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Energy Storage Financing for Social Equity

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Abstract

Energy storage technologies are uniquely qualified to help energy projects with a social equity component achieve better financing options while providing the needed benefits for the community. Because of their flexible operational nature, energy storage systems are often used when targeting multiple applications. Project financing is typically focused only on explicit financial returns on investment for clearly defined applications such as peak shaving or onsite renewable generation. However, the energy industry commonly uses non-financial performance metrics such as reliability to determine both qualification for, and success of, project development. The growth of environmental, social, and governance (ESG) metrics for such issues as energy independence, air quality, job creation, etc. is a similar effort as it highlights other non-financial issues important to the community. By developing metrics for these ESG goals, a blended goal setting for energy projects utilizing energy storage systems can be developed. As financing groups are increasingly taking ESG metrics into account for project funding decision making, this raises the opportunity for such projects to be funded based on more than just direct financial returns.

Summary

Addressing social equity challenges with energy storage assets can make the financing of social equity-oriented projects easier. This can come about by elevating the capability of the combined system to deliver the perceived value of the system's capability, incorporating both financial and non-financial targeted benefits. Leveraging the value of the non-financial targets of the project enabled by energy storage will be the key to successful project financing.

The ability of energy storage systems to improve social equity-oriented projects is rising as the technical, economic, and regulatory aspects of utilizing energy storage systems improve. Energy storage project development has been more complicated than other types of electric power project development. There are multiple technology types with a variety of physical scale, deployment requirements, and operating capabilities. Costs of these technologies have declined for a number of years improving the outlook for their use, but external supply chain pressure has reversed that trend recently and highlighted the complex nature of construction and commissioning. Finally, the regulatory environment is still evolving, producing a changing landscape of market rules that vary by application and regional difference for the "same" service. Since project financing follows the complexity of the technology and market, it can be understood that financing projects with energy storage assets remains a challenge, but one which is improving dramatically with increasing support. Energy storage assets provide added flexibility and functionality to projects, and as experience is proving out this capability, their value is increasing markedly.

Financing social equity-oriented projects will continue to face challenges when electricity services are only valued against the cost of service from wholesale power markets. However, disadvantaged communities typically experience poorer power quality because the economic density of service is difficult for utilities to provide the increased investment required based solely on economic reasons. For this reason, governmental incentives have existed specifically to provide these communities with a level of service provided to other areas. Within this framework, it can be seen that utilizing energy storage is actually an extremely cost-effective decision in order to lower the customer's cost of services. Energy storage systems are multifunctional and are designed to leverage the capabilities of other assets on the power grid. Therefore, energy storage assets are a smart choice for improving the level of service targeted for disadvantaged communities targeted by local, state, and federal governments.

Financing any energy project is dependent upon the perceived risk of the investment. Too high of a risk, and there is no investment. Elevated risks may engender some investment, but possibly smaller than desired by the developer and at a higher interest rate. Therefore, successful project financing is based on reducing the project risk, including design, construction, and operation. Therefore, ensuring that the project has a viable corporate structure to efficiently manage all of the commercial and financial agreements is crucial. The project's financial model will then allow for a clear understanding of the project's financial position. Capital providers will also be keen to review the risk management strategies used to reduce the exposure of the facility in the event of a failure. Through all of this effort, the financial benefits of the project can be ascertained. Combined with the non-financial benefits desired by private and public groups, the project can be positioned to obtain sufficient capital to successfully develop and operate the project.

Social Equity & Project Financing

The generally assumed goal for energy storage project financing is the highest possible monetary return on investment; unfortunately, this overlooks some key issues:

First, it is not the project with the highest possible return, but the project with the highest possible *risk adjusted* return that is the most profitable to that particular investor; different developers and investors have unique risk tolerances and investment targets, and thus different expectations for financial return.

Secondly, getting a *potential* project to completion is the primary goal of project developers. Electric power industry project development is difficult, and project development in the energy storage market can be more challenging yet. Solar and wind project development markets have more successful deployments, and thus well-worn paths for the next developer to follow for project development and financing. Lacking such a bench of experience, social equity programs that provide financial and non-financial support (ease of permitting, etc.) for project development can be essential for getting a project funded and to completion.

Thirdly, the market does not discretely value all of the capabilities that an energy storage system can perform—therefore using their capabilities as part of a needed community goal provides more opportunities. The type of market activity and applications that the energy storage system performs will greatly impact the ability to recognize revenue for providing the service. Energy storage systems are very flexible and can perform a very wide range of market functions. Unfortunately, due to how the power grid was developed, not all of the valuable roles that energy storage can perform have an explicitly transparent monetary value for their services.

Finally, monetary returns are not the only way to measure the capital provider's required return on investment. Capital providers that invest in projects are being held to an increasing number of non-financial goals, requiring different sets of performance metrics to quantify these non-financial requirements. A growing framework to evaluate is referred to as the environmental, social, and governance (ESG) framework, using different key performance indicators to evaluate the worth of a project.

Sources of Capital for Project Financing

Unless purchased with cash, customers or project developers will need some type of project financing to obtain all of the necessary capital for an energy storage asset. As projects grow in scale and cost, the capital will not come from just one source, requiring the customer or project developer to stack or layer the different sources of capital until sufficient capital is raised.

Sources of capital include sponsor equity, tax equity, loans, leases, PACE (property assessed clean energy) financing, and on-bill payments. Each of these sources of capital has different risk tolerances.

Sponsor Equity: The project developers are the first source of capital for an energy storage project. This can be from themselves, or additional private equity investors can be brought into the project as part of a syndicate to fund the equity portion of the project. Additional sources of grant funding for the project are thus of extreme interest to the developer as it relieves them of finding that additional investment capital from third parties. Grants can provide a number of significant benefits to a project developer outside of the benefit of the cash value incentive. Many times, grants are incorporated into a program that will give the recipient access to additional support in the project development process, either private or government. Beyond cash, governmental agencies are able to provide tax breaks, which can be a typical method of targeting governmental support to specific groups or communities.

Tax Equity: In support of furthering the deployment of renewable energy projects, the U.S. Government developed an investment tax credit program where an investor would receive a tax credit for a percentage of the cost of a residential and/or commercial project. Because individual customers can rarely utilize this tax benefit fully, institutional investors provide equity financing for these projects in return for the investment tax credit. Tax equity investors are typically banks and insurance firms that both want the tax credits and see the typical yield of 6% to 8% as an attractive return.

Loans: As energy storage projects grow in scale and cost, project loans are needed for both the scale, and to provide capital at a lower cost. This capital is borrowed primarily against the potential revenue generation of the project, not simply the project's assets.

Three areas of debt can be important to energy storage project finance: construction, mezzanine, and project debt. Construction loans are short term loans used to cover the up-front cash outlays for a large energy storage project. Mezzanine financing is a debt instrument situated between bank lending and equity capital; it is senior to equity capital but subordinated to bank debt. As projects grow in scale, long-term project debt becomes the most important component of project financing. Project developers will attempt to obtain the maximum amount of long-term debt for larger projects, as it has the lowest cost, and can be made available in larger quantities. In return for providing this low-cost capital, lenders require assurance of the safety of their investment.

Lease: An equipment lease arrangement allows customers to access the benefits of a piece of equipment without all of the up-front costs of purchase. In this arrangement, the customer agrees to use the storage system for a specific period of time through paying periodic (generally monthly) payments to the lessor – the actual owner of the system. Since the lessor retains ownership of the energy storage system, it will retain the right to cancel the equipment lease agreement if the lessee does not conform its actions to the terms specified in the lease, such as stopping payments, or using the equipment for illegal activity.

PACE Financing: property assessed clean energy (PACE) financing programs allow residential, commercial, and industrial consumers to access lower cost capital for clean energy upgrades. These programs are funded by the state issuance of bonds, with the proceeds lent out to customers as loans. Consumers repay these loans through an increase in their property taxes.

On-Bill: On-bill repayment or financing allows electric utility customers to repay the cost of loans for energy upgrades at their location. This is similar to PACE financing, but the program is organized and funded through the local utility, although not necessarily by the utility. Since utility bills maintain a very low failure to pay rate, lenders are able to maintain low-cost lending programs targeting groups not able to normally pay for larger capital equipment up front. This type of program is also available to renters under certain circumstances, assuming approval is obtained from the owner of the property.

Commercial Agreements

The project will require a series of commercial agreements needed to ensure safe design, construction, and operation of the facility.

Engineering: Engineering firms help design what type, size, and how the energy storage facility will be used and integrated into the local power grid. For behind the meter systems, this will entail understanding the current customer's energy tariff and demand and how the energy storage system will affect the cost of service. For front of the meter systems, this will entail understanding current market dynamics, and how the system will interact with the power grid, including any necessary interconnection studies.

Environmental: Adhering to corresponding local and state environmental regulations is a requirement that project developers must take seriously. The degree of focus on this aspect will be dependent upon the technology choice of the energy storage system. For example, lithium-ion systems will need to have contingencies in the event of a fire, whereas flow-batteries may have a possible spill of the system's electrolyte as the main concern. Depending on the scale and location, the facility may or may not require a full environmental impact study.

EPC: Engineering, procurement, and construction contracts ensure the safe installation of the facility, and preparation for the unit to be commissioned and ready for operation. Critical in this portion will be adherence to all applicable electrical codes and standards and coordination with the requisite Authorities Having Jurisdiction (AHJs) who enforce these electrical and fire protection regulations. End of life decommissioning responsibility is increasingly becoming a component of EPC contracts.

Insurance. Insurance firms provides risk mitigation for the project, including general liability, workers' compensation, and builders risk insurance. Equity investors and lenders rely on sound insurance agreements to protect the project and their investment from accidents and damage.

O&M: Ensuring safe and reliable operations of the equipment over the life of the facility is essential to ensure repayment of loan. In addition, many opportunities for energy storage assets to provide added value lie with the system's ability to react quickly during turbulent conditions. Finally, maintaining the facility in good working order is typically a requirement of any loan or insurance coverage.

Permitting: The project developer must ensure that they have long-term control of the chosen site, and that it is both suitable for the chosen use, and there are allowances from the AHJs for operation at that location. Safety concerns during operation and procedures for first responders to safely interact with the facility are typically some of the primary concerns.

System Integrator: System integrators are responsible for combining all of the different components of the energy storage system and providing it to the project developer for deployment. A typical component list will include the batteries, cooling system, containerization, power conversion, and communication systems.

Financial Model

If outside capital is going to be required, the project must develop a financial model to encapsulate the revenue impacts of the commercial and financial contracts. The project financial model provides an integrated economic evaluation of the proposed energy storage project covering all the years of operation and is structured to consider the forecast of all of the expected cash flows, expenses, and financial accounting such as taxes, depreciation, and other fees. Once agreed on, it will serve as the basis for structuring the project's financing agreement. The modeling framework of a project economic model is generally straightforward, even for energy storage projects with complicated operation usage profiles. The complication in the modeling arises from how closely the framework will track the actual economic operation of the facility.

Obtaining Capital

All of the forementioned steps, developing a corporate structure with accompanying commercial and financial agreements, a flexible financial model providing deep insight, and risk mitigation strategies to ensure coverage in the event of damage are all requisites for successfully raising capital for any type of energy project. However, due to the obvious complexity, they are all not pre-requisites before beginning dialogue with the different groups. Some components such as grants, and some private equity sources can be done with proven progress. They do, however, need to be completed prior to close on project debt. Scale and stability of the revenue offtake agreement (or costs saving strategy) will of course be essential.

Developing a project targeting social equity goals will require that the project developer ensure that the local community that will benefit from the project is tightly aligned with the developer in partnership, assuming the community organization itself is not the project developer. This alignment of support will ensure access to whatever financial and non-financial benefits are known by all potential sources of capital from the beginning.

Typically, the cost of capital is proportional to the perceived riskiness of the investment: the higher the investment risk, the higher the cost of capital. Unfortunately, the availability of capital is typically in descending order of cost. Highest cost capital—self funding—is typically the first target for development funding. Subsequently, equity and debt funding follow in that order.

Another important caveat is that there is no one cost for each type of project capital. Different private equity and debt providers have different views on the riskiness of the project and have their own internal cost of capital. Therefore, different providers will offer their capital at different rates. As important to their offered cost of capital are any contractual requirements each group may impose on the project in return for funding. These can come in a variety of forms, from financial reserve requirements to operational limits to ensure additional longevity of the batteries. Unfortunately, these contractual requirements may interfere with the originally proposed usage profile of the facility. Therefore, obtaining capital from a source may sometimes preclude the developer from addressing all of the applications originally envisioned.

Social equity-oriented energy projects therefore need to highlight both the financial and non-financial benefits of their blended goalsetting approach in order to obtain the capital needed. Financially based benefits such as energy independence (localized PV power generation) and improved power quality (reliability and resilience) will always be the essential component justifying capital investment for a project. However, these may not be enough to extend the project's scope to the extent that social equity goals (lower emissions, job training, etc.) would be incorporated. Therefore, in order to attract sufficient capital at a low enough cost to achieve all of these goals, non-financial benefits must be included. These may even act in a virtuous circle benefitting the project, as local and state governments who benefit from such projects have the ability to lower the cost and time required by supporting permitting and other project requirements. Targeting these non-financial project benefits can even have direct financial support through opening the project to targeted grants and ESG focused investors—resources a non-social equity project would not be able to approach.

State Level Programs & Support

Leading state energy research groups provide assistance for disadvantaged groups in their states. Two states in particular—California and New York—have an advanced energy storage support program and are good examples of what can be done elsewhere. Green banks are another growing area of state organized support, providing structures for private financing groups to become more involved with the growing investment into projects with a social equity component.

California: California is a leading proponent of energy storage technology development and deployment. A key program in this effort is the California Public Utility Commission's Self-Generation Incentive Program (SGIP). The SGIP program was started in 2001, offering state residents rebates for installing energy storage technology at both households and non-residential facilities. Beginning in 2020, an additional $675 million was approved through 2024. With this reauthorization, the majority of the funds are allocated to the Equity Resilience Budget. This program targets low-income customers, those living in high fire risk areas, residents that have experienced power shutoffs, or critical facilities that service disadvantaged communities. Besides targeting those areas, the rebates for residents in these areas can be four to five times higher than residential rebates in other parts of the State.

New York: New York is another state leading efforts into utilizing energy storage to benefit residents in disadvantaged communities. The effort is to support a transition to a clean energy grid, improved grid resilience, and increased use of solar energy. In 2019, the State passed the Climate Leadership and Community Protection Act, codifying energy and climate goals, including improving the overall efficiency of the system by stimulating third-party investment, and removing impediments to accessing financing by disadvantaged residents, and regulatory changes to utility customer rates that will reflect the environmental benefits and resilience energy storage brings to the grid.

Green Banks: Green banks are state sponsored institutions that leverage innovative financing to provide opportunities for their residents to take advantage of clean energy options and address climate change, with a special emphasis on supporting disadvantaged communities. In addition to addressing climate change, they many times have additional objectives such as servicing disadvantaged communities. Since these groups are organized as non-profit, state sponsored entities, they are able to obtain and provide capital at a lower cost than typical for-profit financial institutions.

Green banks utilize a number of programs when offering programs to the residents of their state, including: Co-investment (investing directly in projects alongside private investors), securitization (merging a pool of investment from a number of different projects or programs into a marketable security), credit enhancements (improving the credit risk profile of a business or project loan in order to obtain lower cost capital), loan guarantees (guarantor agrees to pay for some or even all of the loan remaining in the event of non-payment by the borrower), social impact bonds (funding social service programs using performance-based contracts).

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Acronyms and Abbreviations

BESS	Battery energy storage system
BMS	Battery management system
BOM	Bill of materials
BOP	Balance of plant
BOS	Balance of system
C&I	Commercial & industrial
Com	Commercial
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EMS	Energy management system
EPC	Engineering, procurement, and construction
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ESS	Energy storage system
EV	Electric vehicle
GW	Gigawatts
GWh	Gigawatt Hour
Hr	Hour
HVAC	Heating ventilation and air conditioning
kW	Kilowatt
kWh	Kilowatt hour
MW	Megawatt
MWh	Megawatt hour
NREL	National Renewable Energy Laboratory
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
Res	Residential
SAND	Sandia National Laboratories
USD	U.S. dollars

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Finally, monetary returns are not the only way to measure the capital provider’s required return on investment. Capital providers that invest in projects are being held to an increasing number of non-financial goals, requiring different sets of performance metrics to quantify these non-financial requirements. A growing framework to evaluate is referred to as the environmental, social, and governance (ESG) framework, using different key performance indicators to evaluate the worth of a project.

1.1 Return on Investments

As stated earlier, it is not the project with the highest possible return, but the project with the highest possible risk adjusted return that is the most profitable. Lenders are especially careful about this difference; their willingness to accept a lower return on their capital investment comes with the explicit position of a lower risk profile. In addition, this caveat to project finance investment is especially critical for energy storage projects where there are a number of technical, economic, and regulatory issues that can raise the risk level of the project above that of other project investment opportunities in the power market.

Project developers make decisions on which project to pursue based on the return on their investment. This will obviously focus on the financial returns, but other issues are also important. For instance, the amount of effort and the risk of the project will combine with the project’s financial return to provide a “risk-adjusted return” of the project. For projects based on emerging energy storage technologies and evolving market roles, taking into account the operating risks involved is critical.

Energy focused equity investors recognizes that disadvantaged communities have been historically marginalized and overburdened by pollution, underinvestment in clean energy infrastructure, and lack of access to energy-efficient housing and transportation. Programs targeting these shortcomings are many times at a disadvantage as compared to projects only targeting financial return. However, programs developers have found that projects targeting social benefit results can generate returns acceptable to financial providers; the key is using tools and resources available only to social equity projects and improving the returns using typical financial structuring procedures. On financial terms, grants can provide leverage to equity investments, improving the returns for those investors.

Traditionally the project developer would search for a donor to obtain the full equity requirement. However, for many projects, private investors are required due to the growing number of social equity investment needs. Unfortunately, these same social equity investment opportunities, if funded with private funds, will earn a lower than acceptable return. For instance, if a social equity project is only able to provide a 5% return for investors if using full private funding, obtaining a grant that covered 50% of the equity investment portion of the capital needed results in a 10% return for the private investor. This strategy also benefits the social equity interested donor. Many donor institutions have a specific budget for supporting programs, although the need is always significantly more. By leveraging the donor money with project investors, the donor institution is able provide funds for additional programs, multiplying the societal impact they are able to achieve with their existing funding.

1.2 Getting To Success

Energy storage project development can be more difficult getting to success than other power sector efforts. Equipment options are still not as standardized as in other markets, the pool of experienced firms is smaller, and the market contracts and revenue options can vary greatly regionally and do not necessarily ensure profitability. For these and other reasons, any additional support reducing transaction effort, time, or improving rate of success can be essential.

Equipment and partnership selection is a critical step for energy storage project developers. Because of the great demand for energy storage systems, there is a significant waitlist for delivery of equipment for developers. This can put pressure on the quality and cost for the available systems. Therefore, it is critical that project developers develop a deep bench of capable and experienced partnering firms to ensure that the selection process obtains equipment of the needed quality to ensure the facility can operate over the planned lifespan.

Bankable offtake contracts for services from energy storage projects vary across the United States. Developed with local needs in mind, there are variations in seemingly similar contracts, so developers are typically required to stack multiple services in order to achieve profitability. Social equity programs can many times provide a firm support for a project's success, so incorporating the needs of local groups can many times provide a strategy for overall financial success of the project.

Non-financial support is also critically important for getting a project to successful completion. A project developer's project development effort will guide the idea of a project to a proposed project, moving through Notice to Proceed (NTP), and then a Commercial Operation Date (COD). Customer acquisition, permitting, legal and insurance issues can all delay the project, throwing it off the timeline, raising costs beyond the budget, and causing uncertainties that drive away existing partners. However, developing a project where there are private and public support programs to ensure timely success for the project in order to benefit a targeted community can be invaluable.

1.3 Revenue Recognition

Not all applications that energy storage systems are able to provide have easily identifiable revenue streams associated with them. This is a challenge as the profitability of the project relies on generating reliable revenue from operations. Some applications have formalized definitions in power markets, and thus are easily monetized (although the scale of the monetization will vary), while others have been identified as useful, but the magnitude varies according to time and place with value based on the customer's internal value.

Over time, we have seen more applications that energy storage systems support become more formalized and/or have greater clarity, allowing the project to recognize more revenue from the different actions it provides. This continued growth in revenue recognition supports the greater profitability in the future for energy storage projects, not because the value of the services will increase, but rather because revenue can finally be recognized from a variety of services that the facility could provide all along. This forward progress is unfortunately divided among many different state and regional groups, all starting from their own unique starting point, progressing under separate market rules, and targeting different goals.

To add complexity to the situation, not all the different applications, although valuable, are translatable into easily definable revenue streams. In general, these fall into 3 categories:

Discrete: Some value streams for energy storage facilities are tied to actual services or products in formal electricity markets, allowing the potential revenue stream for that application to be easily and publicly contracted, provided that the facility adheres to all qualifying conditions. This situation provides clear price visibility for the multiple parties engaged in the market for the services. Examples of this type are frequency regulation and spinning reserves.

Definable: Another set of value streams have value to another market participant, but are typically time or locationally specific for price, making any attempt at crafting a market-wide rule of thumb for value difficult at best. If the energy storage developer can contract for one of these services, it is generally on a bilateral basis or is consolidated into a purchase price (asset purchase) with a host of qualifiers to provide the specificity needed. An example of this type is black start.

Indeterminate: The final set of value streams are not easily (or widely) quantifiable and there is little hope for a near-term systematic valuation basis—yet they are often mentioned as a driver for near-term energy storage market growth. These issues can many times be highly sought after and described as highly valuable, but are many times based on highly variable market conditions, and thus typically very individualized in definition. If you cannot contract for something or systematically value it, it cannot be a fundamental market driver for a competitive market until people begin to devise a means to provide a basis for its value, so vendors know how to price a risk adjusted solution. An example of this type would be resilience.

1.4 Social Equity Performance Metrics

Besides direct financial valuation metrics, there are increasingly other criteria that are being used for investment decision making. A growing framework to evaluate these alternative investment criteria is referred to as the environmental, social, and governance (ESG) framework, using different key performance indicators (KPI) to evaluate the worth of a project.

This use of purely non-financial metrics already has precedence in the electric power industry as “resilience” has become a key focus for infrastructure investment, but it is difficult to precisely value the benefits of improved service on a discrete time and location basis. Metrics such as reduced outages and reduction in poor power quality can be generated, but they typically rely on assumed values of improved service for average customers, not actual specific ones. They also have difficulty differentiating the rapidly changing value of resilience during volatile market activity.

For this reason, developing greater transparency and precision around monitoring, measuring, and reporting ESG key performance indicators is becoming critical. Doing this will give investors better understanding and reason for investment as some of these social equity outcomes are important key performance indicators for their investment decision making.

In order to ascertain the effectiveness of programs focused on improving the position of disadvantaged groups, a series of metrics must be chosen to evaluate the effectiveness of the program. Some KPIs could include:

Energy Access: Improving the ability of disadvantaged and/or remote communities’ access to more reliable and expanded energy services.

Energy Affordability: Electric service is an essential component of modern life, so developing strategies to reduce the cost of electrical service for disadvantaged communities will have greater positive economic impact on these groups, freeing up more disposable income for essentials.

Decarbonization: Utilizing energy storage assets allows the greater use and integration of renewable energy supplies to all communities to reduce the carbon footprint of all electrical service customers.

Environmental Impact: Fossil energy power generation can have a significant environmental impact on the immediate area from combustion emissions. These power facilities are many times placed in areas near disadvantaged communities, so replacing them with clean alternatives such as energy storage assets can remove significant local air pollution that is detrimental to the health of the community.

Reliability & Resilience: Ensuring that disadvantaged communities have reliable energy service. Aging electrical infrastructure can produce poor power quality and frequent outages during extreme weather events.

Social Impact: Energy storage can serve as a community asset that can both provide direct benefits while also supporting additional community goals, improving the life of the community outside the provision of services.

2.0 Market Segment Needs & Challenges

Energy storage systems have the ability to support a variety of market needs currently, with more opportunities arising as new market rules are design to take advantage of, and incentivize, their unique capabilities. Conversely, it is imperative for project developers to recognize that power markets differ significantly across the United States—geographically, and whether it is front of the meter of behind the meter.

Therefore, when evaluating an opportunity for energy storage through system and load analysis, it must be recognized that this is specifically localized, but close analogies exist in many other markets. For instance, wholesale power markets have different market rules based on local needs. Behind the meter markets are designed by each of the public utility commissions (PUC) to target benefits for their own state customers. Through these rulemakings—technical requirements and economic incentives—different states can craft vastly different economic values for a similarly sized and operated energy storage system.

As with other power industry capital assets, energy storage systems are scaled to meet the specific support needs of a particular market segment. However, even if the power rating (kW) of the systems will fall within a close band based on market segment, the energy rating (kWh) of the systems will vary based on the applications envisioned. Further, the throughput capability of the system is based on the type of energy storage technology designed, and the supporting equipment such as cooling units that allow a more flexible and capable unit. Those looking to utilize energy storage systems for deployments should recognize that "you get what you pay for", so even though a system may cost more than another one, it may have more capabilities that will make it the more valuable choice for a particular project.

Financing an energy storage project requires the developer to have a clear understanding the "basics" of an energy storage system so they can convince possible capital providers that the project will meet the capital provider's particular revenue requirement and risk profile. This might seem to be an overstatement, but knowing how to design, install, and operate an energy storage system over the life of the facility is key to a capital provider getting paid back through the operation of the facility. Capital providers thus increasingly look for project developers with a proven track record to reduce their investment risk. This also extends to proven technology and market applications. Therefore, groups looking to develop innovative applications need to recognize advantages that they bring—grants, government support on siting, etc.—can help make capital providers interested in their opportunities.

2.1 Residential

Although residential energy storage systems are sometimes sold as a stand-alone unit, they are increasingly bundled with a residential photovoltaic system. The average "attachment rate" has been increasing as more solar PV customers desire the added benefit of energy storage systems, reaching 8% in California, with aggressive growth expected in the coming years.[1] Since the system is designed to be coupled with the existing PV system inverter, the residential energy storage system is centrally a DC system, although the unit can be sold with an inverter for stand-alone usage to provide AC power.

Typically, residential energy storage systems are sized to provide two to four hours of discharge duration, although for some remote locations this can be extended. According to the 2020 Energy Storage Pricing Survey, the average lithium-ion residential energy system with inverter included will cost $1,083/kWh installed, totaling $21,660 for a 10kW/20kWh system.

There are a number of different payment and financing options for a residential energy storage system. These include:

System Lease: A full system lease is a typical equipment lease agreement where the customer agrees to use the storage system for a specific period of time through paying periodic (generally monthly) payments to the lessor – the actual owner of the system. The cost will depend on the scale of the unit, length of lease, and level of support services. Because the customer has agreed to enter into a long-term contract, the monthly payments are typically the lowest option.

Month-to-Month lease: A monthly lease is generally the easiest way to gain access to the use of a residential energy storage system for customers. Typically, this will include a small down payment, plus a monthly lease fee for the use of the system. The cost will depend on the scale of the unit, length of lease, and level of support services. Because the customer has requested the freedom of cancelling the lease arrangement on a short notice, the monthly payments will be slightly higher to reflect the greater asset risk to the lessor.

Full Purchase: Purchasing the system outright allows for the transfer of ownership of the battery system from the seller to the customer. The purchase can either be completed in full or financed over a set period of time. The monthly payment will primarily be based on the cost of the unit and the available interest rate for the financing. At the end of the payment period, the system would be fully owned by the customer.

2.2 Commercial & Industrial

Energy storage assets are used in the commercial and industrial energy markets to reduce the cost of service for the end-user and enable more flexibility and capability in the use of electrical service. Most commercial tariff rates are designed around a time of use schedule, increasing the cost at the peak demand periods of the day, week, and season. Besides the cost of the energy ($/kWh), there is a demand charge, which is composed of a demand charge rate ($/kW) multiplied by the peak demand (kW). Both of these represent an attempt by the utility to align the cost of supporting a customer with their demand. Energy storage systems are thus designed to “shave the peak” of a customer’s demand when the prices are highest by storing low-cost electricity from off-peak, and using it during peak periods, lowering overall service costs. Over time, the power (kW) and energy (kWh) rating of these units have been growing as the usage requirements grow, including supporting onsite EV charging, and integration with solar PV.

Incentives are critically important for commercial energy storage asset deployment. This is especially true in state-level deployment, and those states which have concentrated their efforts have seen the results. Many states have developed support and incentives for behind the meter energy storage deployments, including California, New York, Massachusetts, and New Jersey, among others, with the list growing daily.

Typically, commercial energy storage systems are sized to provide two to four hours of discharge duration, with four hours becoming more common. With the increasing scale of usage, the power output can range from 100kW up to 1MW. According to the 2020 Energy Storage Pricing Survey, the average lithium-ion commercial energy system will cost $668/kWh installed, totaling $267,000 for a 100kW/400kWh system.

Commercial and industrial energy storage systems are supplied to customers along a variety of avenues, direct sales, private service providers, and utilities.

Direct Sales: Some commercial customers are interested in owning all of the electrical assets on-site and are thus good prospects for buying the asset directly (either with cash, or more likely, through a commercial loan.)

Storage as a Service: Commercial energy storage systems can be offered as part of a utility bill cost reduction service, sometimes referred to as “Storage as a Service.” The strategy here is to reduce the peak demand through time shifting, lowering the peak demand charge that is increasingly accounting for larger portions of the customer’s bill. This reduces the upfront cost to the commercial customer and provides a monthly stream of service fees to entice potential providers. This is typically offered as a lease with additional energy management options.

Utility: Utilities have offered commercial (and residential) customers energy storage systems as part of a distributed demand charge reduction capability. This type of strategy builds on the long history of utilities supporting commercial customers adding thermal energy storage (ice) units to their commercial cooling systems. Air conditioning is a significant portion of the commercial load, and utilities have found in the past that it is cost effective to help lower the demand of high use commercial users to delay expensive distribution network upgrades.

2.3 Utility

Energy storage systems are used in the utility market to provide a wide range of grid stability and resiliency capabilities in support of better-quality service to customers. The original power grid was typically devised around a hub and spoke model, with the main power generation units at the core and sharing the power regionally at the transmission level, and then shifting it down to distribution levels lines of ever lower voltage to the end-use customer. As more distributed generation and changes in power usage emerge, utilities are no longer able to provide the same level of power quality easily. At the same time, the change to greater electric usage and more sensitive digital equipment requires enhanced management of the power grid. Both of these drivers provide an opportunity for energy storage to provide enhanced grid stability, essentially acting as a shock absorber for the power grid. As the opportunities to provide stability grow, the scope of deployable energy storage systems will also evolve.

Typically, utility energy storage systems are sized to provide anywhere from two to four hours of discharge duration, with four hours becoming more common. The predominant area for planned deployment continues to be at distribution substations in order to support a multirole usage. In order to provide the needed output, these systems can have a power rating of a few MWs to 10s of MWs. According to the 2020 Energy Storage Pricing Survey, the average installed utility scale energy lithium-ion system will cost $445/kWh installed, totaling $1,780,000 for a 1MW/4MWh system.

Different types of utilities approach the financial markets differently, leading to a variety of pathways to finance energy storage projects.

Investor-Owned Utilities. Investor-owned utilities are able to finance a variety of grid infrastructure projects with access to lower cost capital than most other market participants due to their stable operating nature and large balance sheet of capital assets. They can support projects through a contract for services from a third party (see Merchant / IPP section) or they can put the assets of the project on their balance sheet.

A critical aspect of utility investment into energy storage deals with the impact of deregulation of the electric power industry. Specifically, who can invest. Depending on the state, sometimes energy storage assets are described as generation assets, sometimes transmission assets. Each state has gone through electric deregulation along a different route, making utilities able to invest in both types of assets, and sometimes only in transmission assets. Therefore, this structure will impact whether load distribution utilities can buy energy storage assets to roll into their rate base, or whether they will have to contract for services.

Cooperatives and Municipalities. The National Rural Electric Cooperative Association (NRECA) created the non-profit cooperative National Rural Utilities Cooperative Finance Corp. (CFC) which has more than $30 billion in assets. According to the NRECA, the CFC's services include:

1. Long-term shelf financing for electric infrastructure, such as distribution lines and power generation projects
2. Emergency lines of credit so power can be restored quickly after natural disasters
3. Specialized financing including loan syndications and loan resales through Farmer Mac and other partners
4. Strategic planning and financial analysis
5. Financial education and training

The Federal Government also supports Cooperatives and Municipalities through the Rural Utility Services (RUS) Electric Loan Program from the U.S. Department of Agriculture. This organization provides funding to improve the working capability of the grid infrastructure and support society's expanding use of electricity in rural areas. The group provides loans and loan guarantees for generation, transmission, and distribution assets including renewable energy deployments. The group also provides funding for behind the meter energy management customer programs such as demand side management and energy efficiency programs as these both provide benefits for customers and reduce the capital outlays for the cooperative. Groups available for receiving loans include cooperatives, corporations, states, territories, subdivisions, municipalities, utility districts and non-profit organizations.

2.4 Merchant / IPP

Energy storage systems are also developed by independent power producers and are active across the entire electric power value chain—from the wholesale power market to behind the meter customers. Energy storage systems in the wholesale power market are typically scaled larger, targeting products and ancillary services in the ISO/RTO market or contracts with utilities. Systems in the behind the meter markets are smaller and tend to be focused on costs savings contracts with commercial customers. This section will be focused on the front of the meter units.

The deregulation of the power grid spawned a large a vibrant IPP industry, first with thermal units, then renewable generation, and now the growing interest in storage assets. Because of the need for scale to address market sales requirements, the scale of these systems has increased, and is expected to continue to grow. Since many of these market focused units are increasingly multifunctional, the scale and cycling capability of the units are expected to continue to increase.

Typically, wholesale market merchant energy storage systems are sized to provide anywhere from two to four hours of discharge duration, with four hours becoming more common. These are generally standalone facilities, targeting a number of wholesale market roles in support of ISO/RTO ancillary services markets. In order to provide the needed output, these systems are typically sized in the tens of MWs, although expectations exist for systems reaching 100MWs or more in the near future. According to the 2020 Energy Storage Pricing Survey, the average installed wholesale market merchant lithium-ion energy system will cost $315.6/kWh installed, totaling $126,240,000 for a 100MW/400MWh system.

Funding the development of merchant or IPP energy storage facilities will follow the same pattern as other large capital assets in the power market. Project developers want to attract the most debt possible for the project to lower the cost of capital. To achieve this, they need the most reliable revenue possible in order assure these capital providers that the debt will be repaid. Because they are independently owned and operated, they will naturally work towards capturing the highest value of multiple revenue streams that the facility can operationally support. Since the facility will have a limited output based on battery capacity, this analysis is more complex than for thermal units, but many firms are developing these strategies. These multiple revenue streams will either consist of contracted or purely merchant revenue (spot market activity). Merchant revenue is more volatile, but also promises better opportunities for higher revenue. Strategies to limit the downside of merchant operations follow the same strategies as large independent thermal units—incorporate hedging strategies to lock in some of the revenue gains while giving up the greatest upside potential. As IPP groups gain additional experience with energy storage assets, lenders are becoming more comfortable with their revenue potential from merchant activity.

2.5 Hybrid Storage

Energy storage systems used in hybrid deployments are designed to augment and extend the capabilities of the generation unit it to which they are integrated. For this reason, the scale, design, and operational requirements will depend extensively on the paired generation unit. For instance, energy storage paired with solar systems is one of the fastest growing deployment opportunities for large scale energy storage deployments. The goal here is to extend the run-time of the combined solar / storage facility and provide the combined unit facility enhanced market operation capabilities, such as minimum output of the facility, and slowing power output due to cloud cover. Energy storage systems also provide support for fossil units, to either provide ramping support so the generating unit can keep the rate of change to its output at a safe level, protecting the system from thermal damage.

Typically, hybrid energy storage systems are sized to provide anywhere from two to four hours of discharge duration, with four hours becoming more common. As the name implies, these systems are incorporated directly with a generation unit. Most common integration strategies incorporate these systems into renewable energy production facilities, enabling the generator to either shift power to different parts of the day, provide a minimum output from the facility, allow the generation capacity to be larger than the transmission capacity, or some combination of these strategies. In order to provide the needed output, these systems are typically sized in the tens of MWs, although expectations exist for systems reaching 100MWs or more in the near future. According to the 2020 Energy Storage Pricing Survey, the average installed lithium-ion facility generally used in hybrid facilities cost $382/kWh installed, totaling $15,280,000 for a 10MW/40MWh system.

Since these hybrid projects are typically designed as an integral component of the larger generating facility, the energy storage systems will generally be an add-on to the financing of the larger generating facility. However, due to the difference between the two components, and the greater maturity of the generating facility, the inclusion of the energy storage system will require some risk management ring-fencing to ensure that the complexities of the energy storage system will not negatively impact the financing of the generation facility.

2.6 Tribal Energy

Energy storage assets are used in the tribal energy market in a variety of uses. Since tribal communities can integrate energy storage deployments into a variety of energy management strategies, there will be not one particular use, instead a variety of standard deployments used to reduce the cost of service and enable more flexibility and capability in the use of electrical service including cost savings, remote power, power quality, resilience, and renewable integration.

Because of the wide-ranging possible deployments of energy storage in tribal areas, the scale of energy storage systems will vary greatly. These are best represented by previously described residential, commercial, utility, etc. units. Two primary themes of centralized deployments can be envisioned here, longer duration, and higher cycling. Since many of the tribal deployment opportunities will be focused on integrating renewable energy and/or providing resilience capabilities, the first type of deployment focuses on the longer duration scale, ranging from four hours or longer. This allows the integrated storage facility to shift energy and act as a clean power provider. Conversely, another deployment will need faster power delivery and high cycling in order to balance other local generation on a microgrid.

The U.S. Department of Energy has developed a number of programs to support tribal energy opportunities. In particular, the Office of Indian Energy Policy and Programs was designed to support the development of all types of energy solutions for the benefit of American Indians and Alaska Natives. The Office takes an innovative role, working across government agencies to support Indian tribes and private organizations. In particular the Office's goals are to:

1. Promote Indian tribal energy development, efficiency, and use
2. Reduce or stabilize Indian tribal energy costs
3. Strengthen Indian tribal energy infrastructure
4. Electrify Indian land, housing, and businesses.

The DOE Loan Programs Office also supports tribal energy programs through the Tribal Energy Loan Guarantee Program (TELGP). According to the DOE Loan Programs Office, this is a partial loan guarantee program that can guarantee up to $2 billion in loans to support economic opportunities to tribes through energy development projects and activities. The Program's goals include job creation, income, cost savings, cost stabilization, building knowledge capacity, energy diversification, environmental benefits, and self-reliance.

3.0 Project Revenue

A stable and reliable revenue stream is essential to ensure that equity and debt capital providers are incentivized to support an energy storage project. These revenue streams are based on the energy storage asset providing products and services in a variety of market applications. To structure the payment for services in a reliable manner, energy storage offtake contracts are structured through power purchase agreements, wholesale merchant operations, and behind the meter contracts.

3.1 Power Purchase Agreements

A power purchase agreement (PPA) is a contract that defines the commercial terms for the sale of electricity between two parties, the seller, who generates the electricity, and the buyer, who is to receive the electricity. The PPA is the core agreement of the commercial arrangement, defining the terms under which revenue is generated, as well as the credit quality of the project. PPAs can represent electricity sales across the electric power grid, encompassing front of the meter (FTM) and behind the meter (BTM) arrangements.

Power purchase agreements encompass standard contract issues such as commercial operation date (COD), schedule guarantees, curtailment, performance guarantees, delivery terms, defaults, liability limitations, penalties, etc. Typically, PPAs will last anywhere from 5 to 25 years. Since these standard contracts were designed with thermal, solar, or wind projects in mind, care is required to investigate operating and performance attributes that are different with regard to energy storage assets and make the appropriate change to the metrics to qualify the area of responsibility. This focus also impacts those possible future contractual operating issues that have not been identified in the current contract, leaving open the area of responsibility.

There are a number of current structures for front of the meter offtake agreements, including the tolling agreement and capacity agreement.

3.1.1 Tolling Agreements

In a tolling agreement, the owner/operator is responsible for project operation during the contract period. The offtaker owns the electricity used to charge the energy storage system and exercises full authority to dispatch the charging or discharging of the system acting as the scheduling coordinator for the system from the grid's perspective for its own benefit (capacity, energy, services, etc.) within specified technical or contractual limitations. The offtaker pays a fixed monthly fee, such as a capacity charge to use the storage facility's capacity, plus a variable operating charge on the energy throughput of the unit. The offtaker is typically thought of as a utility, but increasingly can be a number of other market players.

For operating the facility, the owner/operator receives a capacity payment (adjusted by availability and round-trip efficiency) and a variable O&M payment based on the amount of energy throughput. Energy needed for station service is separately billed to the operator. The fixed capacity charge to the offtaker may be subject to reduction for decreases in capacity, availability, or efficiency of the project.

3.1.2 Capacity Agreement

The capacity service agreement is similar to the tolling agreement, but here the owner/operator developer is the owner of the electricity, and is responsible for all costs, including the charging cost. The offtaker pays a fixed monthly fee for the ability to utilize the output of the system for capacity, energy, services, etc. within specified technical or contractual limitations of the energy storage system. These capacity service agreements transfer more of the project risk to the owner/operator, but also provide more of a possible upside revenue potential. For instance, if the offtaker is contracting for only capacity, then the owner/operator may be able to sell additional services into the market. This strategy will only work if the owner/operator has a firm understanding of the system's costs and performance and knows how to apply them to market opportunities (or gets lucky). This structure is often used when the offtaker (e.g., a utility) seeks to contract for resource adequacy benefits or other capacity services.

Because of the evolving nature of the industry, contract terms are not always as specific as they need to be. This is of special concern when there are fixed formulas that form the basis for compensation. For instance, availability of the facility may not incorporate periods out of the control of the owner/operator, such as force majeure events or grid curtailment events. Also, care should be made to ensure that the weights and values ascribed to different capacity attributes are understood by all parties and allow flexibility in the event of a change in relevant market rules and laws.

3.2 Wholesale Merchant Operations

Merchant energy storage facilities operate in the competitive wholesale power market like other independent power facilities. However, because of their limited output duration, their choice in operating modes and strategies will be different than thermal plants operating as merchant facilities.

In the future, the energy rating (kWh) of energy storage facilities is expected to trend longer for a variety of reasons. As merchant energy storage facilities look to support more applications, they will need more reserve capabilities. As grid operators look to incentivize resilience-oriented applications, merchant energy storage facilities are expected to expand their duration capability (increasing the number of hours able to charge and discharge).

3.2.1 Contracts

Revenues for supporting market application can either be based on energy or capacity contracts, or activity in supporting the ancillary services market through the ISO/RTO market. Bilateral energy contracts can be seen at the most basic levels as effectively arbitrage, capturing the spread between the purchase and sale of energy (minus the cost of storage). The scale of the revenue opportunity is based on the height of spread between the two prices (hi / low), and the volume of energy throughput, so this points to larger facilities able to cycle large amounts of energy through the system—typically achieved by longer duration. Bilateral capacity contracts are reservations for the potential to supply power. The most common example would be resource adequacy to provide ready reserves in the event of need.

Finally, ancillary services provide a variety of wholesale market roles to improve stability and reliability of the wholesale power market. These can be contracted with the regional ISO/RTO to ensure the resource will be there when needed.

3.2.2 Hedging

Hedging[2] is a financial strategy in wholesale markets (electricity, commodities, stocks, etc.) that can reduce the exposure to extreme price movements by purchasing the right to buy or sell a product at a certain price level. This strategy can provide a more predictive revenue stream, which can be beneficial when the project developer is attempting to obtain project funding.

For energy storage projects, this will impact projects operating in formalized Independent System Operator (ISO) or Regional Transmission Organization (RTO) areas. Typically, the hedging strategy is incorporated into the strategy to sell ancillary services, such as reserves, frequency regulation, and energy products. These can be used very effectively to protect the project from financial loss. In this way, these options act as insurance for the revenue opportunity for the facility. Two basic mechanisms include the call option, and the put options. Strategies are built around these mechanisms to offset a potential loss.

Call Option. The call option is a contract to purchase a specific ancillary service contract at a specified price up to a specific date. This contract gives the purchaser the right, but not the obligation, to “exercise” the call option and purchase the contract. For instance, if the market price of the contract has fallen below the “strike price”, then they will not purchase the contract as there is no need to protect the project’s revenue.

Put Option. The put option is a contract to sell a specific ancillary service contract at a specified price up to a specified date. This contract gives the purchaser the right, but not the obligation, to exercise the put option and sell the contract. For instance, if the market price of the contract has fallen below the strike price, then they would exercise the contract, and receive the value of the contract at the higher strike price, not the current market price. This ensures that the project would not receive less than the agreed upon price, ensuring (hopefully) profitable operation.

3.2.3 Risks

Merchant energy storage facilities face a number of risks, highlighting the needs for higher returns for investors. Some of these risks include:

Market Rules: Market rules can and will change periodically as ISOs and RTOs review and amend existing market rules to take advantage of new resource capabilities and ensure better and more reliable service for customers. This will impact the structural value of applications, and/or the market strategy in how to supply multiple applications needed to ensure profitability for the project. For instance, FERC order 2222 will allow more DER assets to be active in the wholesale market. This brings significantly more resources as supply, but also changes how existing resources respond to market, making the supply change.

Resource Competition: Unless there is a structural deficit for products or services in the market when the merchant facility is built, adding a new facility will have to cannibalize sales opportunities from existing facilities by offering the products or services in a more responsive and lower cost.

Supply Saturation: Ancillary Services markets are typically very “thin” as compared to the overall market for electricity, thus small changes in supply and demand will have a bigger impact here rather than in the overall electricity supply market. Therefore, new entrants can also change the structural price for an ancillary service due to changing the prior supply and demand balance, to a price possibly lower than the bound found acceptable prior to construction of the merchant power facility.

Price Volatility: Based on changing supply and demand dynamics in the wholesale electricity market, the value of electricity and services will change hourly, daily, seasonally, etc. A key strategy for energy storage facilities operating in the wholesale market is to adopt the risk mitigation strategies of existing thermal power facilities in the wholesale electricity market.

4.0 Project Savings

Capturing savings on customer's electric service costs is another way to generate value from the use of energy storage assets. Although not as direct as revenue generation, a reduction in the cost of electricity service is many times of more interest to customers than finding a way to generate revenue.

Determining the amount of savings—and how to go about achieving them reliably—will be based on the customer's utility bill structure and contracts to lock in the savings to pay for the energy storage assets. In addition to utility customers, groups providing self-power options will also be extremely interested in ways to lower their costs.

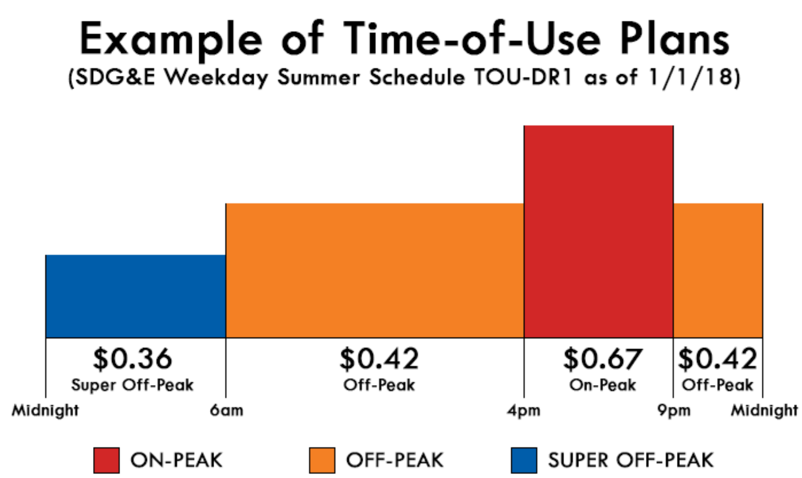
4.1 Electric Utility Rates

Electric utility rates are the structure of how utilities charge for electrical services to customers. Depending on the scale and complexity of the need for electricity, there will be a range of complexity to these structures. Utilizing energy storage assets to avoid the importation of power from the utility at the highest cost period of the day is the central strategy of cost saving for customers.

Depending on where the customer is, and what is the level of their electricity usage, residential and commercial customers could have a flat rate charge per kWh of electricity used, or it could be based on a time of use (TOU) rate. TOU rates have been becoming far more common these days and provide the structure for cost savings through managing the commodity charges and demand charges. Typically, the strategy of using energy storage assets to reduce a customer's cost of electrical service is called peak shaving.

4.1.1 Commodity Charge

The cost of the volume of electricity used (measured in $/kWh) is called the commodity charge. In order to incentivize customers to reduce the use of power during peak periods of the day, utilities elevate the commodity cost of electricity at those times.

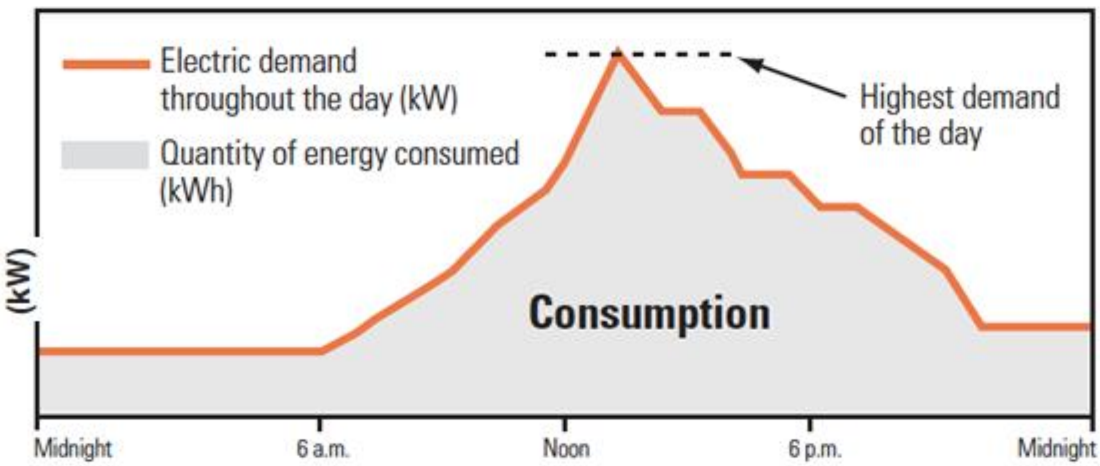


Source: SolarTech Online[3]

Figure 4-1. Time of Use Rates

4.1.2 Demand Charge

For customers with large electricity demands, utilities can add a second component to their utility bill, a demand charge (measured in $/kW). The demand charge is associated with the peak power demand (kW) of the customer. This component is added to account for the cost needed to ensure the physical ability to supply these customers with power when needed. Depending on the utility, this peak measurement can affect differing time periods for the customer. For instance, the peak demand could be measured as the highest peak demand during a month, and then reset the demand charge for the following 132 months.



Source: We Energies[4]

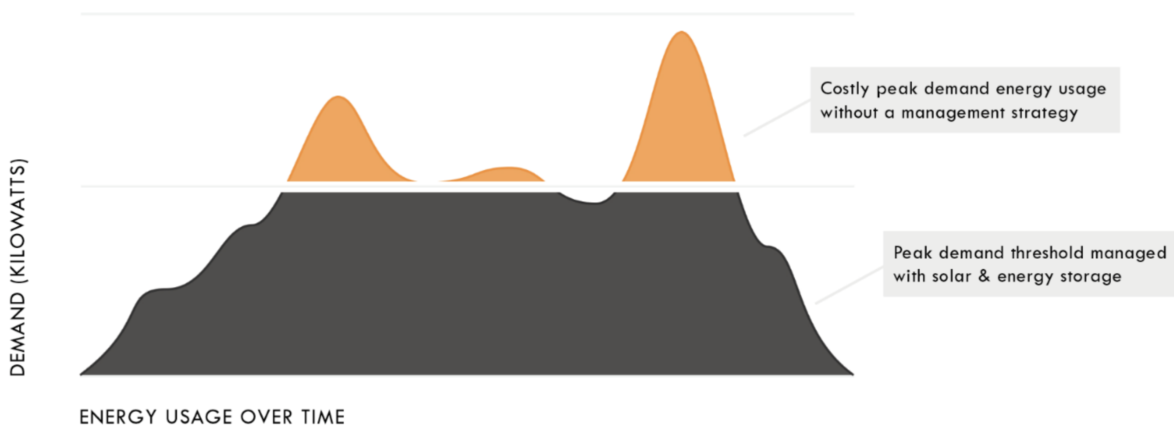
Figure 4-2. Demand Charges

4.1.3 Peak Shaving

Peak shaving is a strategy for customers to use energy storage systems to reduce the demand for energy during the highest part of the day. They accomplish this by storing energy onsite during off-peak periods when the cost of electrical service is low (commodity charge) and releasing it for use during peak periods to reduce the importation of high-cost energy during peak demand periods. This is effectively arbitraging the cost of the energy used.

There are a number of effects to following this strategy.

- First, the overall demand for electricity (kWh) will increase slightly as the energy stored in the on-site energy storage facility will encounter some conversion losses.
- Secondly, the average cost of the commodity charge will be reduced by increasing the amount of low-cost off-peak power used per day instead of higher cost peak power.
- Thirdly, if applicable, the peak demand charge for the customer will be lowered, reducing the demand charge component of the electricity bill.



Source: Ideal Energy[5]

Figure 4-3. Peak Shaving

One caveat to this strategy is the possible use of onsite renewable generation such as solar, wind, or hydropower. If these assets are used as well, they can help offset the importation of electricity from the utility. Using energy storage in connection with these resources can thus be a very effective means for a customer to reduce their cost of electricity service.

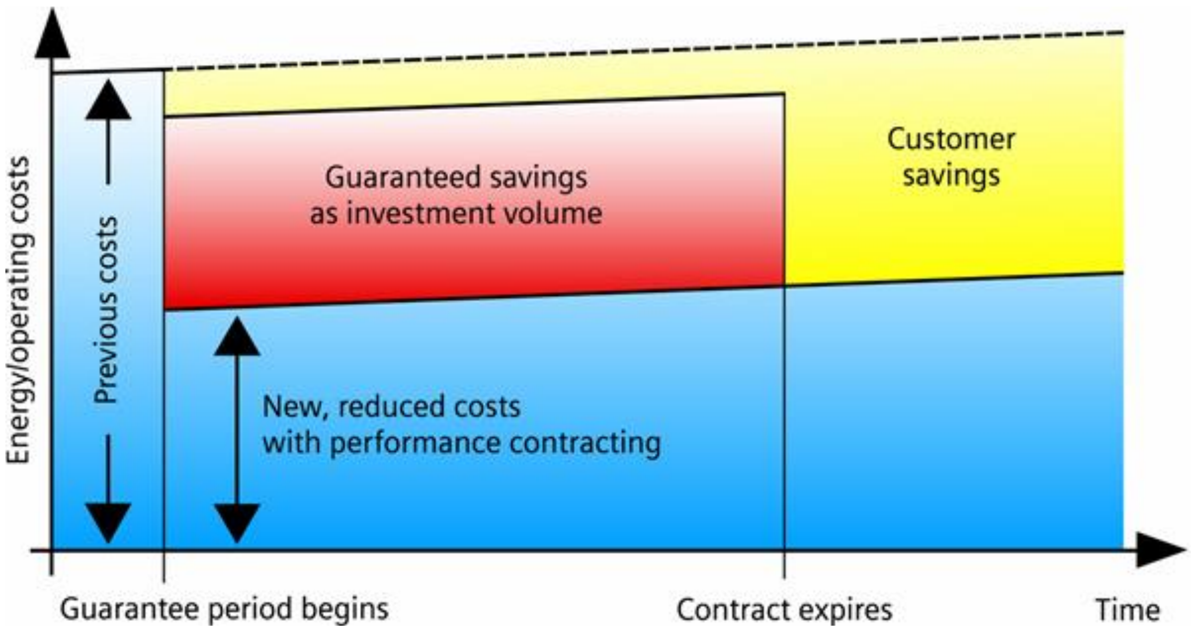
4.2 Behind the Meter Contracts

Behind the meter (BTM) energy storage assets can provide revenue generating and revenue savings opportunities, so the contract structures need to be able to take both of these operating strategies into account. This can become complicated, as both activities can occur during the same deployment. Also complicating these issues is activity in the wholesale market would follow federal regulations, while activities in the retail market would be based on utility-based programs, which follow state regulations.

Wholesale market opportunities for distributed energy storage assets are poised to grow significantly when FERC Order 2222 is finally adopted. FERC order 2222 [6] was approved on September 17, 2020. This Order is designed for distributed energy resources (DERs) to be able to compete on a level playing field in the organized capacity, energy and ancillary services markets run by regional grid operators. This Order will allow DERs to participate alongside traditional wholesale market resources in the various ISOs/RTOs through aggregation in order to satisfy minimum size and performance requirements that individual units may not be able to meet individually. As wholesale operations, the contract structure would typically follow one of the FTM contract structures, but new structures could emerge as the Order goes into effect.

Contract structures for BTM energy storage assets acting to provide revenue savings are based off of the experience in the energy efficiency industry, where very mature contract structures have been developed. The Energy Savings Performance Contract (ESPC) is the central financing structure for BTM energy storage projects and defines the term and requirements for the project. The ESPC structure has been used widely throughout the energy efficiency market to help customers pay for energy efficiency upgrades to their facility through a portion of the cost savings over a set time period, eliminating the need for the customer to pay up-front for the desired project.

Project developers/operators offering these types of contracts to customers usually arrange the financing from a third-party financing company, with the contract typically in the form of an operating lease. In this way, the ESPC is an offtake contract defining a turnkey service for the scope of work desired by the site owner. The contract provides for guarantees that the savings produced by use of the energy storage assets will be sufficient to finance the full cost of the asset, plus a profit margin to provide a return on investment for the developer/operator.



Source: Building Owners and Managers Association[7]

Figure 4-4. Energy Savings Performance Contracts

Two of the most widely used energy savings performance contracts between project developers/operators and their customers in the energy storage market are the Demand Response Energy Storage Agreement (DRESA) and the Demand Charge Shared Savings Agreement (DCSSA).

4.2.1 Demand Response Energy Storage Agreement (DRESA)

In the Demand Response Energy Storage Agreement (DRESA) structure, a developer/operator is compensated by the local utility for providing capacity for demand response programs through aggregating a number of customer sited energy storage assets operating as a virtual power plant (VPP). These contracts are highly sought after by project developers/operators as the capacity contract with a utility provides virtually no counter-party risk, leaving the performance of the system—aggregating software and energy storage hardware—as the area of operational risk in the contract.

Payment is provided to the developer/operator in fixed monthly payments. Typically, the asset owner will also be offered a fixed fee for use of the asset. If there is a developer/operator between the asset owner and the utility, they will need to ensure that the contractual liabilities of having the asset available do not leave them exposed if the asset is not able to participate in the desired for any reason. This particular contract is generally not for exclusive use of the asset, but rather only as part of a demand response program. For this reason, the energy storage asset may be used by the owner of the asset (be that the developer/operator, or the site owner) for other applications. Care should be taken to ensure that the asset is not enrolled into another program that could conflict with the demand response program.

4.2.2 Demand Charge Shared Savings Agreement (DCSSA)

The demand charge shared savings agreement (DCSSA) contract aligns more closely to the typical energy savings performance contract used to finance energy efficiency building retrofit contracts. These contracts provide for service cost reductions based on the performance of the energy storage system. Here, the energy storage asset is used to reduce demand charges by powering the peak demand of the customer at specific times of the month.

This agreement is thus wholly behind the meter and between the developer/operator and the site owner. Variations on the contract structure could allow for either the developer/operator to own the asset, or for the site owner to own the energy storage asset but is much more common to be owned by the developer/operator and offered the activity of the asset as a service. The demand-charge savings are split between the customer and project company under a shared-savings model. Alternatively, the customer pays a fixed monthly subscription fee in return for guaranteed savings. This provides revenue certainty for the project company, but it eliminates upside potential.

4.3 Island Grids

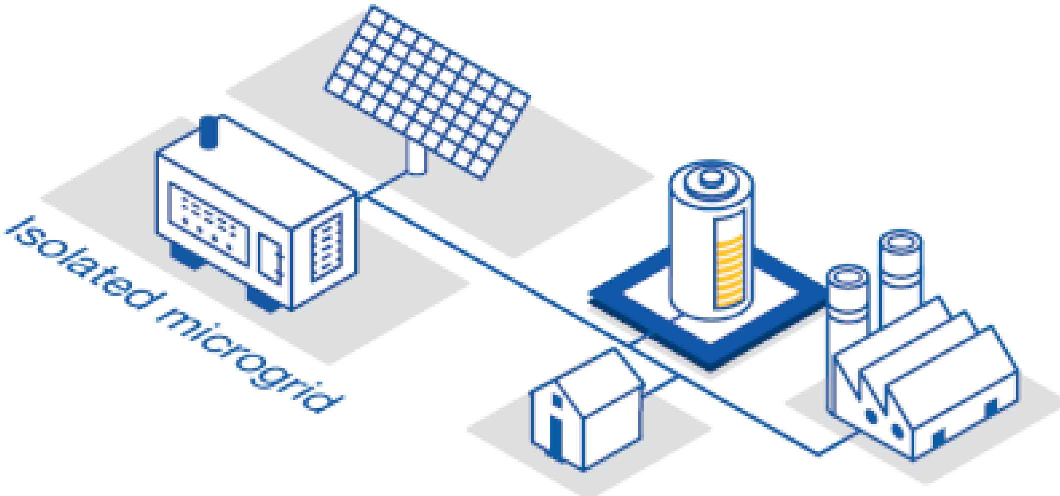
An Island grid is an isolated electrical power system incorporating all the aspects of a larger power grid, but only serving a population not supported by a larger power grid. These grids can range in size from an isolated home to an entire village. These island grids would incorporate all parts of a power grid, including generation, distribution, and consumption.

Because of this physical setup, these power grids are typically designed for use by the end user, ranging from an isolated industrial facility or village. Either way, the customer is essentially responsible for the costs of service, so is primarily focused on cost reduction or minimization as there is no other entity to actually sell electricity generated to.

Because of the small scale of the power grid, there is less stability of the power grid – meaning lower reliability and power quality. Typically, stability for island grids is produced by oversizing the power generation capacity. This can prove very expensive as then the generation equipment is heavily underutilized. Failing to oversize the generation capacity leads to overuse of the generation equipment, shortening its life significantly. Both strategies are capital intensive, leading to high costs for customers.

Energy storage assets are used as a shock absorber for the small grid. When demand is very low, generation facilities can operate at a higher, more efficient rate, storing the excess energy in the energy storage asset. When demand is then high, the existing generation capacity is run at maximum, with the excess demand requirement coming from the energy storage asset. Energy storage assets also more easily allow renewable energy to be utilized on island grids as their time of generation may not be the same as the peak demand period, adding an additional time shift needed to ensure customers receive their electricity when they need it.

Therefore, on an island grid, energy storage assets are an additional class of equipment that can be added to the overall system but help reduce the cost for all customers of the power.



Source: Socomec 8

Figure 4-5. Energy Storage on Island Grid

5.0 Sources of Capital for Project Financing

Unless purchased with cash, customers or project developers will need some type of project financing to obtain all of the necessary capital for an energy storage asset. As projects grow in scale and cost, the capital will not come from just one source, requiring the customer or project developer to stack or layer the different sources of capital until sufficient capital is raised.

Sources of capital include sponsor equity, tax equity, loans, leases, PACE financing, and on-bill payments. Each of these sources of capital has different risk tolerances

5.1 Sponsor Equity

The project developers are the first source of capital for an energy storage project. This can be from themselves, or additional private equity investors can be brought into the project as part of a syndicate to fund the equity portion of the project.

Additional sources of grant funding for the project are thus of extreme interest to the developer as it relieves them of finding that additional investment capital from third parties. Grants can provide a number of significant benefits to a project developer outside of the benefit of the cash value incentive. Many times, grants are incorporated into a program that will give the recipient access to additional support in the project development process, either private or government. Beyond cash, governmental agencies are able to provide tax breaks, which can be a typical method of targeting governmental support to specific groups or communities.

The project developer has a number of duties in the project, many of which are directly connected to their ability to raise additional private equity. The developer will be responsible for organizing the development of the project and will be involved with a number of operational aspects of the project such as design, construction, and operation to ensure success of the project. They are also responsible for promoting the projects development to gain additional investors and sources of capital.

Finally, most private equity investors and lenders look for project developers experienced in carrying out similar projects in the past to give them solace that their investments will be in good hands. To that end, these other groups look for the developer to have some portion of their own equity tied up in the project, in order to align the interests of the capital providers more fully with the developers to ensure a profitable operating lifespan for the facility.

5.2 Tax Equity

In support of furthering the deployment of renewable energy projects, the U.S. Government developed an investment tax credit (ITC) program where an investor would receive a tax credit for 26% of the cost of a residential and commercial project[9]. As this is part of U.S. tax law, it is unique to the United States.

Because individual customers can rarely utilize this tax benefit fully, institutional investors provide equity financing for these projects in return for the investment tax credit. Tax equity investors are typically banks and insurance firms that both want the tax credits and see the typical yield of 6% to 8% as an attractive return. These tax equity investors provide significant capital for the solar market. In 2020, there were more than 40 tax equity investors in the solar power project market, providing more than $17 billion in support.[10]

The investment tax credit program was initially developed for financing projects based on such renewable energy resources as solar and wind. Recent efforts have moved to include other technologies such as stand-alone energy storage projects. Currently, energy storage assets can benefit from the investment tax credit through its incorporation into a solar project. However, IRS current guidelines state that 100% of the energy used to charge the battery must come from the solar generating equipment for no penalty to be applied. This penalty is in the form of a reduction in the investment tax credit. Further, if the amount of energy used to charge the battery from the grid exceeds 25% (meaning less than 75% from the solar assets), then the IRS may begin proceedings to recapture some of the previously provided investment tax credit. For these reasons, developers looking to add storage to solar assets make sure that only solar energy is used to charge the battery. They do this in both physical and software logging procedures so that it can be proved that in no way was any power from the grid used to charge the battery. Since solar storage assets represent a large and growing volume of deployed energy storage systems, this arrangement short-changes these systems from a number of profitable operating applications, which a future investment tax credit focused on energy storage systems directly would alleviate, improving the overall return on investment for battery systems.

5.3 Loans

As energy storage projects grow in scale and cost, project loans are needed for both the scale, and to provide capital at a lower cost. This capital is borrowed primarily against the potential revenue generation of the project, not simply the project's assets. Three areas of debt can be important to energy storage project finance: construction, mezzanine, and project debt.

5.3.1 Construction

Construction loans are short-term loans used to cover the up-front cash outlays for a large energy storage project. Besides constructing the facility, they can also cover such items as land, permits, and labor. This is typically needed when the larger loans procured for the assets do not extend to the construction of the facility itself. Because they are not tied to the operation or the assets, they typically have a higher interest rate than other project debt.

5.3.2 Mezzanine

Mezzanine financing is a debt instrument situated between bank lending and equity capital; it is senior to equity capital but subordinated to bank debt. For this reason, it provides a higher return than bank lending, typically in the mid to upper teens in interest rate. In addition, it has warrants attached, giving the owner the right to have an equity participation in the project. Because of the higher interest rate, developers look to avoid using it, but as projects grow in scale, duration, and complexity, it may become an attractive option to achieve the project becoming fully funded and going forward instead of being mired in inaction.

5.3.3 Long-Term Debt

As projects grow in scale, long-term project debt becomes the most important component of project financing. Project developers will attempt to obtain the maximum amount of long-term debt for larger projects, as it has the lowest cost, and can be made available in larger quantities. In return for providing this low-cost capital, lenders require assurance of the safety of their investment.

Lenders scrutinize a project's plan and focus on details that they know can impact operations. Project debt is repaid to the lenders from the cashflow over the lifespan of the project. For that reason, the more predictable the cashflow, the better. As a secondary recourse, lenders also hold the project's assets and contractual rights as collateral.

Lenders are not able to claim assets of the equity providers, so their due diligence can be quite detailed on the project. This typically leads to high transaction costs. Many of these transaction costs do not scale directly with the project size, so projects leaning toward larger size and longer duration are able to use the project debt more efficiently for enhancing profitability.

In addition to the scrutiny of the project's cash flow, lenders will evaluate all of the possible project risks, and evaluate possible risk sharing mechanisms and determine which parties are more appropriate and able to bear the different particular responsibilities. The more comfortable creditors are about the risk management structure and controls, the larger amount of debt (as % of project cost) they will make available to a particular project.

5.4 Lease

An equipment lease arrangement[11] allows customers to access the benefits of a piece of equipment without all of the up-front costs of purchase. In this arrangement, the customer agrees to use the storage system for a specific period of time through paying periodic (generally monthly) payments to the lessor – the actual owner of the system. Since the lessor retains ownership of the energy storage system, it will retain the right to cancel the equipment lease agreement if the lessee does not conform its actions to the terms specified in the lease, such as stopping payments, or using the equipment for illegal activity.

There are typically two basic types of equipment leases, capital lease and operating lease. Capital leases are typically for longer-term usage of equipment, with the opportunity to purchase the equipment at the end of the lease period. Operating leases are typically reserved for equipment that is expected to be used only for a short time period.

The cost of the equipment lease will depend on the scale of the unit, length of lease, level of support services, etc. Key aspects of an equipment lease will include a number of items that form the basis of the lease agreement and will directly impact the cost of the lease:

Duration: The chosen duration of a lease must balance the cost of the system, with the expected usage profile for the customer.

Payment: The lessor will determine the cost of the lease payment taking into account the capital cost of the system and any other periodic cost needed to support the unit in the field if that is included in the lease agreement.

Payment Schedule: During the duration of the lease the customer agrees to make periodic payments according to a set schedule, including specific due dates for each payment.

Cancellation: The lease agreement will contain provisions for the cancellation of the use of the equipment for both the lessor and lessee. However, typically there are penalties to the lessee for canceling the lease unless the equipment or service has not met the requirements set forth in the lease.

5.5 PACE Financing

Property assessed clean energy (PACE) financing programs allow residential, commercial, and industrial consumers to access lower cost capital for clean energy upgrades. PACE programs are typically authorized through state government lawmaking and operated at the local level. The direct administration of the programs can be a state-sponsored entity, a local municipality, or a public-private partnership.

These programs are funded by the state issuance of bonds. The interest rate of the PACE programs can vary, usually ranging anywhere from 4% to 9%, depending on issues such as the amount of savings and the cost to process the loan. The term of the loan can also vary, lasting anywhere from 5 to 25 years, primarily depending on the scale of the project.

Consumers repay these loans through an increase in their property taxes. The PACE loan is treated as a super-priority lien on the property, and the property owner repays the loan through a PACE linked assessment on their property tax to the local governmental entity. Since the loan is tied to the property and not the borrower, the property owners can obtain a lower interest rate due to the lower risk of default. Also, again since these PACE loans are attached to the property and not the owner, if the property is sold prior to the term of the loan ending, the new owners of the property would take over repayment of the balance of the loan remaining.

5.6 On-Bill

On-Bill repayment or financing allows electric utility customers to repay the cost of loans for energy upgrades at their location. This is similar to PACE financing, but the program is organized and funded through the local utility, although not necessarily by the utility. Since utility bills maintain a very low failure to pay rate, lenders are able to maintain low-cost lending programs targeting groups not able to normally pay for larger capital equipment up front. This type of program is also available to renters under certain circumstances, assuming approval is obtained from the owner of the property.

There are two general types of On-Bill programs: On-Bill Financing and On-Bill Repayment.

On-Bill Financing. On-Bill Financing programs are organized by the utility, which pays the up-front cost for the energy capital equipment and then collects the cost of the system through an adder to the utility bill.

On-Bill Repayment. On-Bill Repayment programs operate in a similar manner to On-Bill Financing, but it is a third party that pays for the capital equipment, and then is repaid through the fee funneled through the utility payment system. These third-party program organizers can be local governmental entities, or a private group looking for a means to enhance the credit of potential borrowers through such a program that would inherently have low delinquency rates.

Both programs benefit from the existing billing relationship and thus streamlined repayment process.

6.0 Financing the Project

Addressing social equity challenges with energy storage assets can make the financing of these social equity-oriented projects easier. This can come about by elevating the capability of the combined system to deliver the perceived value of the system's capability, incorporating both financial and non-financial targets. Leveraging the value of the non-financial targets of the project enabled by energy storage will be the key to successful project financing.

The ability of energy storage systems to improve social equity-oriented projects is rising as the technical, economic, and regulatory aspects of utilizing energy storage systems improve. Energy storage project development has been more complicated than other types of electric power project development. There are multiple technology types with a variety of physical scale, deployment requirements, and operating capabilities. Costs of these technologies have declined for a number of years, improving the outlook for their use, but external supply chain pressure has reversed that trend recently and highlighted the complex nature of construction and commissioning. Finally, the regulatory environment is still evolving, producing a changing landscape of market rules that vary by application and regional difference for the "same" service. Since project financing follows the complexity of the technology and market, it can be understood that financing projects with energy storage assets remains a challenge, but one which is improving dramatically with increasing support. Energy storage assets provide added flexibility and functionality to projects, and as experience is proving out this capability, their value is increasing markedly.

Financing social equity-oriented projects will continue to face challenges when electricity services are only valued against the cost of service from wholesale power markets. However, disadvantaged communities typically experience poorer power quality because the economic density of service is difficult for utilities to provide the increased investment required based solely on economic reasons. For this reason, governmental incentives have existed specifically to provide these communities with a level of service provided to other areas. Within this framework, it can be seen that utilizing energy storage is actually an extremely cost-effective decision in order to lower the customer's cost of services. Energy storage systems are multifunctional and are designed to leverage the capabilities of other assets on the power grid. Therefore, energy storage assets are a smart choice for enabling the improved level of service targeted for disadvantaged communities targeted by local, state, and federal governments.

Financing any energy project is dependent upon the perceived risk of the investment. Too high of a risk, and there is no investment. Elevated risks may engender some investment, but possibly smaller than desired by the developer and at a higher interest rate. Therefore, successful project financing is based on reducing the project risk, including design, construction, and operation. Therefore, ensuring that the project has a viable corporate structure to efficiently manage all of the commercial and financial agreements is crucial. The project's financial model will then allow for a clear understanding of the project's financial position. Capital providers will also be keen to review the risk management strategies used to reduce the exposure of the facility in the event of a failure. Through all of this effort, the financial benefits of the project can be ascertained. Combined with the non-financial benefits desired by private and public groups, the project can be positioned to obtain sufficient capital to successfully develop and operate the project.

6.1 Corporate Structure and Agreements

A project's capital structure is based on the corporate structure of the project, with responsibility of organizing the project residing with the project developer. Therefore, the ability to raise funds for a project is based on corporate formation and extent of business plan execution. The first step in developing an energy project is to create a project company to own and operate the assets. This is many times referred to as a special purpose vehicle (SPV) which is a legally independent entity through which contracts for the purchase, construction and operating the facility can be coordinated. This has a variety of benefits, protecting the assets of the host organization, and also providing investors and lenders a clear understanding of the creditworthiness for the project. To ensure clearly defined separation and independence, projects are many times structured as a limited liability corporation (LLC).

The group acting as the project developer is responsible for managing all aspects of the project; depending on the scale of the energy storage system, this can be an individual buying a residential battery system to a stand-alone wholesale market grid energy storage facility. The project developer will need to coordinate with a number of professional service providers in order to enact all of the different contracts. These will include legal service firms to organize all contracts and financial liabilities, technical service firms to develop and operate the project, and financial service firms to ensure repayment of any loans, and ensure the project is protected.

6.1.1 Legal Support

Securing a law firm experienced in energy project development is the first step in project development and project financing. Finding a firm for a social equity target energy project with an energy storage component will be somewhat trickier but finding one that is familiar with the local laws and private and public sector aspects of the electric power industry is critical.

Law firms provide support in structuring the corporate documents (articles of incorporation) needed to establish the project, define the type of firm, and then be filed with the appropriate state oversight agency. A number of related project documents are required such as the project description and business plan. This will be amended over time as additional firms to provide commercial contracts for project development services are identified and established.

Law firms provide support for a variety of project development contracts needed to ensure successful completion of the project. Depending on where the project is developed, the project developer will need to have some aspect of these issues completed, with the law firm being responsible to the developer to ensure that there is no regulatory exposure to the project. Some of these issues will include real estate or control of the site for use in the project, land use and environmental permitting, and tax matters, covering local, state, and federal issues, and assisting in the negotiations for any incentives and/or abatements. Through evaluating all of these project documents, and the commercial and financial agreements (following sections) law firms ensure that the project is not exposed beyond its capabilities to liability from other parties.

6.1.2 Commercial Agreements

The project will require a series of commercial agreements needed to ensure safe design, construction, and operation of the facility.

Depending on the scale of the project, these functions may or may not be provided by separate firms, as when projects are smaller, some firms take on responsibility for a number of steps. A critical early step for the project developer is to identify these possible support firms to supply the functions needed.

Engineering: Engineering firms help design what type, size, and how the energy storage facility will be used and integrated into the local power grid. For behind the meter systems, this will entail understanding the current customer's energy tariff and demand and how the energy storage system will affect the cost of service. For front of the meter systems, this will entail understanding current market dynamics, and how the system will interact with the power grid, including any necessary interconnection studies.

Environmental: Adhering to corresponding local and state environmental regulations is a requirement that project developers must take seriously. The degree of focus on this aspect will be dependent upon the technology choice of the energy storage system. For example, lithium-ion systems will need to have contingencies in the event of a fire, whereas flow-batteries may have a possible spill of the system's electrolyte as the main concern. Depending on the scale and location, the facility may or may not require a full environmental impact study be completed.

EPC: Engineering, procurement, and construction contracts ensure the safe installation of the facility, and preparation for the unit to be commissioned and ready for operation. Critical in this portion will be adherence to all applicable electrical codes and standards and coordination with the requisite authorities having jurisdiction (AHJs) who enforce these electrical and fire protection regulations. End-of-life decommissioning responsibility is increasingly becoming a component of EPC contracts.

Insurance. Insurance firms provide risk mitigation for the project, including general liability, workers' compensation, and builder's risk insurance. Equity investors and lenders rely on sound insurance agreements to protect the project and their investment from accidents and damage.

O&M: Ensuring safe and reliable operations of the equipment over the life of the facility is essential to ensure repayment of loans. In addition, many opportunities for energy storage assets to provide added value lie with the system's ability to react quickly during turbulent conditions. Finally, maintaining the facility in good working order is typically a requirement of any loan or insurance coverage.

Permitting: The project developer must ensure that they have long-term control of the chosen site, and that it is both suitable for the chosen use, and there are allowances from the AHJs for operation at that location. Safety concerns during operation and procedures for first responders to safely interact with the facility are typically some of the primary concerns.

System Integrator: System integrators are responsible for combining all of the different components of the energy storage system and providing it to the project developer for deployment. A typical component list will include the batteries, cooling system, containerization, power conversion, and communication systems.

A critical aspect of this will be the integration of all of the warranties from the various component manufacturers into one combined warranty so the project developer and any associated service provider will have a clear understanding of what type of environmental conditions and operational regimes are covered, and which ones could damage the unit and not be addressed by the original equipment manufacturer (OEM) in the event of damage to the unit. Warranty management can be covered by different providers, typically either the equipment provider, or the EPC firm.

6.1.3 Financing Agreements

The project will require a series of financial agreements needed to structure all of the capital requirements and cash flows for the safe design, construction, and operation of the facility. A list of important financial agreements include:

Commercial Bank. If third-party financial transactions are required, then a commercial bank will be required for cash management of the project. For larger projects, larger expenses at a later time can be accounted for in a sinking fund, which accumulates the required capital slowly over the life of the facility.

Equity Investor. Project developers typically need outside investors to provide early-stage capital for project development expenses and cover the residual need for funding not covered by debt financing.

Lender. Debt providers, or lenders, provide larger and longer-term capital for the project. The arrangement for the funding is described in the credit agreement, which documents the terms of the loan agreement.

Offtake. The offtake agreement will describe revenue generation or cost savings contracts for the use of the energy storage asset, depending on whether the unit is acting in front of the meter or behind the meter applications.

6.2 Financial Model

If outside capital is required, the project must develop a financial model to encapsulate the revenue generation or cost savings impacts of the commercial and financial contracts. The project financial model provides an integrated economic evaluation of the proposed energy storage project covering all the years of operation and is structured to consider the forecast of all of the expected cash flows, expenses, and financial accounting such as taxes, depreciation, and other fees. Once agreed on, it will serve as the basis for structuring the project's financing agreement. The modeling framework of a project economic model is generally straightforward, even for energy storage projects with complicated operation usage profiles. The complication in the modeling arises from how closely the framework will track the actual economic operation of the facility.

The project's financial model is developed by the project developers to ascertain the financial viability of a proposed project. Developers use them to evaluate the sensitivity of a proposed project as it relates to a variety of assumptions and possible market conditions, while equity and debt providers use them to evaluate the soundness of a project's ability to provide the required return, and the project developer's assumption and approach. Through evaluating the sensitivity of the model to the potential range of input conditions, the equity and debt providers can gain a better understanding of the risk-adjusted return for the project.

6.3 Risk Management

Investors and capital providers will be concerned not just with understanding the use of funds—as described in the financial model—but also in the current level of risk exposure of the project to a loss of invested capital. Reviewing the commercial and financial contracts will assist in determining possible avenues of risk. Therefore, these capital providers will want to review product warranty and insurance coverage to ensure protection in the event of a damage to the facility.

6.3.1 Warranties

Warranty coverage ensures asset owners that there is recourse from the OEM in the event that the product does not perform as stated. Warranty coverage is very important to customers, project developers, insurance firms, and capital providers to reduce downside risk of the equipment not being available to support revenue generation. The warranty period can vary depending upon the market and/or usage profile under which the battery is intended to operate; residential and commercial units are typically focused on 10-year lifespans, while utility and front of the meter systems are focused on 20-year project lifespans. Some aspects related to warranty coverage, however, are not expected to ever be covered freely by the OEM, however. For instance, warranties cover the cost of the equipment, and not the labor to replace the unit, or shipping it back for repair or replacement. This is an important issue with price-conscious customers—such as residential—who are primarily concerned with up front capital costs and not total life operating expenses. Warranty coverage is typically focused on three areas: manufacturing defect, performance, and availability.

The limited warranty covering manufacturing defect guarantees the energy storage system to be free from defects in material and workmanship and provides relief in the event only that there were defects in the manufacturing of the product with the vendor required to repair or replace the defective components. This warranty does not extend to any design issues of the product and does not reimburse for economic loss resulting from downtime. These warranties are included in the purchase price of the unit and can have a lifespan of between 15-20 years. These warranties have grown in duration as experience proves out the products.

Performance warranty coverage ensures that the system will perform according to the specification details provided at purchase. These are typically not a simple blanket coverage (x number of cycles, etc.) but provide conditional coverage depending on the usage (cycle life, depth of discharge, C-rate, etc.) and operating conditions (temperature, elevation, etc.). The cost of these warranties is dependent upon the energy storage technology. Most lithium NMC manufacturers provide the first 1-3 years of coverage with the purchase price, and then allow an annual subscription for the remainder of the project life. Many non-lithium energy storage technologies follow this strategy. Conversely, many lithium LFP manufacturers include the full lifespan coverage in the purchase price. Current offerings are typically up to 10–20-year range (depending on the market and operating conditions) but have specific attribute limitations. As with manufacturing warranties, the length of coverage for performance warranties has also expanded as the experience level grows.

The most recent area for warranty coverage development deals with the availability of the unit. Whereas manufacturing warranties are targeted at ensuring the unit can operate, and performance warranties are targeted at ensuring the unit can operate over the intended life of the unit, availability warranty coverage is designed to ensure that the unit is available to operate when the unit can operate. This area is of growing importance for systems targeted at providing capacity services into the market. The coverage is usually linked to the number of operations per month or year required, and has a lifespan typically linked to the same as the performance warranty lifespan.

6.3.2 Insurance

Insurance is an important consideration for capital providers of any power system project and is a standard component of a project development effort. Typical standard insurance coverage for energy storage systems includes property, liability, business interruption, etc. These costs run typical to other property costs but remain higher than for other technologies. Insurance policies are important for energy storage projects where factors such as design, operation, and market strategy could put the project at risk. Insurance can be seen as an arrangement where companies with a strong balance will cover certain risk factors for a project for a fee. Firms that provide this coverage reduce their own risk through detailed understanding of the technology, its operation, and interaction in the power market.

As more operational experience is gained, insurance firms will be able to provide better and more innovative risk management market strategies for energy storage systems at all levels of the industry. As the industry matures through a growing body of project development and operational history, the cost of insurance should continue to decline as additional performance data and loss experience help refine the loss potential evaluation of these firms. Lacking sufficient data in emerging industries like energy storage, insurance firms have long been a driver to promote better testing and standards development (in both equipment, installation, and operation) to reduce insured loss through performance degradation or failure. Better information provides these firms the ability to determine the actual risk premium cost for a variety of project development choices. As the industry gains more experience, re-insurers (insurance for insurance firms) will get involved, reducing further the cost for insurance coverage.

6.4 Obtaining Capital

All of the forementioned steps, developing a corporate structure with accompanying commercial and financial agreements, a flexible financial model providing deep insight, and risk mitigation strategies to ensure coverage in the event if damage are all requisites for successfully raising capital for any type of energy project. However, due to the obvious complexity, they are all not pre-requisites before beginning dialogue with the different groups. Some components such as grants, and some private equity sources can be done with proven progress. They do, however, need to be completed prior to close on project debt. Scale and stability of the revenue offtake agreement (or costs saving strategy) will of course be essential.

Developing a project targeting social equity goals will require that the project developer ensure that the local community that will benefit from the project is tightly aligned with the developer in partnership, assuming the community organization itself is not the project developer. This alignment of support will ensure access to whatever financial and non-financial benefits are known by all potential sources of capital from the beginning.

Typically, the cost of capital is proportional to the perceived riskiness of the investment: the higher the investment risk, the higher the cost of capital. Unfortunately, the availability of capital is typically in descending order of cost. Highest cost capital—self funding—is typically the first target for development funding. Subsequently, equity and debt funding follow in that order.

Another important caveat is that there is no one cost for each type of project capital. Different private equity and debt providers have different views on the riskiness of the project and have their own internal cost of capital. Therefore, different providers will offer their capital at different rates. As important to their offered cost of capital are any contractual requirements each group may impose on the project in return for funding. These can come in a variety of forms, from financial reserve requirements to operational limits to ensure additional longevity of the batteries. Unfortunately, these contractual requirements may interfere with the originally proposed usage profile of the facility.

Therefore, obtaining capital from a source may sometimes preclude the developer from addressing all of the applications originally envisioned.

Social equity-oriented energy projects therefore need to highlight both the financial and non-financial benefits of their blended goalsetting approach in order to obtain the capital needed. Financially based benefits such as energy independence (localized PV power generation) and improved power quality (reliability and resilience) will always be the essential component justifying capital investment for a project. However, these may not be enough to extend the project's scope to the extent that social equity goals (lower emissions, job training, etc.) would be incorporated. Therefore, in order to attract sufficient capital at a low enough cost to achieve all of these goals, non-financial benefits must be included. These may even act in a virtuous circle benefitting the project, as local and state governments who benefit from such projects have the ability to lower the cost and time required by supporting permitting and other project requirements. Targeting these non-financial project benefits can even have direct financial support through opening the project to targeted grants and ESG focused investors—resources a non-social equity project would not be able to approach.

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7.0 State Level Programs & Support

State governments are a growing area of support for energy storage projects, as social equity goals are a growing area of policy focus many existing and new energy storage support programs are being used to support these goals.

Resources for groups wanting to incorporate energy storage into projects with a social equity component exist, but can quickly absorb significant time and effort, and not necessarily leave them with all of the programs where they qualify. Luckily, leading state energy research groups already provide assistance for disadvantaged groups in their states. These programs can be taken advantage of by those in those particular states, and act as examples for other state organizations looking to craft their own programs. Green banks are another growing area of state organized support, providing structures for private financing groups to become more involved with the growing investment into projects with a social equity component.

7.1 State Programs

State governments have a major role in supporting energy storage systems of all scales, but especially those from residential, commercial, microgrids, and renewable, distribution utility uses. Through these existing energy storage deployment programs, state governments are able to target benefits for specific programs to benefit disadvantaged communities. Two states in particular—California and New York—have an advanced energy storage support program and are good examples of what can be done elsewhere.

7.1.1 California

California is a leading proponent of energy storage technology development and deployment. A key program in this effort is the California Public Utility Commission's Self-Generation Incentive Program (SGIP). The SGIP program was started in 2001, offering State residents rebates for installing energy storage technology at both households and non-residential facilities. Beginning in 2020, an additional $675 million was approved through 2024. With this reauthorization, the majority of the funds are allocated to the Equity Resilience Budget. This program targets low-income customers, those living in high fire risk areas, residents that have experienced power shutoffs, or critical facilities that service disadvantaged communities. Besides targeting those areas, the rebates for residents in these areas can be four to five times higher than residential rebates in other parts of the State.

7.1.2 New York

New York is another state leading efforts into utilizing energy storage to benefit residents in disadvantaged communities. The effort is to support a transition to a clean energy grid, improve grid resilience, and support more use of solar energy.

In 2019, the State passed the Climate Leadership and Community Protection Act, codifying energy and climate goals, including improving the overall efficiency of the system by stimulating third-party investment, and removing impediments to accessing financing by disadvantaged residents, and regulatory changes to utility customer rates that will reflect the environmental benefits and resilience energy storage brings to the grid.

7.2 Green Banks

Green banks are state-sponsored institutions that leverage innovative financing to provide opportunities for their citizens to take advantage of clean energy options and address climate change, with a special emphasis on supporting disadvantaged communities. In addition to addressing climate change, they many times have additional objectives such as servicing disadvantaged communities. Since these groups are organized as non-profit, state-sponsored entities, they are able to obtain and provide capital at a lower cost than typical for-profit financial institutions.

Table 1. U.S. Green Banks

Green Banks
Connecticut Green Bank
NY Green Bank
CA Lending for Energy & Environmental Needs
Rhode Island Infrastructure Bank
Montgomery County Green Bank
Hawaii Green Energy Market Securitization

Green banks utilize a number of programs when offering programs to the residents of their state, including:

Co-investment: Co-investment occurs when the green bank invests directly in projects alongside private investors.

Securitization: Securitization occurs when a green bank merges a pool of investment from a number of different projects or programs into a marketable security, which it then sells to private investors. This allows more private investors to support clean energy projects at a level where they are comfortable, and it frees up capital for the green bank to engage in additional project loans and programs.

Credit Enhancement: Credit enhancement is a method to improve the credit risk profile of a business or project loan in order to obtain lower cost capital and better terms of repayment of a loan. Customers with better credit risk profiles have a lower incidence of default, reducing the risk to investors and thus the interest rate they require for a particular customer. Green banks can provide additional loan loss reserves, over-collateralization, or subordinated debt in order to lower creditor exposure to customer default risk to improve the risk profile of the creditor to private lenders. Through improving the risk profile of customers, more capital from private investors could then become available.

Loan Guarantees: Loan guarantees are an efficient way for a well-capitalized institution to extend its mission to a wider group of loan recipients. A loan guarantee is a legally binding agreement where the guarantor agrees to pay for some or even all of the loan remaining in the event of non-payment by the borrower.

Social Impact Bonds: Social impact bonds are developed through public-private partnerships to fund social service programs using performance-based contracts. Investors wanting to incentivize a specific level of results from social programs can engage with governmental agencies to fund programs with a specific public outcome.

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8.0 Lessons Learned

In order to understand how energy storage systems can add benefits to projects focused on social equity challenges, previously successful projects can provide insights into how they were successfully undertaken. These projects allowed the communities to improve resilience and enhance the use of local renewable energy, all while lowering the cost of service. They are instructive in understanding how to get started to pay for deploying energy storage systems. Critically, we see through these projects that values need to be attributable to local service providers, local communities, and investors. If that is accomplished, then the project has an increased chance for better financing terms.

The three following projects can provide lessons learned for others looking to incorporate energy storage deployments into projects hoping to advance social equity goals.

8.1 Cordova, Alaska

Cordova is a small, isolated town in Alaska that integrated a battery energy storage system [12, 13, 14] with an existing microgrid. The purpose was to capture lost hydropower generation and reduce reliance on diesel generation. The microgrid consists of the 6 MW Power Creek run of river hydro power facility, the 1.25 MW Humpback Creek run of the river hydro power facility, and two 1-MW diesel generators at the Orca Diesel Generating facility. The majority of the power for the microgrid is supplied by the hydropower, with diesel being used in the winter when the rivers freeze, and during summer to support peak loads. Hydropower can make up to three quarters of all of the energy supplied, which is important as hydropower will cost $0.06/kWh, diesel generation can cost ten times as much at $0.60/kWh.

Microgrids suffer instability problems because of typical variations in customer load. In this microgrid when only hydropower is being produced, the grid stability is managed by adjusting the input of water into the turbines to vary the output of the generation. In addition, about 500 kW of potential generation are also diverted to provide capacity for sudden increases in power generation need, and this reserved capacity is critical for maintaining stability of the power grid. An important point to remember is that in a run of the river operation, diverted water is simply lost potential, not like typical hydro power generation where it can be stored until needed. When the customer’s demands continue to increase and the reserves fall below 500 kW, a diesel unit is started. However, the 1-MW diesel gensets have a minimum output of 40% and must be maintained for a while to reduce cycling aging on from quick on and off usage. An important point to recognize is that when the diesel gensets are started, more water is diverted to balance to load.

The results of deployment of the energy storage facility have been positive, leading to planning on extending the strategy used. The reduction in diesel fuel used and lower maintenance on diesel gensets amounts to $150,000 per year, important for small communities. The flexible nature of the asset supports the community becoming more resilient, less reliant on imported diesel fuel and more reliant on local, renewable power supply. The reduction in diesel usage has also improved the local air quality. Finally, the deployment of this first battery system provides key insights as the community looks to add pumped hydro capacity and become even more reliant on hydropower, potentially removing the need for diesel.

8.2 Bad River Band of Lake Superior Chippewa, Wisconsin

The Bad River Band of Lake Superior Tribe of Chippewa Indians is located on the shore of Lake Superior in Northern Wisconsin. During July of 2016, severe flooding caused extensive power disruption and outages at critical facilities such as the Health & Wellness Center, Administration Building, and the Wastewater Treatment Plant. During rebuilding, the Tribe decided to take advantage of the unfortunate opportunity and make progress towards the Tribal sovereignty goals and enhance the resiliency of the electricity supply.

Core to rebuilding the power grid is the $2 million Ishkonige Nawadide Solar Microgrid Project [15, 16]. This project is composed of a 500-kW solar field and a 500kW /1000 kWh battery system. There were a number of key reasons the Tribe decided to build this hybrid power facility. First was to enhance the energy resilience of the community over previous levels of service, providing greater levels of self-reliance. Secondly, the solar generation provided lower emissions from the power generation used to provide the Tribe's electrical services. Finally, there was an economic benefit to the Tribe through generating their own power and providing a means through the energy storage assets to enjoy better and more reliable service in the event of another disruption from extreme weather events.

The Tribe went into this endeavor knowing that that there were not a lot of examples of utilizing energy storage to enhance the value and resilience of local solar energy, and thus went into the project with a degree of understanding that the project would serve as an example to others. It would also provide key lessons learned for those hoping to achieve similar goals. Some of these were expected, such as gathering the knowledge of designing, deploying, and paying for the equipment. Others were less expected but still vital. One in particular was the importance of the education on codes and standards needed to ensure the safe and reliable operation of the facility. As other groups design and deploy their own projects, a similar mindset will be important. A number of critical points are apparent as part of a typical power project, but a great deal of critical points is not as apparent due to the emerging nature of energy storage deployment, but require attention, nonetheless.

8.3 Oakland Battery Energy Storage Facility, CA

The Oakland Clean Energy Initiative (OCEI) [17, 18, 19, 20] provides an innovative approach to solving grid reliability challenges as well as improving social equity values that can be copied by others. The OCEI was developed by Pacific Gas & Electric (PG&E) and East Bay Community Energy (EBCE) to develop a non-wires solution to meet Oakland's transmission reliability needs without relying on the existing local fossil-fired generation. EBCE is a community choice aggregator (CCA) that started in 2018 to purchase power for Alameda County. The mandate is to buy clean power for the community while keeping prices affordable for residents.

The existing 165 MW West Oakland power facility was a jet-fueled peaker unit, originally built in 1978. The facility was at an important location on the grid, receiving "reliability must run" payments to ensure its readiness in the event of grid instabilities. Unfortunately, the plant's age relegated its actual use to only a few hours in 2018, the last year of operation. However, the plant had long been blamed for increasing local air pollution and higher local asthma rates over its operating lifespan. In fact, Oakland has been identified by the California Environmental Protection Agency as having one of the worst pollution profiles in the San Francisco Bay Area, so every opportunity has been followed up to remove local sources of pollution.

The OCEI was announced in December of 2017 to address these environmental and other local challenges. The decision was to install a 20 MW, 80 MWh battery facility. This follows California State targets of grid decarbonization, while maintaining or improving reliability of the grid with non-wires solutions. This solution provides improvements that were important to local community and government leaders, labor groups, and environments such as local air quality improvement, local jobs production, and enhancing the reliability of the local power grid.

Specifically, the battery facility will provide resource adequacy (RA) on behalf of EBCE for enhanced grid reliability in times of stress. The facility can also allow the OECI to participate in the California wholesale power market on a daily basis providing other products and services. The facility can also serve as transmission obligation for PG&E, allowing it to postpone the development of a new transmission line to get power into Oakland during times of peak demand when transmission assets are fully used.

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APPENDIX A. APPLICATIONS

Energy storage systems are able to provide a wide range of services across the power grid. There are a wide variety of different usage profiles that energy storage facilities can perform, sometimes single applications (less common), sometimes performing a variety of applications (at different times), resulting in increased flexibility. As the technology continues to improve, and as market participants learn how to utilize these systems in the market, additional applications continue to be explored.

These applications may or may not have a widely accepted or clear way to generate value or revenue, however. Also, although the industry typically divides applications into different market segments, the evolving nature of how energy storage assets in different parts of the power grid interact with the market continues to blur, such as the growth in BTM assets becoming active in ISO markets for wholesale services. The following is a description of how energy storage systems can operate.

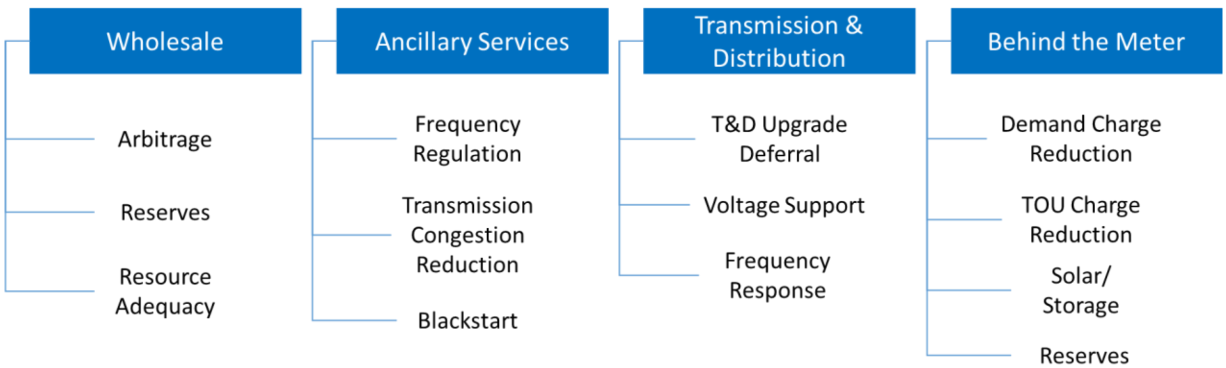

Figure A-1. Energy Storage Applications

Source: Mustang Prairie Energy

A.1 Arbitrage

Arbitrage is the act of absorbing low-cost, off-peak power and selling it during peak demand periods when its value is highest. This application is typically provided as a product in an organized market. Arbitrage would compete against generation resource. Because of this, arbitrage for energy storage systems is considered a low value product, lending itself to facilities with the ability to cycle large volumes of electricity through the project.

Reserves: Reserves are energy resources from facilities that are online and operational but not at full load, leaving some capacity for them to ramp quickly and provide the grid additional power very quickly. Reserve resources are the first tier of resiliency for regional power grids and are required to operate the grid effectively. There are different types of reserve resources, generally divided by the speed of response. Spinning reserves are able to react immediately and have typically been sized to support the largest single generator or resource on the grid and replace it in the event of a fault. Non-spinning reserves are generally fast reacting resources that are able to react at a slightly longer timeline. There are also categories for longer term replacement reserves that are envisioned to be available for multiple hours. Depending on the resource mix and the reliability of different generating resources, the total reserve capacity will vary but can represent 15%-20% of the total generating supply capacity, with spinning and non-spinning representing approximately 10% each. Each of these values will vary depending on the ISO/RTOs requirements.

A.2 Resource Adequacy

Resource adequacy (RA) is similar to reserves but provided by behind the meter (BTM) resources. In the California ISO (CAISO) area, utilities or other load serving entities (LSEs) are required to have available (own or contract for) sufficient resources to meet their share of the CAISO system's peak demand, plus a Planning Reserve Margin (PRM), currently 15% of demand. Owners of BTM assets are able to bid these resources into an auction to provide these resources in the event of a resource need. The RA auction is designed to provide appropriate incentives to private developers for the siting and construction of new reliability resources for the power grid. Many resources are able to provide RA resources, with energy storage finding it one of the more important markets for deployment in the CAISO system.

A.3 Frequency Regulation

Frequency regulation (a.k.a. regulation) acts to stabilize the power grid by managing the moment-to-moment changes in the demand or supply balance of the power grid. The frequency of the AC power in North America is 60 Hz and is primarily maintained by the system inertia from the rotating mass of power generators. As load changes, excess generation causes a frequency increase above 60 Hz; insufficient generation causes a decline. Small shifts in frequency (load) do not degrade reliability, but large ones can damage equipment, degrade system efficiency, or even lead to a system collapse. These changes are first counteracted by the rotational inertia inherent in the connected synchronous generators. As the variation continues, regulation can also be provided through generating units operating under automatic generator control or participating in manual frequency control, both of which can change output quickly (on the order of MWs/min).

A.4 Transmission Congestion Reduction

Transmission line congestion occurs when energy cannot be delivered across one or more transmission lines to the intended loads because the transmission capacity is not sufficient to deliver the requested energy. This condition can present a number of challenges to the power grid: the potential for physical damage from overburdened powerlines and increased wholesale electric costs (typically in the form of higher locational marginal pricing).

A.5 Blackstart

Blackstart services are used as the starting point for the grid's restoration after a blackout. After a blackout occurs, most power generating facilities self-isolate and begin a shutdown process as there is nowhere for the power output to go. Blackstart units are able to self-start and stabilize independent of the power grid. These power facilities with self-starting capabilities are needed after a power grid shutdown since most generation facilities require system power from an outside source to begin operation (provide auxiliary plant-load and cranking power for the generator) and export power. In addition to self-starting, these units have the capability to maintain frequency and voltage under varying load while the system is restored since most of the system inertia (rotating mass of the major power generators) will not be available.

A.6 Voltage Support

Utilities manage the carrying capacity of the transmission and distribution system through maintaining the voltage level within a preset range; this effort also protects utility and customer equipment from damage. Traditionally, conventional generation provides the majority of the voltage support to the electric systems, with some specialized power electronic equipment also providing some voltage injection or absorption to maintain voltage levels within the desired range.

A.7 T&D Upgrade Deferral

Transmission and distribution (T&D) lines are upgraded over time as needed to support the increasing load from customers. Deferring the upgrade by a few years will enable the utility to delay a large capital expense and maintain a higher utilization rate for its transmission and distribution assets. Utilities upgrade individual power lines on the distribution system based on the experienced and planned load growth. Typically, load growth is in the 1%-3% annual growth range, but sometimes can be as high a 5% annually if significant new customer growth is experienced. With the increasing load, a bottleneck on the line will eventually emerge where the carrying capacity of a portion of the line, typically after leaving the substation, becomes insufficient to transmit all of the power demanded along the entire powerline. As the peak demand begins to near the carrying capacity of the powerline, the utility will commence an upgrade of the line, generally higher voltage transformers and related equipment but could include restringing of the line if needed.

A.8 Frequency Response

Frequency response is very similar to frequency regulation, except it reacts to system changes in even shorter time periods of seconds to less than a minute. The frequency of the AC power in North America is 60 Hz and is primarily maintained by the system inertia from the rotating mass of power generators. As load changes, excess generation causes a frequency increase above 60 Hz; insufficient generation causes a decline. Small shifts in frequency (load) do not degrade reliability, but large ones can damage equipment, degrade system efficiency, or even lead to a system collapse.

A.9 Demand Charge Reduction

Utilities typically apply a demand charge to customers in addition to the cost of the commodity energy. The rationale is to provide feedback to the customers as to what is the most expensive portion of the service period for the utility, and hence, provide incentives to customers to reduce their demand, and thus the most expensive portion of the cost of service for the utility. More prevalent historically in larger customers, this is becoming more widespread with all customer classes as time of Use (TOU) rates are introduced. The demand charge is based on the utility measurement of the highest demand during any 15-minute period in a billing period. These charges are billed to the customer in $/kW. Originally a relatively small portion of the bill, the demand charge has grown to be significant, even sometimes half of the total dollar value of the bill.

A.10 Time of Use Charge Reduction

Similar in nature to the Demand Charge Reduction, the Time of Use (TOU) Charge reduction is based on the provision of energy from an energy storage system situated behind the meter. Customers are increasingly being subjected to time of use rates for the commodity energy charge ($/kWh). Although the level difference between peak and non-peak rates is generally not significant, making the economics of pursuing this operational strategy by itself generally uneconomical, the direction is for continued divergence. Thus, customers that are utilizing energy storage to reduce their demand charge reduction could also then benefit from shifting their import of power (through the meter) from a higher cost period to a lower cost one.

A.11 Solar Storage

Energy storage is fast becoming a standard component of BTM residential and commercial solar deployment. The energy storage system provides the owner a variety of capabilities, the relative value of each depends on the type of deployment envisioned. For instance, residential users on time-of-use rates in areas with high electricity rates may see as their primary value shifting some of the on-site generated power to an evening peak to reduce the cost of their utility bills, whereas residential uses in remote areas may see the primary value in powering the house through semi-frequent power disruptions or even allowing the house to go off grid when desired.

A.12 Reserve Power

Energy storage systems have a key role to play in ensuring reliable, high-quality power for BTM sensitive or mission critical loads and maintaining operation and/or bridge to backup generators in the event of a service disruption. Historically the realm of uninterruptible power supply market, the growing use of distributed resources allows for additional opportunities for these assets. The core operation of these assets it to provide power during an outage either to bridge to longer duration backup generator, or to allow for an orderly shutdown of operations. Because of this wide range of uses, the amount of energy required onsite will vary greatly due to the intended usage profile. A BTM battery storage can provide back-up power at various scales, ranging from sub-second-level power supply for important industrial operations, to 24-hour back-up by pairing with an on-site solar PV system.

APPENDIX B. POLICY RESOURCE

B.1 Policy Resources

An important early step in developing financial support for project developers is knowing what current state policies are out there, and what might be applicable to their needs. A number of resources exist, including the following providers.

B.2 Global Energy Storage Database

Sandia National Laboratories maintains the Global Energy Storage Database[21] which lists both energy storage projects and policies that play an important role in guiding and supporting the growth in the use of energy storage. According to Sandia National Laboratories, state profiles are available within the Global Energy Storage Database providing summaries of energy storage policies, legislation and regulatory rules; data regarding energy storage project deployments; and “Issue Briefs” (short, analytical papers on significant policy topics).

B.3 PNNL Energy Storage Policy Database

The Pacific Northwest National Laboratories maintains an online database[22] of state level energy storage policies, including:

- Procurement Targets
- Regulatory Requirements
- Demonstration Programs
- Financial Incentives
- Consumer Protection

B.4 DSIRE

The North Carolina Clean Energy Technology Center at North Carolina State University developed the Database of State Incentives for Renewables & Efficiency® (DSIRE)[23]. According to the group, DSIRE is the most comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States and was established in 1995. It is widely regarded as one of the most thorough repositories of information on incentive programs and incorporates information about energy storage programs as well.

B.5 Clean Energy States Alliance

The Clean Energy States Alliance[24] is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. According to the group, CESA works with state leaders, federal agencies, industry representatives, and other stakeholders to develop clean energy programs and inclusive renewable energy markets.

CESA has a program focused on supporting low- and moderate-income households' access to clean energy options, with one focus as support of financing options for these communities. CESA's activities in this area date back to 2014, including programs, a monthly newsletter, a directory of state clean energy programs, and reports on lesson's learned to improve other state's adoption of these policies.

CESA also has a focus on supporting energy storage deployment and use at the state levels. The Energy Storage Technology Advancement Partnership (ESTAP) is designed to accelerate deployment of energy storage projects through technical assistance and co-funding partnerships with the U.S. Department of Energy. CESA also runs the Energy Storage Policy for States policy project where it looks to support states to develop and adapt policies in support of energy storage deployment and market development. Finally, CESA also supports the Resilient Power Project organized by the Clean Energy Group. This program is targeted at solar and storage deployments and maintains a database of resources for interested parties on its website.