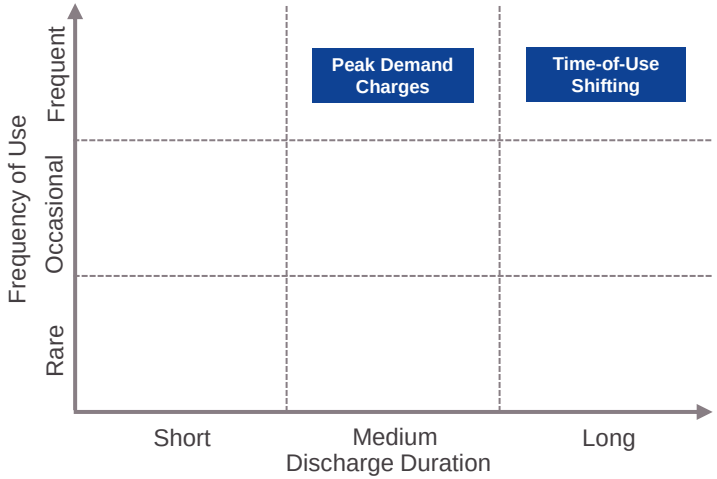
If Hawaiian utilities require 100% Self Supply as a requirement to interconnect, will necessitate addition of storage to solar, even at poorer economics.

Storage may be necessary to enable solar if value of solar is reduced in changes to net metering structure, but solar-plus-storage may still only be viable for a limited set of customers.

Behind-the-Meter Solar-Plus-Storage

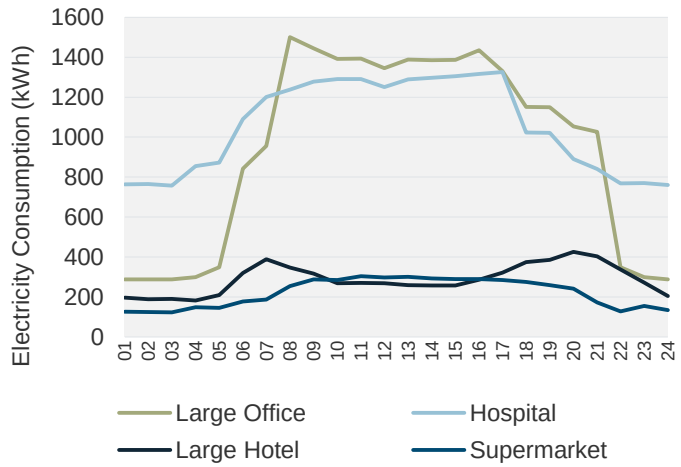
Non-Residential Segment

Commercial Solar-Plus-Storage Value Proposition is Clear - Demand Charge Reduction



Source: GTM Research

Hourly Load Profile – August 1st



Source: Open EI

A big portion of commercial and industrial (C&I) electricity customers are on time-of-use tariffs. Hence TOU shifting is an applicable value stream for this segment. However, the bigger driver of solar-plus-storage deployments in the C&I space is the potential of demand charge reduction offered by pairing solar with storage.

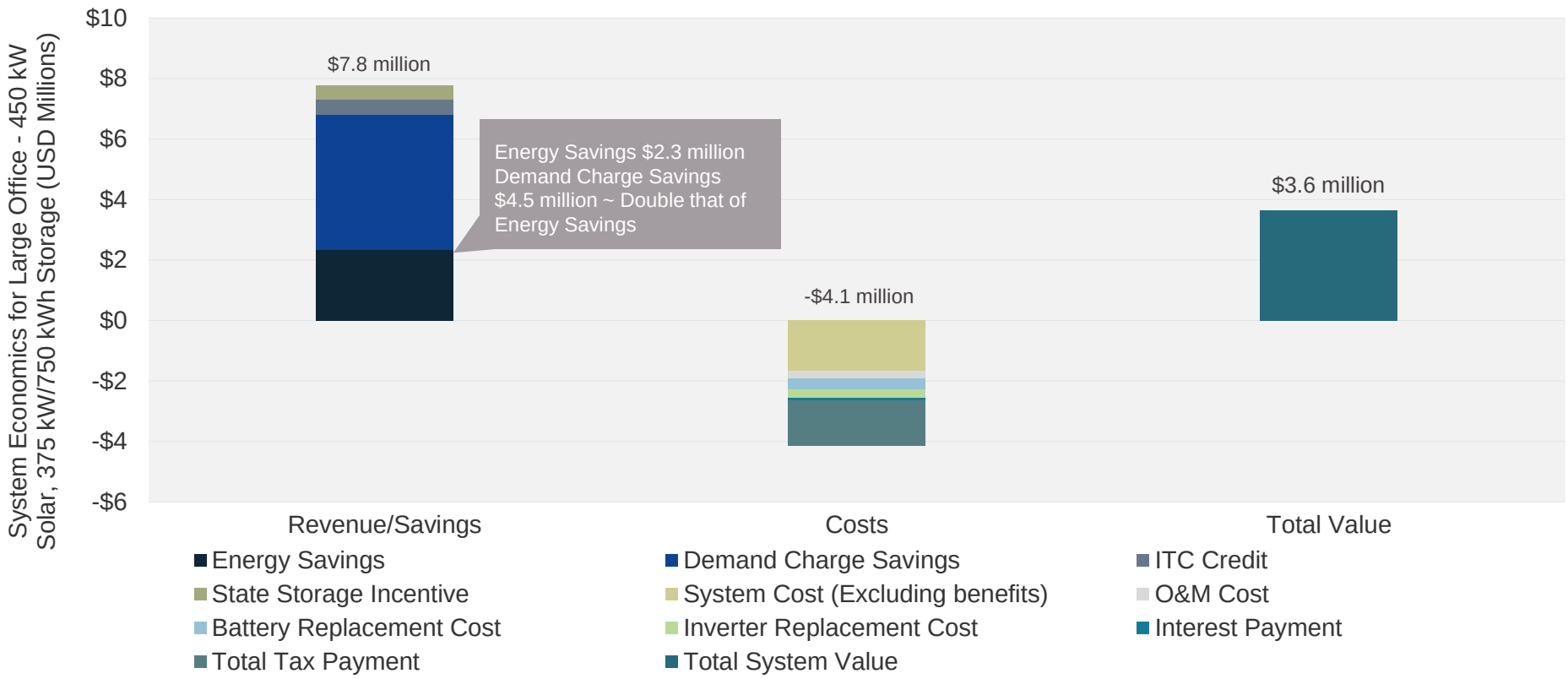
C&I tariffs, including demand charges, vary across utilities and territories. Additionally, the extent of demand charges, which are based on 15 or 30 minute intervals, depend on customer's load profile. As a thumb rule, demand charges can contribute anywhere from 20% to 50% of a C&I customer's electricity bill.

Solar cannot reliably reduce an end-customer's demand charges, due to its intermittent nature, and potential mismatch between timing of peak demand and generation. Pairing storage with solar enables reduction of peak demand.

The extent of demand charge reduction possible with storage depends on several factors, mainly tariff structures and customers' load profiles. Understanding of customer's load profile is critical in estimating the total demand reduction potential and overall system economics. For instance, within the same geography (Southern California), four archetypical C&I customer types have very different load profiles, with different number of peaks through the day. Large office hits two highest peaks during 8 am and 9 am hours, while the hospital hits them at 4 pm and 5 pm, large hotel at 8 pm and 9 pm, and supermarket at 11 am and 1 pm. If these customers were in the same utility territory (Southern California Edison), hospital's peak would fall during SCE's peak hours, while the office and hotel would be during partial peak hours, and one of supermarket's peak will be during utility's peak hour, and the other during partial peak.

These differences will impact the economics of solar-plus-storage for demand charge reduction, and influence the adoption of solar-plus-storage across customer types.

Lifetime Commercial Solar-Plus-Storage System Economics

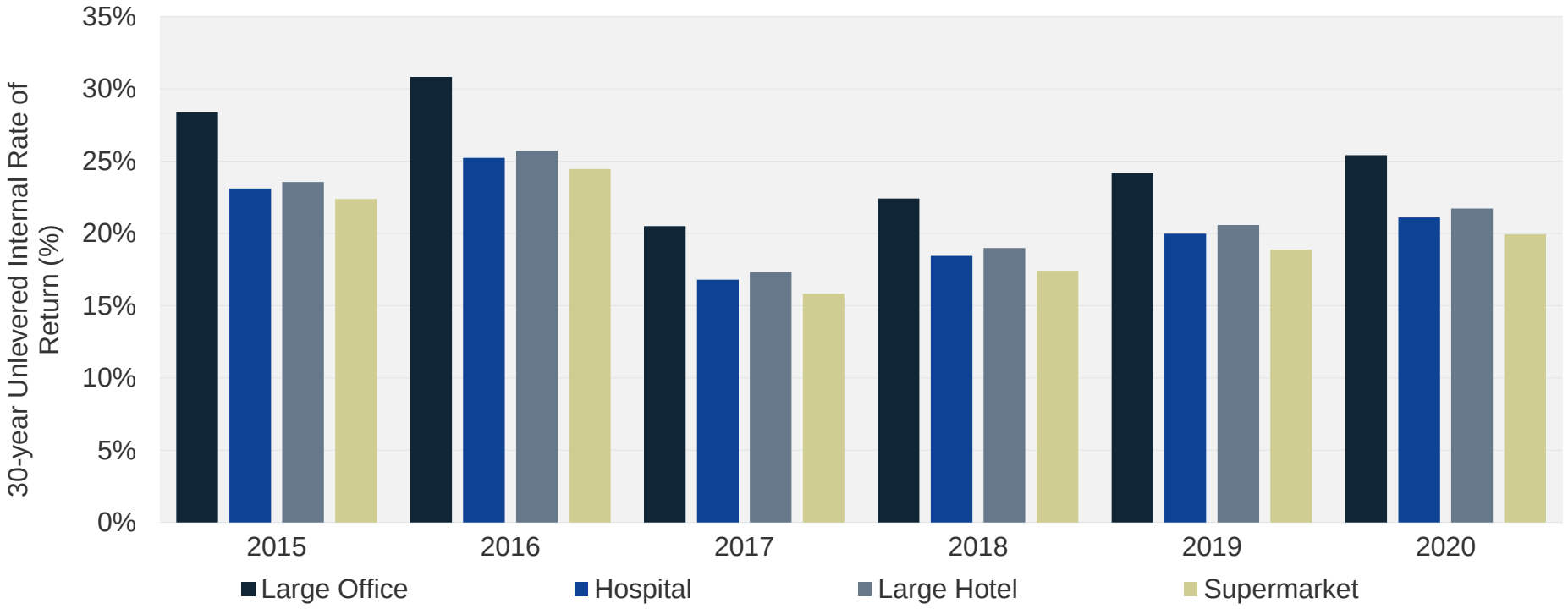


Source: GTM Research

A 450 kW solar paired with 375 kW/750 kWh storage system at the large office customer type in Southern California Edison has a lifetime system value of $3.6 million. The biggest revenue component in that case was from demand charge savings, while the system cost was the largest cost component at $1.7 million (excluding incentive and tax credit).

Key assumptions: Year of installation = 2015, Solar system cost = $2.20/W, Storage system cost = $1,055/kWh, Cost of equity = 15%, Cost of debt = 4%, Term of loan = 10 years, Debt-to-equity = 43%, Storage incentive = $1.46/W, Investment tax credit = 30%.

Demand Charge Reduction Offers Positive Returns for Customers in Southern California Edison



Source: GTM Research

Solar-plus-storage economics for the four customer types are largely positive with over 20% unlevered internal rate of returns in 2015 and 2016 (over 30 year project-life). Drop in Investment Tax Credits (ITC) from 30% to 10% reduce the returns to high teens for three out of four customer type in 2017. Dropping solar and energy storage costs and rising electricity rates improve the returns from 2017 onward to reach over 20% by 2020.

We did not take into account any potential changes in net energy metering rates, as we did for residential customers in pages 15 and 16. It should be emphasized that changes to net energy metering rules that lower the value of solar export would have positive impact on time-of-use shifting even for commercial customers.

Key Findings: Non-Residential Segment

Demand charge management offers a distinct value proposition to commercial customers, particularly in markets with high demand charges (industry used thumb-rule of $20/kW and above).

After the value of demand charge tariff, end-customer's load profile is the single most important factor for determining the potential of solar-plus-storage.

Generally speaking, customer profiles with spikier load requirements (such as use of heavy HVAC, elevators, motors, etc.) that coincide with peak demand periods are good candidates for higher demand charge reduction potential.

In addition to demand charge reduction, commercial segment also benefits from time-of-use shifting as majority of commercial tariffs have time-of-use components.

Net energy metering reforms will provide the same incentives for pairing storage with solar as in the residential segment. In presented case studies, we did not assume any net energy metering reforms, which will likely improve the economics even further for commercial customers.

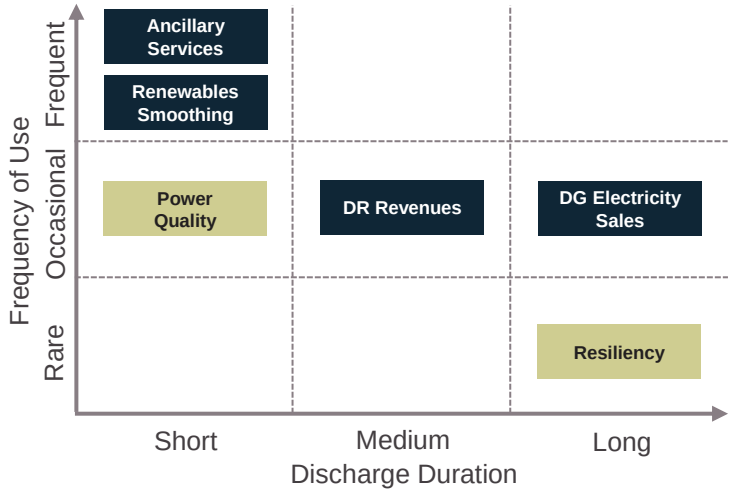
Solar-plus-storage economics for the four customer types in Southern California Edison are largely positive with over 20% unlevered internal rate of returns in 2015 and 2016. Drop in Investment Tax Credits (ITC) from 30% to 10% reduce the returns to high teens for three out of four customer type in 2017, before coming back up to over 20% by 2020.

Behind-the-Meter Solar-Plus-Storage

Grid Services

Grid Services - Untapped Opportunity for Behind-the-Meter Solar-Plus-Storage

Solar-Plus-Storage Value Streams – Front-of-Meter



Source: GTM Research

Behind-the-meter solar-plus-storage can provide benefits not just to end-customers, but also benefits that extend to the connected grid, both locally as well as at the system level. We broadly call these benefits as grid services and include ancillary services, capacity benefits, demand side management, electricity sales as virtual power plants, and resiliency.

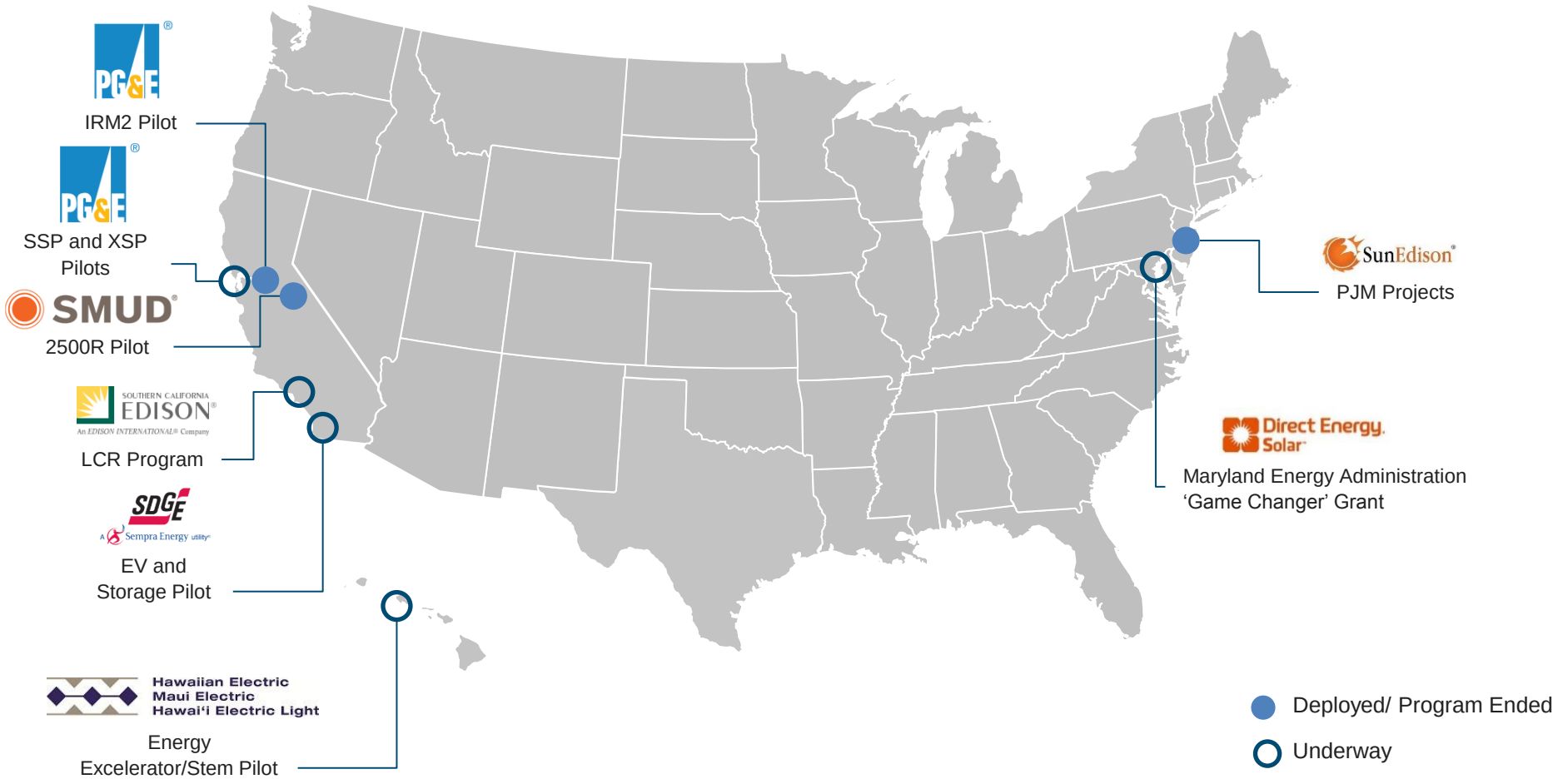
Existing market rules and state policies restrict the use of behind-the-meter resources for grid services. Barring a few state pilot programs and PJM's inclusion of behind-the-meter resources for fast frequency regulation, these opportunities are mostly theoretical at this point. However, as distributed energy resources grow in multiple markets, the regulatory, technological and business model bottlenecks will likely get resolved and increase the participation of behind-the-meter solar-plus-storage resources for grid services.

States such as California, Hawaii, New York and Texas have already seen pilot programs that are helping inform market rules and technical requirements.

California has already tested several pilot programs across multiple utilities, and Southern California Edison last year announced its plans to procure over 150 MW of behind-the-meter storage, and 50 MW of behind-the-meter solar toward its Local Capacity Requirement procurement.

New York through the Reforming the Energy Vision (REV) Initiative is at the forefront of using distributed energy resources for grid participation.

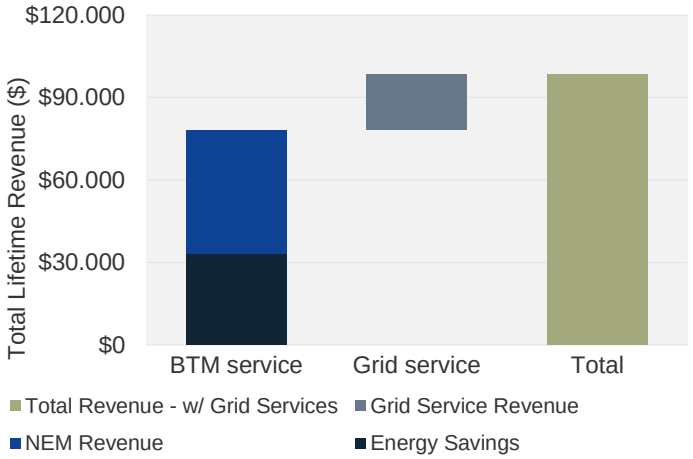
Behind-the-Meter Solar-Plus-Storage Resources for Grid Services



Source: GTM Research

Stacking Grid Services to Customer Benefits Can Considerably Improve Economics

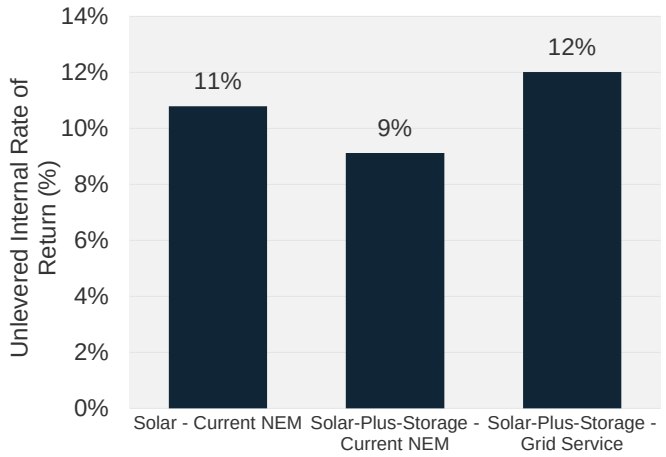
Lifetime Revenue - Grid Service



Grid services could be monetized through payments by utilities or from ISO/RTO for wholesale market participation. Utility agreements carry lower volatility versus wholesale market merchant model. Under current market structures, individual assets are not large enough to qualify for grid services (even if behind-the-meter resources were allowed to participate), hence size of aggregated portfolios matter more than individual projects.

In the adjoining case, we looked at the economics of a 8 kW solar system paired with 3 kW/6.5kWh storage system, deployed at a large residential customers in Southern California Edison in 2018. At a grid service payment of $15/kW/month, and without assuming lowering of net energy metering tariff, the resulting returns (12% 30-year unlevered IRR) are even higher than a solar-only system (11% 30-year unlevered IRR).

End-Customer Economics - Grid Services in California



Source: GTM Research

Key Inputs			
Customer Type	Large Residential	Solar System Size	8 kW
Utility	Southern California Edison	Storage System Size	3 kW/6.5 kWh
Tariff Structure	Time-of-Use, B	Solar System Cost	$2.59/W
Assumed Grid Service Payment	$15/kW/month	Energy Storage System Cost	$1,165/kWh
Year of Installation	2018	Solar Installed Cost	$20,746
Retail Rate Escalator	1.5%	Solar-Plus-Storage Installed Cost	$22,894
Cost of Equity	10%	State Incentive	$1.06/W

Utility-Scale Solar-Plus-Storage

Utility-Scale Solar-Plus-Storage Examples

Location	Project Size	Status	Involved Parties
Albuquerque, NM	500 kW storage on 500 kW solar	Completed	Ecoult and Schott Solar (Vendors), PNM (Customer/Partner)
Cedartown, GA	1 MW storage on 1 MW solar farm	Under Construction	Washington Gas Energy Systems (Vendor), Southern Company and EPRI (Customers/Partners)
Coatesville, PA	Storage on 9.1 MW solar farm	Under construction	Axion Power (Vendor), Keares Electrical (Customer/Partner)
Hanford, CA	4 MW storage	Under Review	PG&E
Helm, CA	4 MW storage	Under Review	PG&E
Huron, CA	4 MW storage	Under Review	PG&E
Kauai, HI	6 MW storage on 12 MW solar farm	Undergoing Commissioning	Saft (Vendor), KIUC and REC Solar (Customers/Partners)
Koloa, Kauai, HI	1.5 MW storage on 3 MW solar farm	Completed	Younicos (Vendor), KIUC (Customer/Partner)
Lanai, HI	1.125 MW storage on 1.5 MW solar farm	Completed	Younicos (Vendor), Lanai Sustainability Research (Customer/Partner)
New Orleans, LA	Storage paired with 1 MW solar system	Under Review	Entergy
Oahu, HI	1 MW storage	Completed	Altaimano (Vendor), Hawaii Natural Energy Institute (Customer/Partner)
Rutland, VT	4 MW of battery storage near 2 MW solar farm	Undergoing Commissioning	groSolar (Developer), Green Mountain Power (Customer/Partner)

Source: GTM Research

Key Market Drivers

Mandates or Utility RFPs

The utility segment in the U.S., particularly in California will be driven by energy storage mandates. In recent months, several utilities have issued RFPs to deploy storage at new or existing solar farms. The main uses of these systems will be to provide renewable integration as well a firmer solar output. For instance, California IOU, Pacific Gas & Electric (PG&E) has included procurement of up to 12 MW of storage at three PG&E solar facilities. Hawaii utility, Kauai Island Utility Cooperative, is completing a 6 MW storage project connected with a 12 MW of solar farm in Anahola. The project will provide capacity firming, frequency regulation, and time-shifting benefits.

Capacity Needs

Wholesale markets in CAISO, ERCOT and PJM, as well as utilities, are looking at market rules to enable non traditional resources to provide capacity needs. New York is looking at similar benefits at distribution grid through the REV initiative. FERC recently approved PJM's Capacity Performance Program that will enable solar-plus-storage systems to receive capacity performance (in addition to standard participation payments) for the ability of these systems to provide accurate and efficient capacity. Southern California Edison awarded 100.5 MW of utility-scale storage toward its LCR procurement. While these are stand-alone storage projects, it indicates the potential of solar-plus-storage projects to provide similar benefits in the future for other utility local capacity programs.

PPA or Auction Mechanisms

There haven't been any publically announced projects, but there are indications that utilities are increasingly expecting utility-scale solar project developers to bid not only as non-dispatchable resource, but also as a dispatchable generation asset. Dispatchability of solar projects can be met with addition of storage. This could result in adoption of storage in different ways: higher PPA value for firm solar output, or preference to solar-plus-storage applications ahead of stand-alone solar.

Key Market Drivers

Technical Requirements

Remote markets such as Hawaii and Puerto Rico have considered or implemented technical requirements as part of interconnection process. Puerto Rico's Minimum Technical Requirements (MTR) is one of the most direct pushes for utility-scale solar-plus-storage. However, due to the Puerto Rico Electric Power Authority's (PREPA's) recent struggles with staying as a going concern have delayed the implementation and made financing of such projects extremely difficult. Hawaii has imposed strict ramping requirement on wind projects that saw a series of wind-plus-storage projects in 2011-2013.

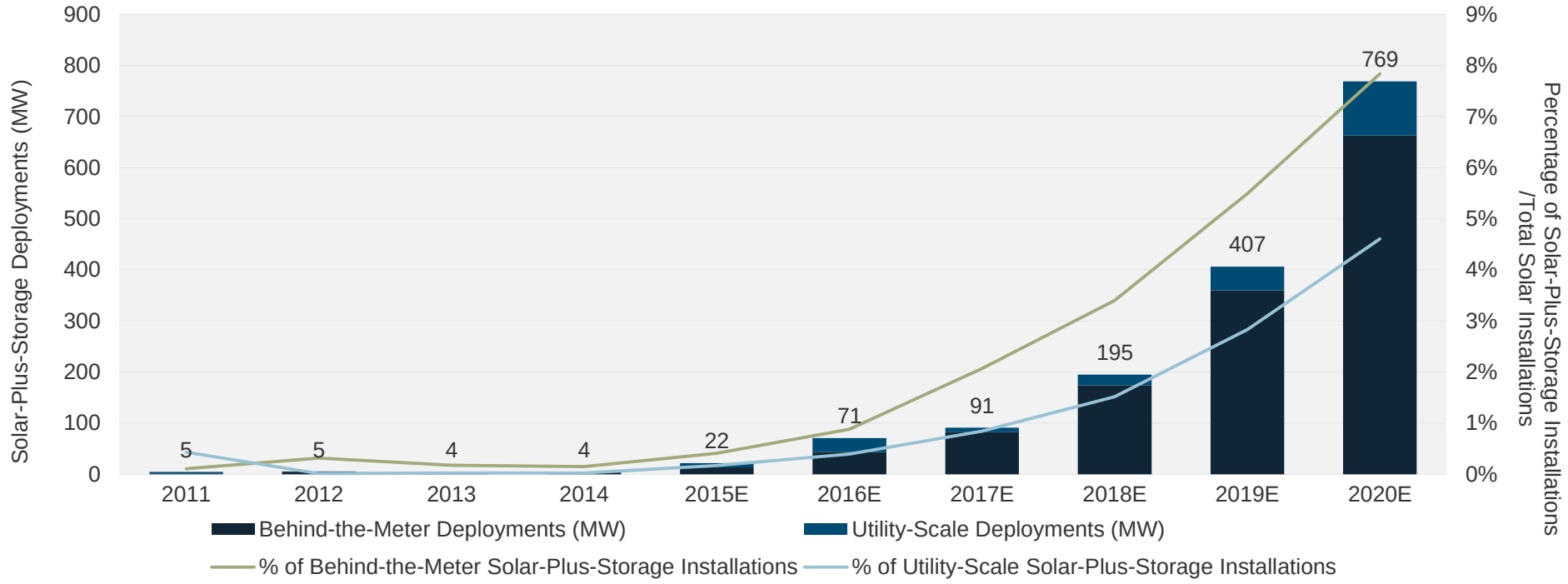
Curios Case of Co-Location

Even in instances where storage cannot improve or enable new use cases for utility-scale solar, the industry has been exploring co-locating solar and storage projects to tap into project development, construction and operation synergies, without necessarily having the two technologies interact with each other. Co-location can reduce installation costs such as siting, interconnection, and use of other resources (labor, logistics, etc.). The rise of utility-scale storage projects with other generation assets has been fairly common, and utility-scale solar is seeing a similar adoption as solar and storage costs keep coming down.

Solar-Plus-Storage Market Outlook

California and the U.S.

Annual U.S. Solar-Plus-Storage Market to Reach 769 MW by 2020



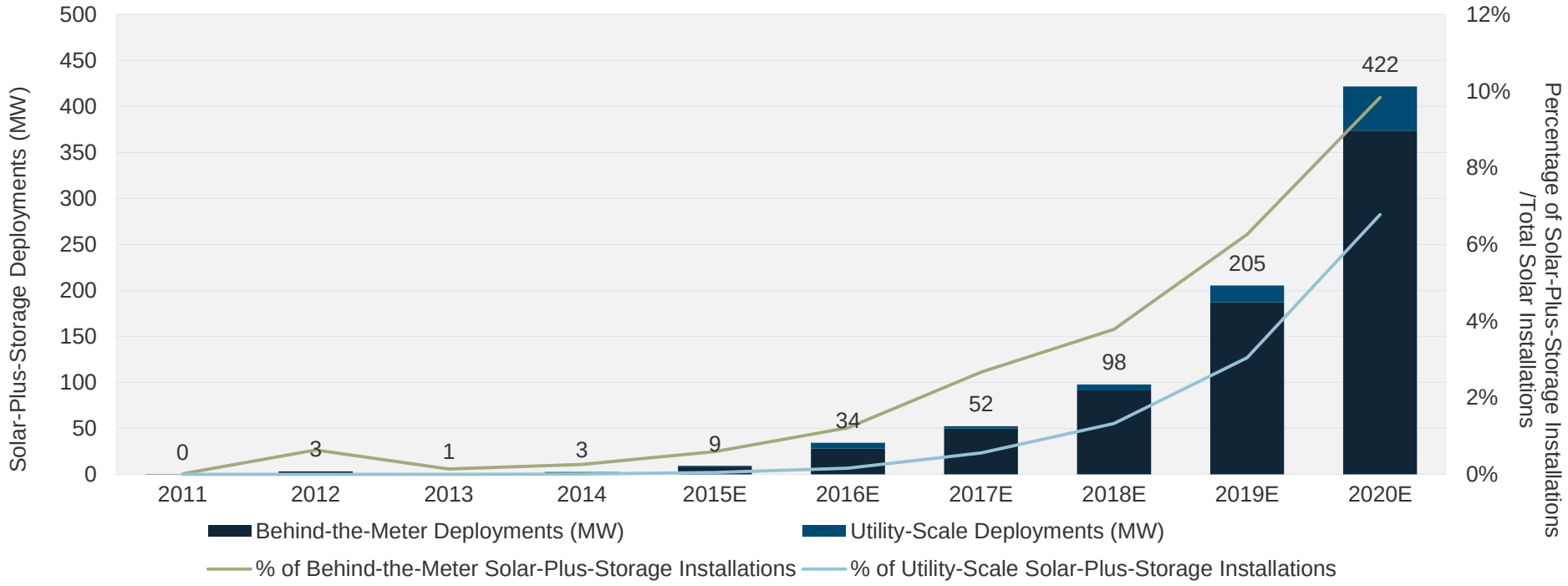
Source: GTM Research

The U.S. solar-plus-storage market is very nascent today; less than 0.1 percent of solar installations were paired with storage in 2014.

But behind-the-meter solar-plus-storage is set to quadruple in 2015 to 14 MW and triple year-over-year in 2016 to 44 MW. By 2020, behind-the-meter solar-plus-storage will cross 660 MW. Behind-the-meter penetration in terms of number of solar installations that are combined with storage will grow from 0.2% in 2014 to 0.4% in 2015 and reaching 8% in 2020.

Utility-scale solar-plus-storage is set to grow ninefold in 2015 to 8 MW and triple year-over-year in 2016 to 27 MW. By 2020, utility-scale solar-plus-storage will cross 100 MW. Utility-scale penetration in terms of number of solar installations that are combined with storage will grow from 0.03% in 2014 to 0.2% in 2015 and reaching 5% in 2020.

Annual California Solar-Plus-Storage Market to Reach 422 MW by 2020



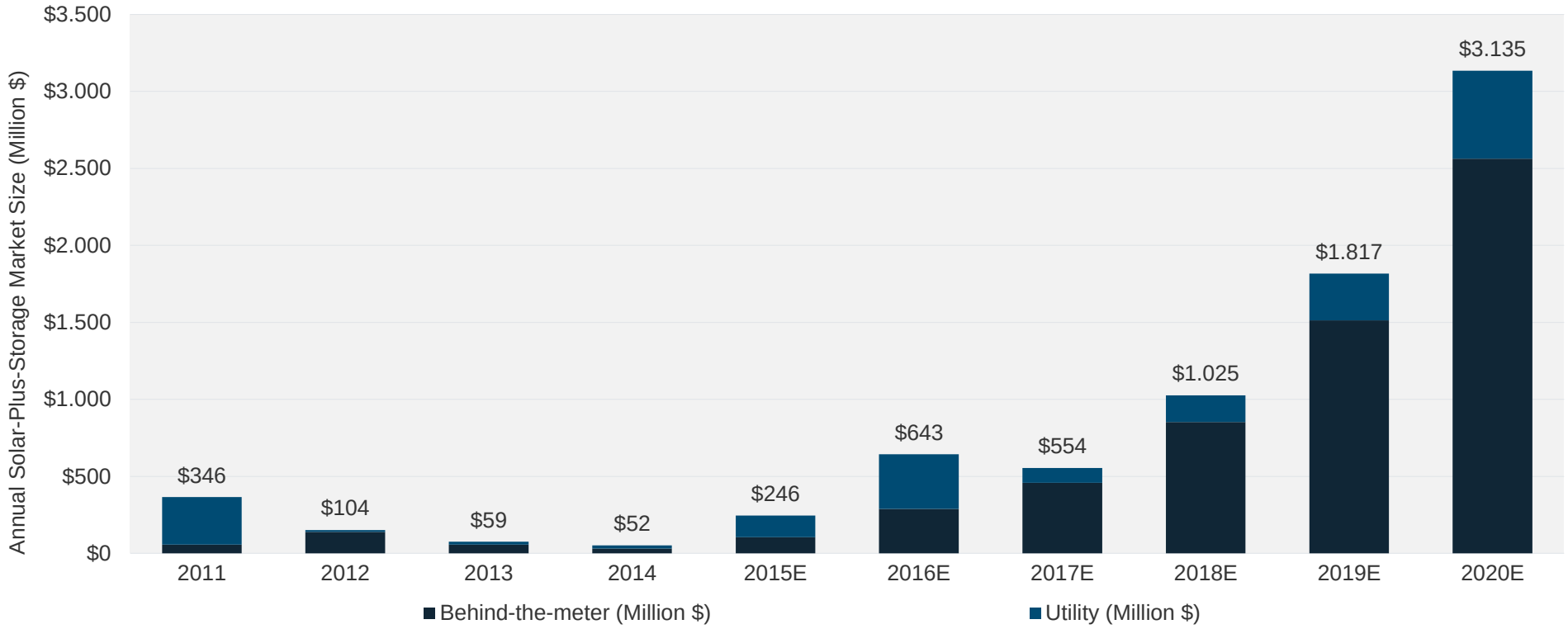
Source: GTM Research

California solar-plus-storage market is relatively further along, particularly in behind-the-meter segments. In 2014, 3 MW of solar-plus-storage projects came online, accounting for 61% of total U.S. solar-plus-storage market.

Behind-the-meter solar-plus-storage in California is set to quadruple in 2015 to 8 MW and triple year-over-year in 2016 to 28 MW. By 2020, behind-the-meter solar-plus-storage will cross 370 MW. Behind-the-meter penetration in terms of number of solar installations that are combined with storage will grow from 0.3% in 2014 to 0.6% in 2015 and reaching 10% in 2020.

Utility-scale solar-plus-storage in California will be slower to grow versus behind-the-meter segments. By 2020, utility-scale solar-plus-storage will be almost 50 MW, representing 55% of total U.S. utility-scale market.

Annual U.S. Solar-Plus-Storage Market to Cross $3.1 Billion by 2020



Source: GTM Research

The U.S. solar-plus-storage market (in USD) shrunk by 12% in 2014, even though the deployments increased by 8%. This downward trend is expected to change in 2015 and 2016, when the market will grow to $246 million in 2015 and $643 million in 2016. By 2020, the annual U.S. solar-plus-storage market will be $3.1 billion.

The utility segment will be the largest till 2016, due to the size of the associated solar PV projects. The utility market dips in 2017, partly due to expected reduction of investment tax credits.

Behind-the-meter solar-plus-storage segments will continue to grow and starting 2017 will account for over 50% of the market each year. By 2020, behind-the-meter market will be $2.6 million (82% of total market).